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Purpose of the Series

The aim of this publication is to provide an opportunity for students to publish the findings of their undergraduate or postgraduate work. Guidance on publication will be given by staff who will act as second authors. It is hoped that by providing a guided transition into the production of papers that students will be encouraged throughout their future careers to publish further papers. Guest papers are welcomed in any field relating to the Built Environment. Please contact E.A.Laycock@shu.ac.uk. A template will be provided on request.

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RESEARCH INTO THE USE OF POZZOLANIC MATERIAL SUBSTITUTES IN MORTARS USED IN THE REFURBISHMENT OF PERIOD PROPERTIES

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Josh Androliakos studied Building Surveying at Sheffield Hallam University and graduated in 2017. This dissertation was supervised by Steve Hetherington.

In recent years an increasing trend is the use of cement based mortars in period properties where there is no statutory restriction on the choice of material. This is especially damaging to traditional stone, brick or timber dwellings, and due in part to a lack of knowledge on the part of the homeowner or specifier, or where basing decisions around cost alone. However, the construction industry has relied solely on lime based mortars where there is statutory restriction. The introduction and research into the assimilated properties of pozzolans and augmented mixes as alternatives to traditional mixes has added another dimension to the choice of binder and mortar specification. This limited comparative study is designed to explore and clarify the merits of these mortars in terms of their compressive strength, flexural strength, water absorption and porosity and establish whether these are alternative to the current binders specified in period properties, including those under statutory protection. The study was conducted using six different binder designations at a ratio of 1 part binder and 3 parts sand. The binder designations where selected to encompass a range of commonly used mortar types (i.e. Lime and Cement) and modern alternatives (i.e. pozzolans including brick dust and Ground Granulated Blast-furnace Slag). A constant mass of aggregate and binder was used and the portion of 'water to be added' calculated to give the desired ratios. This was done to enable greater control and consistency over the workability of each mix. Findings showed that pozzolanic additives were effective in modification of the lime mortars and improved compressive strengths.

Keywords: comparative study, hydraulic lime, non-hydraulic lime, Portland Cement, pozzolan, brick dust, GGBS, compressive strength, flexural strength, porosity, water absorption

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INTRODUCTION

The use of Lime mortars as the viable option for to Portland Cement has been the focus of previous debates over the past years with publications by researchers such as Hetherington (2014). This and other papers focus on the comparison of mortars bound with lime and those with Portland Cement with reference to properties such bond strength or their ability to breathe being discussed. Recent publications have suggested that advancements in materials allow the production of mortars which are 'lime' in name only which very similar to, or in some instances can be more detrimental than, a modern Portland Cement. Further study has also found that by blending or varying the number of components in the mix, it may be possible to create true lime mixes with similar or even improved properties. This method is known as gauging and has been successful in many projects such as The Smeaton Project carried out by English Heritage to identify suitable mortars to repair Hadrian's Wall (Teutonico, McCaid, Burns & Ashurst, 1993).

There is little knowledge around the use of pozzolans within the industry and how their use will affect the properties of mortar. As there are a large amount of different mortar types and modern processes refining the materials it is increasingly difficult to specify a single mortar that may be able to withstand any condition or environment while still being sympathetic to the individual masonry unit. This paper addresses whether pozzolanic mortars share characteristics with the traditional Limes or those of modern Portland Cement mortars. Compressive and Flexural strength were used to compare behaviour. The accepted wisdom is that-lime mortars are more flexible, weaker compressively, and breathable and are thus more sympathetic to the masonry units.

PRODUCTION OF POZZOLANS

Pozzolans are materials which enable the mortar to set more rapidly. Pozzolans are defined as siliceous or siliceous and aluminous material that has little to no cementitious values when stand alone. However when finely divided and in presence of a moisture source react chemically with the calcium hydroxide to form compounds that possess cementitious properties. Simple non-hydraulic mortars set by drying and carbonation, which is the conversion of calcium hydroxide to calcium carbonate through the reaction with carbon dioxide in the atmosphere. A hydraulic lime sets through a chemical reaction between calcium hydroxide and reactive silicates or aluminates, when in the presence of a moisture source. In hydraulic limes the mortar is supplied with silicates from the limestone or clay used. Where there silicate content is low in a mix, a pozzolan is added to aid the set (Gibbons, 1977). The addition of any pozzolanic material will modify the mortar characteristics with the belief that softer pozzolans allow for more flexible and permeable mortar. The research focussed on the addition of single pozzolans, these being Ground Granulated Blast furnace Slag (GGBS) and Red Brick Dust.

METHODOLOGY

Laboratory testing was undertaken to collect data and allow a comparison with similar studies found during the literature review, predominantly The Smeaton Project. Classification methods on including mortar workability, porosity, flexural and compression

strength were carried out. The methods used were in accordance with the British Standards. Sand was placed in a drying oven at a temperature between 105°C and 110ºC for 24 hours to remove any moisture before the batching for each binder/aggregate and additive was undertaken.

Binders:

- Slaked Lime Putty (non hydraulic)
- Singleton Burch Natural Hydraulic Lime 5
- Ordinary Portland Cement (OPC)
- Red Brick Dust
- Ground Granulated Blast Furnace Slag (GGBS)

To ensure all mixes were comparable the volumetric cylindrical cup (VCC) was used to portion the mixes. The determination of the volumetric weight of each constituent allowed calculation of the mass percentages of the substituting binders (Figure 1). The weights of each component were recorded when the VCC (Figure 2) was filled and levelled without additional compaction. This weighing procedure was repeated five times for each material and the average of each was then calculated and used as one volume-portion of the mix (Table 1).

Figure 1 Binders and aggregates as weighed

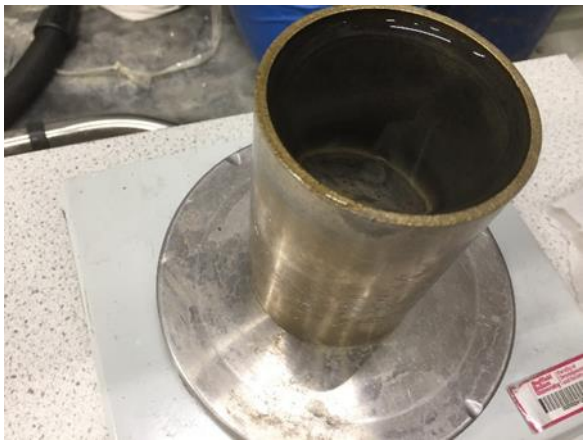

Figure 2 Volumetric weight of the water being established

Table 1 Volumetric Weights for Binders and Aggregates

Binder Type	***Weight 1 (g)***	***Weight 2 (g)***	***Weight 3 (g)***	***Weight 4 (g)***	***Weight 5 (g)***	***Average Weight (g)***
Lime Putty	655.96	659.90	667.50	621.74	634.94	648.01
NHL 5	465.35	456.33	439.54	441.10	426.20	445.70
OPC	604.27	584.51	583.90	589.22	566.30	585.64
GGBS	488.85	501.54	488.26	486.10	489.76	490.90
Brick Dust	484.02	479.63	493.58	464.46	492.12	482.76
Aggregate	718.64	730.46	718.20	723.42	736.91	725.53

Mixing and sample preparation

Mixing the samples required a clearly stated procedure to ensure a consistent mix throughout.-The volume proportions were batched with reference to the masses obtained from the VCC (Table 1). Each mix was placed on a spot board and mixed by hand using a trowel for approximately 20 to 30 minutes; the time varied slightly for each mix as mixing by hand meant that variables such as energy and type of binder affected the mixing time. Water was slowly added in order to build the mix up to the correct consistency which was then recorded using three methods. Prisms were made from each mix with each being filled in two increments with 25 tamps on each layer before levelling off and curing for 28 days.

Consistency (workability) testing

An initial assessment of workability was done by eye using three methods. The first was that the mortar adhered to an inverted trowel (Figure 3), the second that a trowel travelling through the mortar in a zigzag pattern left no crack marks in the track. The third was to use the drop ball test according to BS4551:2005 (Figure 4).

Figure 3 Lime Putty Mortar Mix

Figure 4 Drop Ball Test of Lime Putty Mix

Flexural Testing

Flexural testing was carried out using an Instron 5kN compression rig which was capable of applying the load without shock at a uniform rate in the range 10 N/s to 50 N/s so that failure occurs within a period of 30 s to 90 s (BS1015-11:1999). For these tests the prisms (width: 40mm; depth 40mm and length 160mm) were tested under an applied load of 30N/s

Figure 5 GGBS Sample 2 Flexural Testing in accordance to BS1015-11:1999

Figure 6 OPC and Lime Putty Sample 3 Flexural Testing in accordance to BS1015-11:1999

Compressive Testing

As with the flexural testing, BS1015-11:1999 requires the load to be applied without shock and increased continuously until failure occurs. The loading rates given in the guide (Appendix B) in this standard were used; however the use of pieces of prism from the tensile testing is a deviation from the standard method. The Instron 30kN compression rig linked to a laptop ensured that accuracy was within the tolerances stated in BS1015-11:1999. A steady load was applied to the samples at 30N/s until failure occurred. In the first test the initial fluctuations in machine noise caused the test to terminate prematurely. The test was originally configured to end when load dropped by 50% and during the chatter phase the load fluctuations trigged this, before contact with the sample was made. Subsequently the parameters were altered and a 10N start load was applied in which any +50% drop in the chatter/ noise fluctuations was ignored. Once a load of greater than 10N was applied the specimen tested was in accordance to the load rate and settings as originally specified.

Figure 7 Compressive testing on OPC and lime putty sample 1

Figure 8 OPC and lime putty sample 1 showing fracture after completion of compressive testing

Porosity testing

Following tensile and compressive testing the recovered pieces of specimen were used to establish porosity. For porosity testing BS3921:1985 was followed in which samples were immersed in water for a minimum of 24 hours under atmospheric pressure. Apparent porosity was determined by the top pan weighing method.

RESULTS

Workability Results

The results show a consistent workability within each of the individual mixes. British Standards 4551:2005 required the workability of the mortar to have a penetration of 10mm (+- 0.5mm) when tested during the drop ball test, the final results showed that from the six samples only the Lime Putty, GGBS and the Augmented Mix (OPC and Lime Putty) were within the threshold stated in the British Standards. The NHL5 sample fell within a threshold of -1mm, with the OPC and Brick Dust samples falling far short of the required threshold by deficit of - 2mm to 3mm. Thus, although the mix workability between the respective samples did not differ, the overall workability between the individual binders did vary considerably (Figure 9; Table 1).

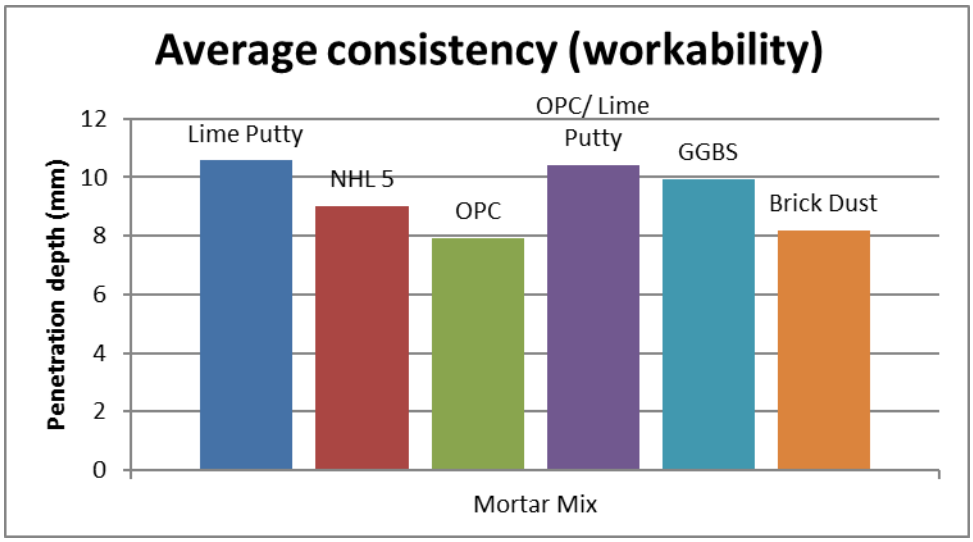

Figure 9 Average dropping ball penetration (consistency) for each binder

Table 2 Drop ball results for mortar mixes

Mortar Mix	***Drop Ball Test 1 (mm)***	***Drop Ball Test 2 (mm)***	***Drop Ball Test 3 (mm)***	***Average Drop Ball (mm)***	***Standard Deviation (mm)***
Lime Putty	10.90	10.50	10.30	10.57	0.25
NHL 5	8.70	8.90	9.50	9.03	0.34
OPC	8.30	7.90	7.60	7.93	0.29
OPC/ Lime Putty	10.80	10.40	10.00	10.40	0.33
GGBS	9.90	9.70	10.20	9.93	0.21
Brick Dust	8.00	8.50	8.00	8.17	0.24

Table 3 Maximum load under compression for mortar mixes.

Mortar Mix	***Maximum Load Sample 1 (N)***	***Maximum Load Sample 2 (N)***	***Maximum Load Sample 3 (N)***	***Maximum Load Average (N)***	***Standard Deviation (N)***
Lime Putty	959.97	848.47	873.85	894.10	47.71
NHL 5	2,244.08	2,847.44	3,001.86	2,757.13	309.82
OPC	27,964.45	22,067.91	27,225.51	25,752.62	339.37
OPC/ Lime Putty	15,803.08	20,698.56	17,853.31	18,118.32	386.52
GGBS	27,907.25	25,869.44	26,164.22	26,646.97	393.42
Brick Dust	1,456.88	1,522.02	1,456.06	1,478.32	239.65

Porosity Results

Lime binders were found to have the highest porosity; Lime putty (11.8%) NHL 5 at 14.6% while Portland Cement was the lowest (6.8%). Combining OPC and lime increased the porosity from the 6.8% (for OPC binder only) up to 11.17% this may allow better breathability. The other pozzolans performed in a similar fashion, such that the GGBS mortar had a porosity of 8.5% and the brick dust of 11.17%.

Table 4 Absorption Percentages for Porosity Testing in accordance with BS3921:1985

Mortar Mix	***Absorption (%) Sample 1***	***Absorption (%) Sample 2***	***Absorption (%) Sample 3***	***Average Absorption (%)***	***Standard Deviation (%)***
Lime Putty	9.74	14.58	10.94	11.75	2.00
NHL 5	14.26	16.33	13.33	14.64	1.25
OPC	4.84	8.01	7.51	6.79	1.39
OPC/ Lime Putty	13.16	8.64	11.72	11.17	1.88
GGBS	6.13	11.26	8.09	8.49	2.11
Brick Dust	13.16	8.64	11.72	11.17	1.88

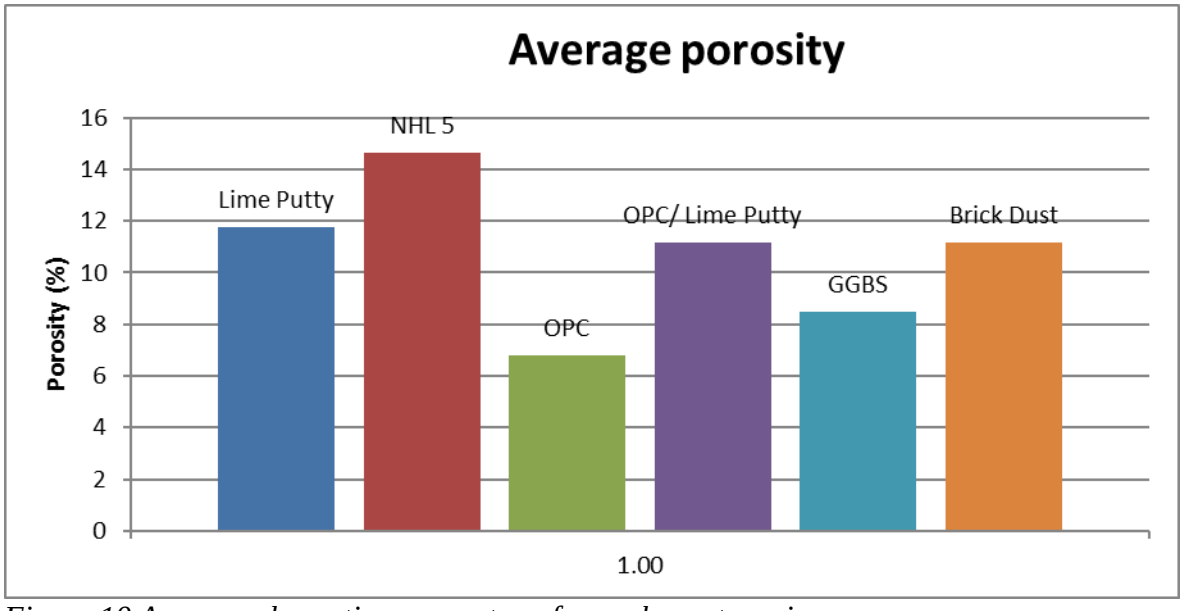

Figure 10 Average absorption percentage for each mortar mix

Flexural Results

Samples made with OPC achieved the highest loads before failure in the flexural testing and were able to accommodate a high level of extension prior to failure. Lime putty was flexible but failed at low strength. NHL 5 demonstrated both low extension and low strengths with the pozzolanic mixes exhibiting intermediate properties (Figure 11).

Table 5 Extension under load during flexural testing

Mortar Mix	*Extension Sample 1 (mm)*	*Extension Sample 2 (mm)*	*Extension Sample 3 (mm)*	*Average Extension (mm)*	*Standard Deviation (mm)*
Lime Putty	0.23	0.22	0.40	0.28	0.08
NHL 5	0.12	0.14	0.11	0.12	0.01
OPC	0.30	0.26	0.31	0.29	0.02
OPC/ Lime Putty	0.21	0.17	0.22	0.20	0.02
GGBS	0.43	0.00	0.20	0.22	0.17
Brick Dust	0.09	0.14	0.13	0.12	0.02

Table 6 Maximum load under extension for flexural testing

Mortar Mix	*Extension Load Sample 1 (N)*	*Extension Load Sample 2 (N)*	*Extension Load Sample 3 (N)*	*Extension Load Average (N)*	*Standard Deviation (N)*
Lime Putty	293.47	177.02	272.40	299.63	50.66
NHL 5	287.17	290.49	246.75	274.80	19.88
OPC	1,897.04	1,506.67	1,599.37	1,667.69	353.53
OPC/ Lime Putty	948.33	890.12	971.36	936.60	34.18
GGBS	1,203.58	0.00	892.73	698.77	366.53
Brick Dust	174.91	194.87	230.70	200.6	23.08

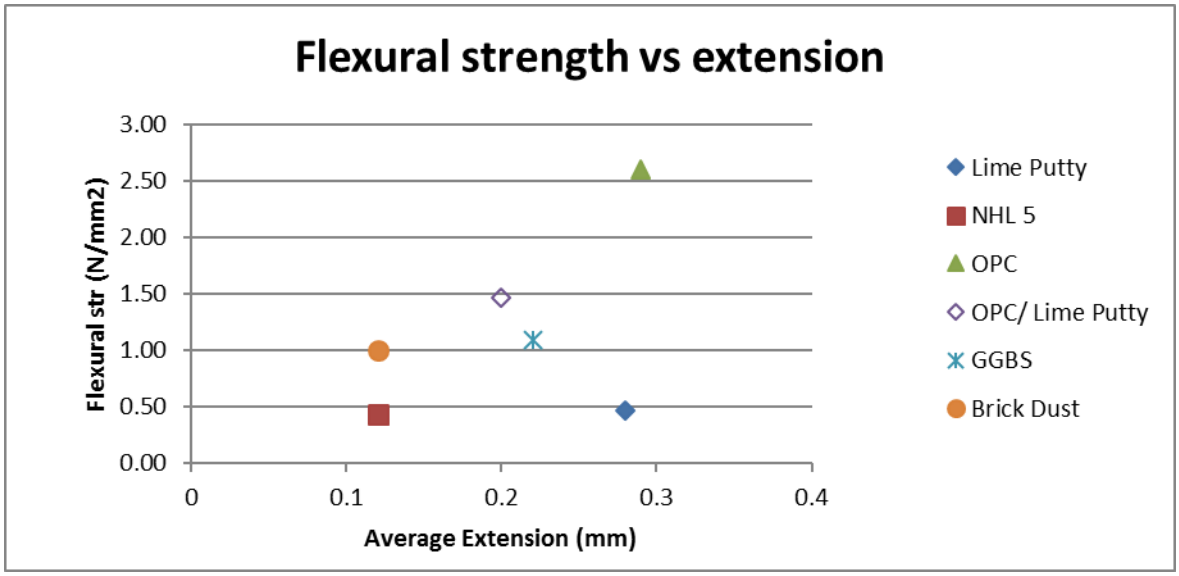

Figure 11 Average extension under load for each binder during flexural testing.

Compressive Results

Lime binders were weaker in compressive strength than that of the Portland Cement binder while the GGBS was found to be the strongest, exceeding the strength of the Portland Cement Binder.

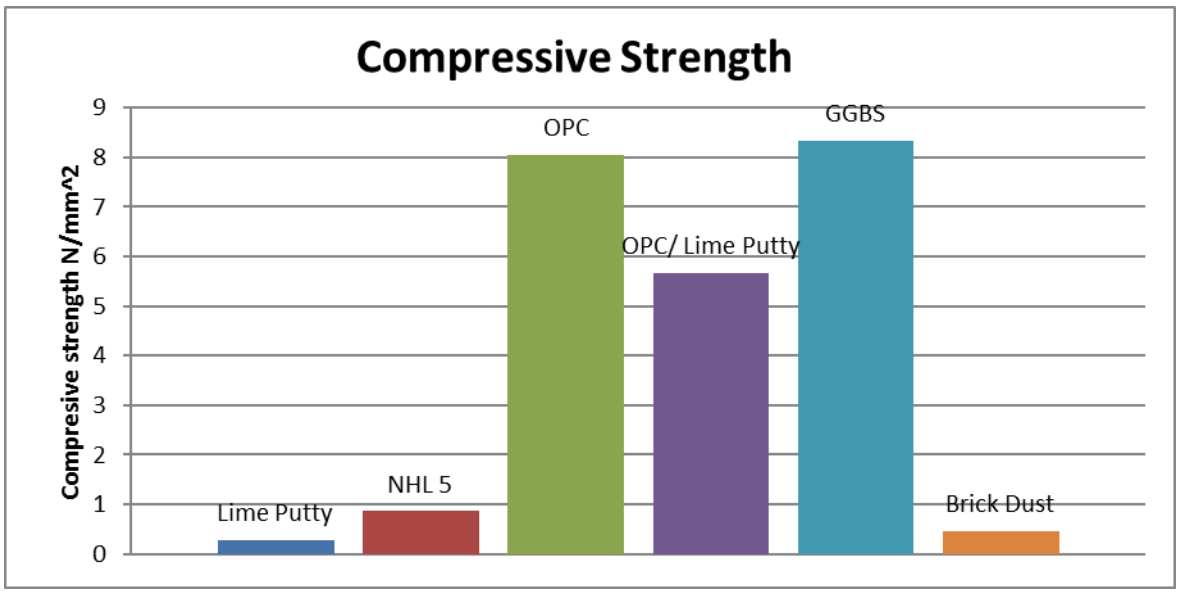

Figure 12 Maximum load under compression for each binder

CONCLUSION

The aim of the research was to test the use of pozzolans as an alternative material within the refurbishment of period properties, with my research based on the data from the Smeaton Project which summarized that weaker mixes such as 1:3:12 (cement: lime: sand) proved weaker however were still stronger than that of a Lime mix (Teutonico et al 1993). Barr et al, highlighted that the workability, compressive and flexural strength of mortar will affect the bond, and that the bond strength affects the deterioration of the masonry unit. The conclusion defined from their research showed after 28 days curing period the bond strength of Natural Hydraulic Limes were like low strength cement based mortar (Barr, McCarter & Suryanto, 2015).

The results gained by this work demonstrated that after 28 days curing and using the same mix proportions as those in the Smeaton project, the augmented mixes demonstrated different properties from those of Portland Cement or Lime Putty over the range of tests. The evidence suggests that by augmenting a Portland Cement mix with a lime it is possible to change increase the compressive strength over a lime mix towards an OPC mix, to gain an intermediate performance in flexural performance and to increase the porosity of the mortar towards that of a pure lime mortar.

The testing of other pozzolanic mortars shows that they may be a viable alternative to pure lime mortars and GGBS was seen to give properties closest to the OPC augmented mix. This may therefore be a plausible alternative in a project (such as the Smeaton) where the mortar needs to be durable but sacrificial compared to the masonry unit.

Further study is required into the comparisons of the different mixes looking at a wider range of mix proportions and performance which will may allow the increased use of pozzolans and lime mortars as alternative replacements to the current mixes used in industry.

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AN INVESTIGATION INTO THE FACTORS WHICH MAY INFLUENCE A BUILDING OPERATOR'S SATISFACTION WITH THEIR BUILDING AUTOMATION AND CONTROL SYSTEM.

Philip Crampton and Jonathan Took[2]
Philip Crampton studied BSc (Hons) Construction Project Management at Sheffield Hallam University and graduated in [2017] with First-class honours. He now work as a Project Manager at Vinci and is studying for a Masters in Construction Law. Jonathan Took is a senior lecturer in the Built Environment at Sheffield Hallam University who supervised the dissertation].

This work set out to investigate the factors which may influence a building operators' satisfaction or dissatisfaction with their Building Automation and Control System (BACS). A positive finding from this research is that many of the respondents are happy with the BACS they operate. Generally, building operators are happy with the level of control their systems are providing, which brings improvements to the buildings performance. More specifically, the building operators recognise the individual value of open systems, trend data and fault detection and diagnosis. As with most technology, there is always room for improvement. Recurring themes in the research highlighted areas BACS could be improved, which included the following:

- Errors and assumptions made during the design process
- Errors made during installation and commissioning
- Inadequate training for building operators
- Room for improvement with fault detection and diagnosis features.

Finally, building operators should, at times, be more realistic about their expectations of a system and what it has been designed to do, particularly if it has been in operation for some time.

Keywords: Automation, BACS, BMS, BIM, FM

INTRODUCTION

Building Automation and Control Systems (BACS) consist of both software and hardware which allows for the automatic control, monitoring, optimisation, human intervention and management of building services and equipment. These building services may include:

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- • Heating, Ventilation and Air Conditioning (HVAC)
- • Lighting
- • Electric blinds
- • Security (access control; cameras)
- • Fire alarm systems
- • Lifts; escalators

The demand for building automation is increasing significantly as building operators look to improve efficiency and reduce operational costs. The strategies used to make these savings must take into consideration the building operator's responsibility to maintain comfortable conditions with regards to temperature, humidity, air quality and light, in line with minimum or maximum requirements specified by regulations or contractual obligations. As a result of these complex requirements and the benefits BACS can provide, the total building automation and controls market is expected to reach a worldwide value of £40.6 billion by 2018 (Markets and Markets 2013). With the ever increasing impact of BACS on the way in which buildings perform, it is the intention of this study to establish whether those systems in operation today are meeting the expectations of the building operator.

RESEARCH METHOD

The overall aims of the research were to investigate the current level of satisfaction of building operators with their BACS, and to establish their expectations of future BACS. The opinions of the building operators and system providers are subjective and for this reason the research paradigm adopted is that of an interpretive perspective (Collis and Hussey 2014). The investigation utilises different research methods and techniques of the interpretive design such as questionnaires and interviews to collect the building operators' feelings and inner thoughts (Ahmed 2008). The Epistemological stance used is constructionism where 'meaning' is not discovered, but constructed in the minds of the building operator. Thus, it is appropriate for the researcher to interact with the participants to record and analyse these thoughts. All research was carried out following SHU ethical processes.

Two questionnaires were drafted: one for building operators and one for system providers which covered the same topics and aimed to compare the responses of the two groups of participants. These questionnaires were sent out as pilots to 4 people in both groups and the questions amended as a result of feedback received. Finalised questionnaires were created on an online survey website with links sent initially to 71 building operators working for a facilities management company. Following this, a total of 243 building operators were contacted, with further requests made via social media. A total of 89 responses were received during the 25 days the survey was active. The second questionnaire targeting system providers was sent to 104 people within the industry as well as via social media posts predominantly posted on LinkedIn. During the same 25-day period, 73 responses were collected. An approximately equal number of questionnaires were analysed from each of the two respondent types. Questionnaires from building operators are referred to as 'BOS' and those from system providers are referred to as 'SPS'.

After analysis of the questionnaires, a semi-structured interview was devised and three interviews were conducted:

- One with a regional Building Services Manager of a Principal Contractor
- One with a University Operations manager providing in house FM
- One with a Facilities Manager working for a commercial property and real estate services provider

Each interview lasted approximately 30 minutes; audio recordings were transcribed, then primary and secondary coding was carried out over two consecutive days. This was completed manually using Microsoft Word to highlight key words or phrases (threads) which revealed a total of 31 codes. This was reduced to 20 upon secondary coding, when it became evident that there were significant similarities between some codes, allowing them to be merged. The second author then condensed the 20 codes into 5 themes which were discussed.

LITERATURE REVIEW

The 2008 Climate Change Act established a target to reduce the UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. Buildings currently account for 45% of the UK carbon emissions (UK Green Building Council 2017). For this reason, as well as the utility bill payer's bottom line, an effective BACS is key to ensuring optimal building performance. The performance is first predicted at design stage and then measured during operational life. Aste et al. (2016) argue that there is a mismatch between the performance simulated results calculated at design stage, and the actual operational results, which is often referred to as the 'performance gap'. BS EN 15232 further reinforces this argument, stating 'The experience from real projects shows that an installed BACS will deviate dramatically from desired sustainable optimisation and expected energy efficiency over time' (British Standards Institute 2012, p31). In many cases previously, this gap may have gone un-noticed. However, the development of automated meter reading (AMR) and monitoring and targeting (M&T) has highlighted this issue to the building operator. Bridging the gap becomes even more important if the industry intends to protect their buildings against future changes of use or environmental conditions. (de Wilde and Jones 2015). Miscommunication between the client and the design team regarding the expectations of the system and how the building will operate may result in a performance gap (Newsham, Mancini and Birt, 2009). When designing BACS, the level of automation for each element will be specified using the four different BACS efficiency classes, to ensure the finished system performs in the way that is expected by the client.

- Class D corresponds to non-energy efficient BACS. Building with such systems shall be retrofitted.
- Class C corresponds to standard BACS.
- Class B corresponds to advanced BACS.
- Class A corresponds to high-energy performance BACS.

(British Standards Institute 2012)

Designers often overestimate energy performance at the design stage in terms of (Torcellini et al. 2004) due to being optimistic about the behaviour of the future occupants and their energy use.

For many buildings it is difficult to accurately predict the future occupancy levels, the use of the building and the how the building operator will control the system (Menezes et al. 2012). there is also the likelihood that the investigation into the facility's needs will be inadequate, causing functions to be missed or money to be spent on features that will have no real impact on the performance of the building (Piper 2014). Value engineering may reduce the specification of certain areas of the building in an attempt to save money, but may unknowingly remove elements crucial to achieving energy performance targets (Bunn and Way 2010). During the construction phase, specified design criteria may not be met, such as correct levels of airtightness or insulation, significantly affecting the buildings ability to perform as designed. Once the building is complete, testing and commissioning during the hand-over stage can often under-deliver due to budget and time constraints (Bell et al. 2010).

As the industry pushes for increased energy efficiency in buildings, there is a rise in the popularity of various Energy Saving Technologies (EST). Unfortunately, building operators often experience teething problems with the EST. According to Newsham et al. (2012), in many cases the EST does not meet the manufacturer's performance specifications and are subject to degradation over time. An effective way to reduce energy consumption and meet the predicted performance of the building is through occupancy control using sensing and schedules. However, it is not uncommon for many pieces of equipment to remain unscheduled, have their schedules overridden, or be programmed incorrectly. If building operators are not adequately trained to effectively operate their BACS through lack of training and understanding of the system, or though inability to understand the various metering systems and M&T applications, poorly performing equipment may be routinely missed. Denning (2014) stated that the most common user related errors that adversely affect BACS are based around set point changes, made in response to complaints from building users or in an attempt to reduce running costs and save money.

BACS servicing and retro-commissioning

Zmeureanu and Vandenbroucke (2015) believe the BACS installed in commercial and institutional buildings contain a 'gold mine' of data, which could be exploited for the purpose of ongoing servicing. This information is referred to as 'trend data', which is a record of the building's historic performance, used to identify and diagnose faults within the BACS and detect any inefficiencies (Zibin, Zmeureanu and Love 2016). Further to routine servicing, retro commissioning is a systematic process for identifying and implementing operational and maintenance improvements in a building to ensure continued good performance over time, as well as increasing occupant comfort. This is achieved by optimising the performance of the buildings mechanical and electrical systems and how they operate together (Building Operating Management 2006). Zibin et al (2016) argues that trend data is rarely used effectively to maintain optimal energy performance. They found 'Currently, [BACS] perform poorly when diagnosing HVAC faults, yet are essential to provide data for commissioning.' (Zibin, Zmeureanu and Love 2016, p125).

Fault Detection and Diagnosis (FDD)

Simon (2011) describes fault detection and diagnosis (FDD) as a subfield of control engineering which monitors a system, identifying any issues as they occur, pinpointing the location and type of fault and in some cases even automatically generating work orders for the maintenance team. FDD tools can plug into a building's trend database to identify a

wide range of problems from uncalibrated sensors to heating and cooling occurring simultaneously (Schmits 2015). It is common for today's building operators to respond reactively to building system alarms and occupant comfort complaints. Regardless of the issues with the current technology, it is agreed by all literature reviewed that detecting faults can play a vital role in the successful running of a building, Zibin et al (2016) found that equipment which is either poorly maintained or improperly controlled can significantly affect the whole system performance, citing that such equipment may 'waste an estimated 15% to 30% of energy used in commercial buildings' (Katipamula and Brambley 2005). Techno-commissioning, with an FDD system focuses on identifying non-critical deficiencies which do not prevent the system functioning, but does decrease efficiency (similar to retro commissioning with trend data). The FDD system can recognise when plant and equipment begin to deviate from optimal performance, so that the building manager can identify the problem before it occurs (Veronica 2011). Piper (2014) further argues that money can also be saved in the long run when utilising FDD by detecting and addressing a relatively minor problem before it becomes a larger and potentially more expensive issue. Ascertaining how common it is for FDD to be incorporated into the BACS will be beneficial to the research as it may identify this as a cause of poor performance and building operator dissatisfaction. Should FDD be included, it will then be beneficial to explore whether the benefits of FDD are recognised by the building operator.

Issues with ageing systems

With the advent of computers in the 1980s, building automation rapidly evolved to the powerful systems available today and the industry is now on the verge of the 'internet of things' era, which will alter the way buildings are operated. This presents an issue to some of the ageing systems that are currently in operation today and whether they can adapt to the changing requirements of the building operator (Sinha, Taparia and Mansukhani 2014). BACS, like all other building elements have a limited lifespan. As they age, it becomes more difficult and expensive to keep them operating effectively. Replacing failing components becomes harder as parts become difficult to find and in some cases manufacturers terminate support to older systems, rendering them obsolete. A culmination of these issues can quickly cause the building operator to have a negative impression of their system (Piper 2008).

Summary

Building Automation offers great potential for improving a building's energy efficiency and for the comfort and productivity of users. However, there are a number of reasons why BACS do not always perform as specified, such as incorrect installation, changes to specification of other elements, reactionary behaviour by the operators of BACS undermining its performance and general maintenance work interfering with the BACS. The literature supports the need to deduce what building users and operators understand about the BACs they have experienced.

RESULTS

Questionnaires

The questionnaires revealed that there were significant differences and similarities between the experiences of system providers and building operators (FM professionals)

Higher running costs

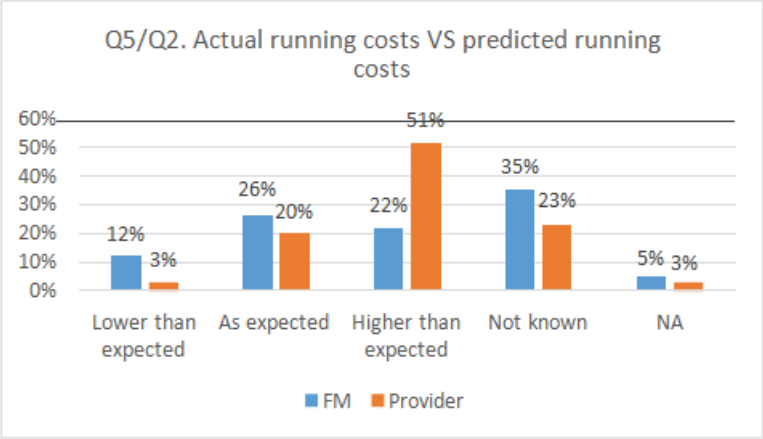

Figure 1 Comparison of responses from building operators and system regarding predicted and actual running cost.

There is a difference between the experiences of the 2 groups (Figure 1) with providers significantly less likely to see fault in their systems than FM operators ($p < 0.05$).

Service Intervals

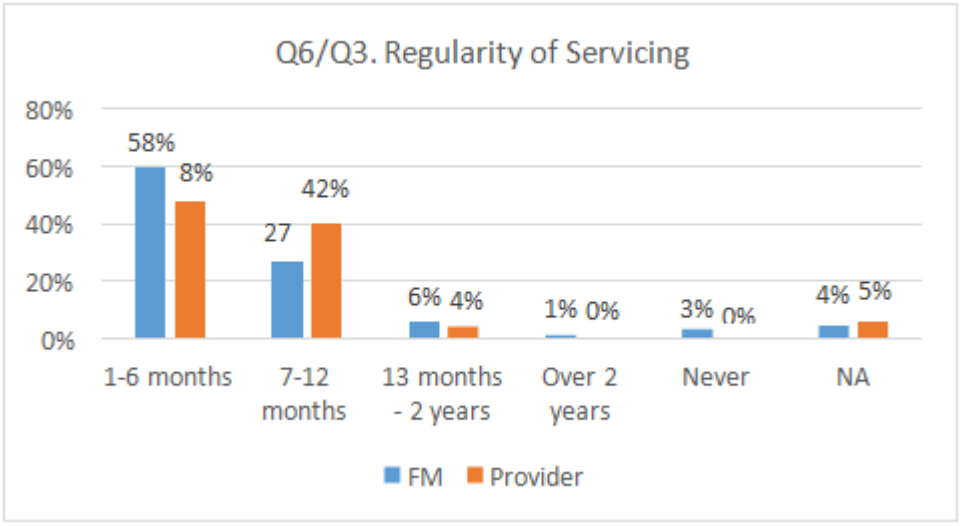

Figure 2 Comparison of responses from building operators and system regarding service internals

Both BOS and SPS agreed that service intervals should be 12 months at most (Figure 2).

Trend data

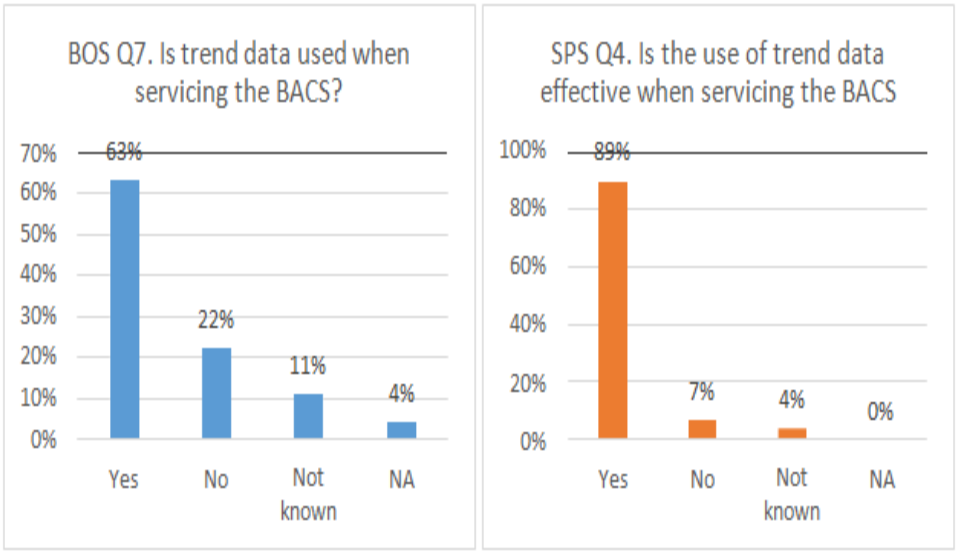

Figure 3 Comparison of responses from building operators and system regarding predicted and actual running cost.

Both building operators and system providers agreed that trend data was useful (no statistical significance) as shown in Figure 3.

Does BACS meeting your expectations?

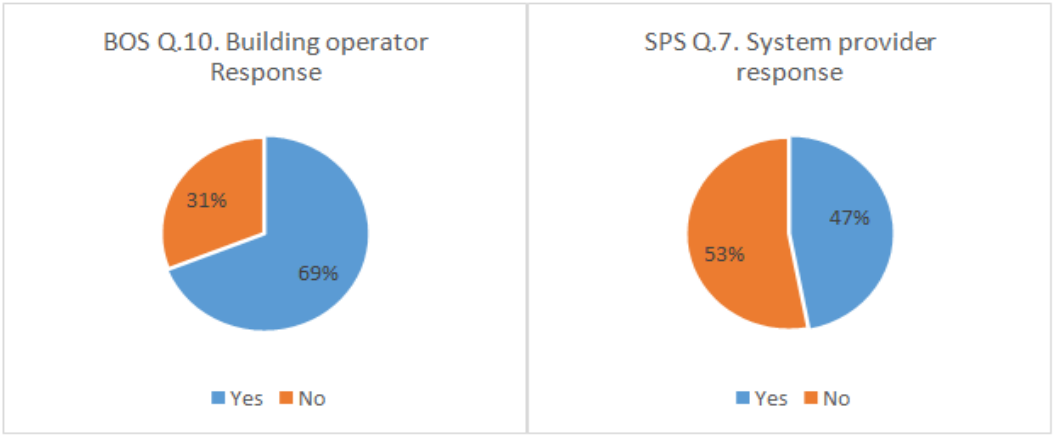

Figure 4. Comparison of responses from building operators and system regarding predicted and actual running cost.

Figure 4 illustrates the finding that system providers are significantly less likely to be happy with BACS ($p < 0.05$).

A number of other questions were found to demonstrate no significant results when comparing the attitudes of building users and system providers.

INTERVIEWS

Interviews were conducted with three participants. The transcriptions were thematically coded, revealing five themes:

1. Control of Performance
2. Dealing with Complaints
3. Fault Detection and Diagnosis
4. Subjectivity
5. End Use differs from intended use

1 and 2 were seen as positive perceptions; things that were liked. 4 and 5 were seen as negative. Theme 3 had positive and negative aspects. Some of the codes and themes had not been seen in the questionnaire or literature data.

DISCUSSION

Causes of satisfaction with a BACS

The literature review highlighted the following four key areas in which BACS may prove beneficial to building operators:

- Lower utility costs and higher efficiency
- Few complaints from building users
- Improved productivity from building users
- Reduced maintenance costs

The primary data supports these findings and identifies further areas which may lead to user satisfaction, as discussed below.

Control of performance and optimisation

The general response was that the ability to control and optimise the performance of the building is of benefit to the building operators: this is a perceived benefit more than a realised one as the majority only had HVAC linked to their BACS.

Dealing with building user complaints

During the interviews with both building operators, the ability for BACS to provide assistance when dealing with complaints from building users was highlighted as a benefit of the system. Participant 3 discussed how they felt the operation of buildings is becoming more and more data driven and this information can be used to demonstrate performance when a complaint is made. For instance, if a user reports poor ventilation in a room, the building operator can run off a report to clearly show the number of air changes is meeting the requirements of the building owner or applicable regulations. Results from the questionnaire show the majority of both building operators and system providers felt it was easy to generate reports that had all the information they required and a Mann-Whitney test showed no statistically significant difference in the way both groups answered this question. Whether proving a customer's complaint to be invalid is worthwhile was not investigated.

Fault Detection and Diagnosis (FDD)

FDD was considered to be beneficial to both sets of respondents, with no significant difference in how they replied. All three interviewees also supported FDD, although there was some dissatisfaction with the mode of reporting (below).

CAUSES OF DISSATISFACTION WITH A BACS

The literature review identified several issues which could lead to building operator dissatisfaction. This included issues with both servicing and FDD, problems arising from ageing systems and a term called the 'performance gap' which covers several factors that may lead to the BACS not performing as designed. Again, the primary data further reinforced the findings of the literature review, as well as identifying further areas which may lead to user dissatisfaction.

Subjectivity

A recurring theme in the interviews only is that the performance of a BACS is subjective. How a young person perceives with the conditions within a room may be different to how an elderly person would. This subjectivity can influence the building operators' views of how the system is performing, with potentially contradicting feelings within a team about how the BACS has been designed or operated. For this reason, it is important to remember when discussing the pitfalls of BACS that regardless of how sophisticated and well designed a system may be, it will often be very difficult to achieve complete satisfaction as it is almost impossible to please everyone.

End use differs from original design

As the BACS settings are based on the design, when this changes, the implementation may no longer be suitable. This can happen during value engineering, where the quality of the specification is reduced. A lot of assumptions are made during the design stage which are often proven to be incorrect (Newsham et al 2012).

Fault Detection & Diagnosis (FDD)

It was identified in the literature that many feel FDD is still underdeveloped, with the reliability of this feature being called into question. A further issue (unidentified in the literature review and questionnaires) but was discussed by the three interview participants, is that there is still a need for manual fault finding once an alarm has been raised. This can be a cause of frustration as (for example) in cases where a leak was detected it was actually found to be usual condensate on the pipes.

CONCLUSIONS

Generally, building operators are happy with the level of control their systems are providing and the improved building performance, as well as the associated time and cost savings enjoyed. More specifically, the building operators recognise the individual value of open systems, trend data and fault detection and diagnosis. Building operators can look forward to a greater level of control and an efficient building resulting in operational savings and a lower carbon footprint. In turn, comfort levels for the building users will also improve, as well as being far more consistent.

Recommendations to the industry

As with most technology, there is always room for improvement. Initially, the design process should be adapted to improve the end performance of BACS. System providers should approach the building operators during the design process, allowing them to advise the designer on the building end use and requirements. This will reduce the amount of assumptions the designer must make. Furthermore, the building operator will be fully aware of what the system has been designed for so they will be able to identify any changes in building requirements post completion which will affect the performance of the

BACS, allowing adjustments to be made quickly. As the system is installed, the principal contractor should ensure there is sufficient time allowed for the BACS to be commissioned and should return for seasonal commissioning. For retrofit projects, decision makers should thoroughly investigate the long-term costs and savings which could be made by upgrading the BACS during a building refurbishment. Omitting the upgrade of BACS should not be the first port of call when value engineering. All members of the building operation team should have training on their BACS, with continual refresher sessions held on a regular basis. If the team does not comprise of staff who have sufficient M&E experience, the building operator should employ an adviser who is independent to their system provider. System providers should continue to develop fault detection and diagnosis to improve the reliability of alarms and increase the detail the system can provide regarding the fault. Finally, building operators should, it is suggested, be more realistic about their expectations of a system and what it has been designed to do, particularly if it has been operational for some time.

Limitations

The researcher had little experience of the research process at the beginning and as a result attempted to generate generalisable data from questionnaires. However, the questionnaire data was almost entirely supportive of the literature and could have been omitted. The interview data, whilst not generalisable, was valid and revealed more of interest to the researcher. The interview themes which were novel contributed new knowledge to the body of work regarding BACS and in hindsight should have been the focus of this project.

Recommendations for further study

There is likely more qualitative research that should be undertaken to (i) determine if these research conclusions can be replicated and (ii) to reach a point of data saturation

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AN ANALYSIS OF WHAT CAUSES THE DIFFERENCE IN YIELDS BETWEEN TWO SUBMARKETS IN A GLOBAL MARKET: A CASE STUDY OF THE CITY AND WEST END OF LONDON

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A deviation between yields on business space property in the City and West End was found to be on average as much as 1%. This research project determines the cause of yield divergence between two sub markets in a global market utilising the City and West End of London as a case study. Secondary research through the medium of reviewing published sources such as journals and websites was used in order to gather an initial cause of the yield divergence, however it was found that no academic research had been carried out on this subject in the past. Due to this a qualitative approach was adopted when conducting primary research in this subject area. Key Industry players were interviewed and then analysed in order to determine the driving factors behind this divergence in yield. Twelve interrelating factors were found to be the key reasons behind this shift in yields. Once these factors were determined a model was produced that can explain the cause of the yield divergence Further research should be carried out in order to test, refine and further improve Model One presented in this report.

Key words: Yield, London, City, Westend, Office, Business Space, Planning

INTRODUCTION

The Property market is well established as an inefficient market due to the characteristics of property interests and its diverse nature (Evans, 1995). This suggests it is imperfect, valuations of properties are assumptions until factorised at transaction. Whether investing in Property or the Stock Market, investors are looking at the same thing, their rate of return on investment, and their yield. Dunse et al (2010) defines the yield as "a function of expected rental growth net of depreciation, the riskless rate of return and risk premium". Research on yields across London points on average to a 1% difference in yields achieved on the sale of business space property between the City and West-end of London as at

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January 2016. This has since narrowed to 75 bps at January 2017 as demonstrated in Figure 1.

Much academic research has studied factors that drive the differences in property return but it appears that none have been conducted on the difference between two sub markets, particularly between the City and West End of London. The overall aim of the research is to determine the factors that cause the difference in yields on business space space property between submarkets in a global market using the City and West End of London as a case study for this analysis.

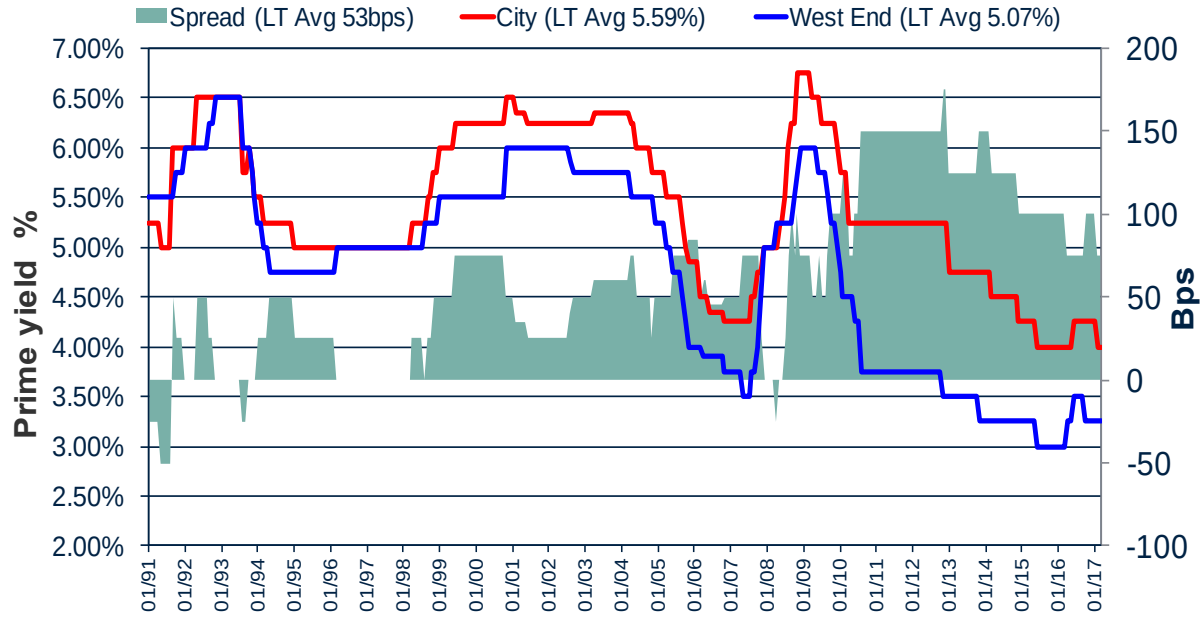

Figure 1 Yield Shifts, a graph to show the spread between yields in the City and West End of London on business space property. Source: Savills research, 2017).

RESEARCH METHOD

My literature review highlighted the lack of research when investigating the difference in yields between two sub markets in a global market. For this investigation a mixture of secondary and primary data sources were used and a qualitative research method adopted for my investigation.

Secondary Research

The literature review allowed the determination of the primary research method to be used. Well respected academic journals and articles were consulted. As there was no specific research in the chosen field, the search parameters where changed and the investigation widened to determination the factors from which a yield is derived; value and income of a property. Using these two elements, factors affecting their value were investigated, in addition to their relation to yield divergence. Additionally factors such as economic variables, planning regulations and interest rates, were derived from industry knowledge and publications from the reputable sources including publications from Savills, JLL and CBRE as well as property press.

Primary Research

A qualitative research method was adopted in order to generate a range of insights and understandings. Semi-structured interviews with professionals in the market were conducted, with the intention that these would allow for a deeper insight into the subject. A sample size of four candidates was used, once the data was transcribed, coded and analysed a strong correlation could be seen within the thoughts and opinions expressed by the respondents. The four candidates were chosen for their influential role and professional status and reputation within the industry. Table I demonstrates the candidates job role and position in industry.

Job Role	Position in Industry
City Investment Agent	Director
West End Investment Agent	Director
Institutional Investor	Fund Manager
Service Side Researcher	Executive Director

Table 1. Interviewees Job role and position in Industry.

Twelve questions were derived from ten themes found by secondary research, these themes are detailed below:

1. Tenant take Up and Pre Lets *.
2. Tenant Business Sector *.
3. Tenant Migration *.
4. Type and Nationality of Investor*.
5. Interest Rates.
6. Supply and Demand & Positional Value.
7. Lease term and structure.
8. Economic events.
9. Planning policy.
10. Secured lending package.

These ten themes were arranged in the above order to ensure flow of conversation in the interview and try to prompt further discussion. As can be seen, themes similar to one another such as all questions relating to tenants were grouped one after another. The themes were then related to the yield difference between the two sub markets in order to create the interview questions. Themes marked above with an asterisk were presented with prompts such as charts and diagrams in order to help the participant generate a greater understanding.

LITERATURE REVIEW

Research between real estate returns and macroeconomic variables seems to be plentiful. Chan in particular has published numerous articles between 1986 and 1997 and has showed that changes in risk and the term of interest rates within a multifactor arbitrage pricing model explain real estate returns (Chan et al, 1990). In 1998 Chan et al investigated variations in equity real estate investment trusts using a pooled cross sectional time series. Four models were used to demonstrate returns on property investment, the combined model showed size as the significant variable.

Sheppard stated that "Permanent lenders come armed with long-term commitments, often at fixed rates, and this is valuable in allowing Real Estate Investment Trusts (REITs) to ladder their maturities and remove interest rate risk" (Sheppard, 2012). Another study was conducted by Chan et al (1997) to find the priced macro-economic variables and to compare the performance of the two empirical versions of the APT. Using three sample periods they found that unanticipated inflation, unanticipated change in the term structure and the unanticipated change in the risk premium were significant variables in real estate returns. Payne (2003) studied the effects of what unexpected variables to the economy would have on the returns of REITS. He found that unexpected changes in the stock market index had significant impact on all three types of REITS. The study also found unexpected changes to inflation and default risk did not affect all three types of Real Estate Investment Trusts, unexpected changes to the term structure had a negative impact on REITS and, unexpected changes to federal funds had a negative impact.

Ewing and Payne (2005) also using the same methods as Payne (2003) found that unanticipated changes or innovations to monetary policy, economic growth, and inflation reflect a fall in yields for real estate investment trusts. However, all these studies were conducted on the United States property market. In the UK, Lizien and Satchel (1997) investigated the relationship between interest rates and property prices using a Threshold Autogressive Model. They found that where high interest rates were secured on an asset, property prices fell. Brooks and Tsolacos (1999) investigated the impact of macroeconomic and financial variables on real estate returns; they concluded real estate returns in the UK cannot be related to the variables chosen in their study. However, there was an indication that the term of a lease and inflation do have an effect on property returns. Shilling et al (1987) found in residential markets, vacant properties trade in a thinner market. Whereas, in commercial markets Landlords would rather leave their properties vacant until markets or rents improve. This "stockpiling" is mainly found to be due to the long leases associated with commercial property. He does state there are vacant costs attached to this strategy but the overall strategy can pay dividends over these incurred costs. Contrast this with Brooks and Tsolacos (1999) and with Hoskins, Higgins and Cardew (2004) who compared macroeconomic variables in Australia, Canada, the UK and USA property markets and found variables such as GDP, unemployment and inflation were the main determinant factors.

Leone studied the impact of economic and property factors on UK listed property returns to find how unexpected economic conditions impacted on property yields (Leone, 2011). Yields are derived from the price paid, factors affecting the price of an asset could affect its yield. Research into the characteristics that affect the pricing of specific commercial properties has been plentiful however, by US academics. Cannaday & Kang, (1984), Glascock et al, (1990), and Fehribach et al, (1993) all found factors such as age, location, condition and the availability of finance to affect the pricing of a commercial asset.

However, there have been very few UK studies conducted on the subject. Typically, these studies have applied hedonic regression analysis to identify these factors (Jones and Dunse, 1998). The findings suggest that commercial property prices depend on physical features such as those found in the US studies. Dunse et al (2003) has also found that agent knowledge plays an important factor in segmenting commercial submarkets. A concept hinted by Jud who suggests that by using agents it enables buyers in unfamiliar markets or who lack experience to minimise this disadvantage (Jud & Winkler, 1994) & Jud, et al,

1996). However, Black and Diaz (1996) reject this concept being a positive as they argue it can create a bias asking price as surveyors ignore market information and let asking prices bias their valuation. Between 1980 and 2000 there have been a number of seminal papers written to address the issue of valuation accuracy. The findings of these studies vary with the key issue being a variation between valuation and transaction date. (Barras, 1994; Key at al, 1994; Wheatton, 1999). However, when considering valuation as a factor of pricing a key point is made by Crosby (2000) who argues there is a legal requirement for valuers to follow the guidelines set out by the RICS and this creates a defined network in which surveyors have to operate.

Further to this, Investment Property Databank researched differentiation between capital valuations and actual values achieved within the UK and Europe. These reports found that initial valuations were generally lower than actual transaction prices (IPD, 2003; 2004, 2006; 2007; 2008; 2009). Greenspan also discusses this concept of over and under-pricing depending on the boom or bust cycle, stating that this causes an asymmetrical cycle that exaggerates the upturn and slows the recovery. These are contributing factors as to why the City of London office market is seen as the most risky market within the UK (Greenspan, 2008), this is also reflected by the City's higher yield. Gunnelin, et al (2004) also discuss this concept of a risk premium relating it to the concept of thinner markets as a result of less diversified demand resulting in a higher risk premium. Dunse, et al (2007)considers the influence of exogenous and endogenous influences on the determination of office space yields within a city. Their findings suggest that exogenous investors play a significant part in the influence of yields in the short term but less in the long term as the analysis found that yields in cities do follow national cycles, which implies the dominance of exogenous factors. Very little further research has been taken of this concept.

Whether good or bad, there is support here for the statement that available information affects the price of an asset. Lizieri (2008) conducted a very interesting study into rental valuation trends in 32 city's across the world from 1990 – 2007. The findings state that international financial centres have the greatest volatility. This is interesting because the City submarket of London from 2006 – 2015 has been dominated by the financial services industry when considering take up by the business sector. When comparing this to Graph 1 we see that during this period there are some of the biggest shifts in yields with the City being higher, representing more risk or volatility as stated by Lizieri.

With regard to the theory of supply and demand, there appears to be little previous research relating this to yields or take up. Clayton and Eichholtz present the topic in relation to the supply and demand in the rental sector (cited in Geltner et al, 2001). The study explains that because both supply and demand are location and type specific, real estate space markets are highly segmented. That is, space markets tend to be local rather than national & specialized around building categories. Although related to planning, Hirsh also discusses the theory of supply and demand. Hirsh (1977) distinguishes between material goods where the balance of supply and demand determines price and positional goods whose value lies in its social scarcity. Goodchild (2017) states, "positional value is usually considered in relation to housing and to the way some neighbourhoods become more expensive than others." and how the same principal can be related to prestigious offices. The concept of positional value is also demonstrated by Dunse and Jones (1998), although using the concept to heterogeneous and homogeneous value, stating age and location are the primary attributes causing significant variation in value. Some Cities have

heterogeneous stock built over decades whereas others have homogeneous stock built post war.

Law in relation to planning can also have an effect on the concept of supply and demand as shown in Cheshire and Hilber (2008) who argue planning restrictions impose a premium on heavily regulated areas such as London's West End market. This relates to Goodchild (2017) who argues sub markets such as London's West End are likely to stand out from other office markets through virtue of its position and argues unregulated development could lower office rents by destroying the unique character of the area. Further to Goodchild's point, with regard to character of an area, early studies in relation to residential properties have demonstrated that non-residential land uses have an impact on property values (Li & Brown, 1980; Cao & Cory, 1981). The proximity of non-residential land uses to residential uses can also have an effect on the value of property dependent on externalities such as noise and reduced travel times (Mcmillen & McDonald, 2002; Taleai et al, 2007). If the aforementioned argument is reversed, could residential property uses in close proximity to commercial have an impact on yield as the city market is predominately commercial use? Interest in this topic has certainly grown considerably. However, very little has been produced on the impact to commercial property (Kuethe, 2012; Song & Knaap, 2004; Guttery; 2002; Boer, et al, 2007). This could also be the reason for high levels of tenant migration from the West End to the City.

There is little to no research on the effect that planning policy has over property yields however there are plenty of publications as to the effect policy has on price. When considering planning policy, a key topic would seem to be the influence that urban design master plans have on property value. Clark (2004) demonstrated how urban development plans can affect urban amenities and attract a creative workforce, resulting in increased development and increased property prices (Clark, 2004). Tu and Eppli (1999) also found a link between urban design projects and property prices. Further to this, research has found a premium for planned residential property, irrespective of its location (Eves, 2007).

Therefore, when considering this in a commercial context, could the City hold a premium on price overflowing to an increase in rents resulting in a higher yield? A more recent study however by Kozlowski and Huston found "favourable general economic and policy conditions override local spatial factors as the main driver of residential property price growth. However, in a cooling market, innovative and sustainable urban design may reduce relative price falls" (Kozlowski and Huston, 2008). Therefore, could the City have more favourable planning regulations than the West End resulting in this yield divergence?

RESULTS

The results of the research are presented and the relationship between key drivers is reviewed and shown in numerical form. Finally each driver is reviewed and the key concepts presented.

Themes and Drivers

The data gathered from interviews was transcribed and coded into the key themes presented in Table 1. Out of the five Themes, Occupational Market, Investor and Property were then able to be drilled down into specific issues/drivers for the yield divergence, as presented in Table 2. The incidences of each of these themes are summarized in Figure 2.

Theme
Occupational Market
Investor
Property
Planning
Supply / Demand

Table 1 Key themes derived from analysis of interviews

Theme	Driver
Occupational Market	Rents
Occupational Market	Tenant business sector
Occupational Market	Tenant diversity within sub market
Occupational Market	Lease length
Occupational Market	Lease structure
Occupational Market	Vacancy rates
Investor	Investor type
Investor	Risk presented to investor
Investor	Nationality of investor
Investor	Economic factors
Investor	Finance of purchase
Investor	Requirements
Investor	Investor risk taste
Property	Property type / grade of space
Property	Asset price
Property	Positional Value
Property	Lot size
Property	Land Value
Property	Residential Land use

Table 2 Summary of themes and issues/drivers.

Occurrence of Drivers and Themes

This section presents the occurrence of themes and drivers from the research. By coding the data it was possible to add a numerical value to the concepts noted in Table 2, Figure 2 shows Occupational market, Investor and property as the key themes of the research, by more than three times as much as Planning and Supply/Demand. However, on more detailed review the most occurring factors are a mixture of different themes. This drill down, represented by Figure 3, the first nine drivers and themes, which could be classified as the top drivers, as after this the moving average declines more rapidly.

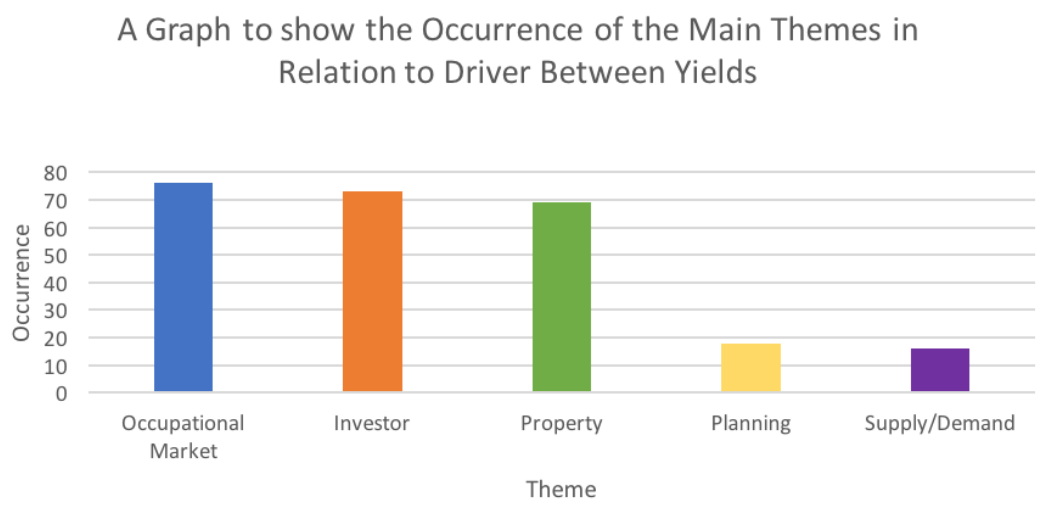

Figure 2. Graph to show the occurrence of the main themes in relation to the driver between yields

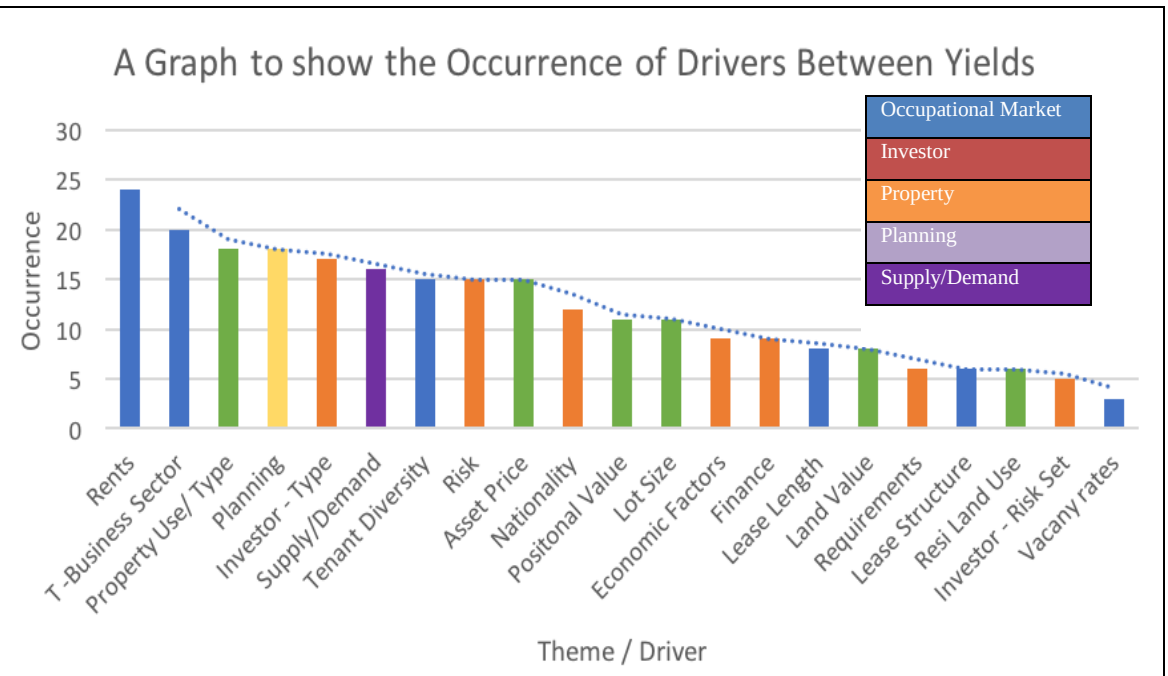

Figure 3. Occurrence of Drivers between yields

Co-Occurrence between Key drivers and Themes

Figure 4 represents the co-occurrence between key Drivers and Themes demonstrating the relationship between codes, represented by a square, each occurrence of the relationship results in a greater square size, the larger the square the stronger the relationship between drivers. The key co-occurrence relationships are represented in Table 3, these were selected by choosing the themes with a relationship between four repercussions and above as most occurrences were between one and two.

Driver One	Driver Two	Co-Occurrence
Type of Investor	Lot Size	7
Type of Investor	Asset Price	6
Planning	Property use/type	7
Residential Land Use	Planning	4
Tenant Diversity	Risk	6
Tenant Business Sector	Economic Factors	5
Property Use/Type	Residential Land Use	5
Planning	Demand	4
Rent	Demand	4
Tenant Business Sector	Rents	4
Rent	Supply/Demand	4

Table 3. The number of co-occurrences between two key drivers.

Tenant Business Sector

When considering tenant business sector, research has revealed that the overriding judgment associated with this is risk. Risk as a result of economic factors, which is represented also by the Co-Occurrence between Tenant Business Sector and Economic Factors in Table 3. Interviews revealed how external risk can have an effect on tenant business sector, in particular this risk was associated with the large operators within the financial sector. As a result of this, Tenant Business Sector Risk was more associated with the City than West End as the City was shown to have more of the large Financial Business Sector operators.

Supply and Demand

Supply and Demand was certainly highlighted as a factor by all four Interviewees, however when considering Supply and Demand it was found to be more a factor in the West End rather than the City. Interview one stated “the underlying issue is supply and as a result that feeds into cost. The lack of supply of Office space in the West End, as mentioned in previous sections has resulted in rents in the West End being driven up as a result of this rise in rents, tenants are moving East in search of cost savings. Interview 3 related this supply and demand issue in the West End to Residential land uses stating “Also it’s the fact that residential values are so high. So, competing uses to offices. You don’t have such a residential competition in the City, or even in midtown” which also corresponds to table three.

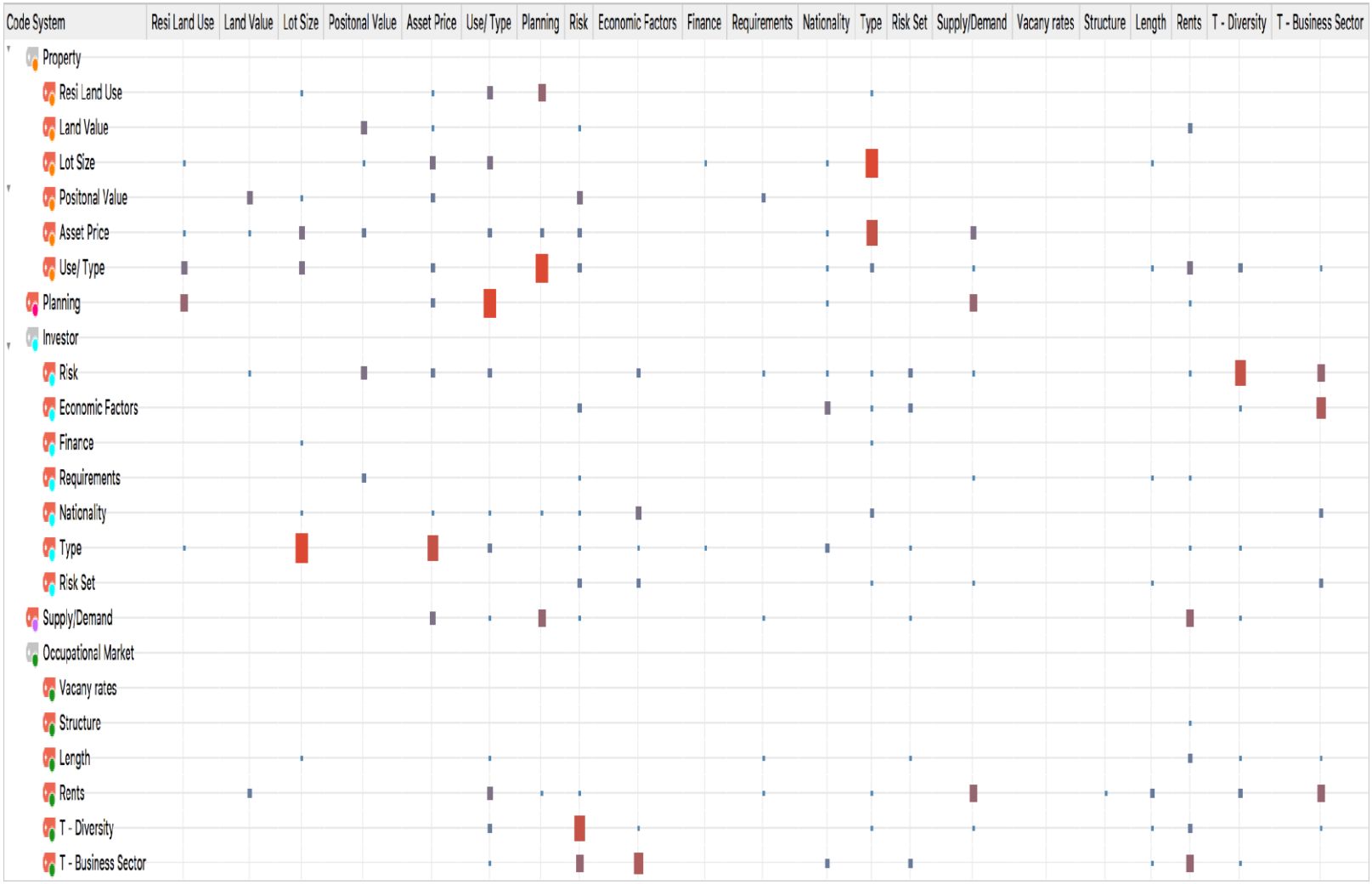

Figure 4.– The strength of Co-Occurnaces Between Key Drivers and Themes.

Rents

When considering rents, an overriding theme that presented throughout all interviews was that rents in the West-End are higher than those in the City, although related to a number of different causes. Interview one said "because there's not huge amount of supply in the West End, that's driving rents up even higher". Interview two stated "rents are dramatically higher in the West-end pushing towards double in some cases". Interview three, when talking in relation to City take up stated "they will probably go for longer leases, and there'll be low rents to reflect that quantity". Interview four states, "companies are coming further North and going further east, in search of cheaper rents". Table four represents how often higher rents in the West End were mentioned per coded segment.

Interview	Mention of Higher Rents (coded segment)	Total number of coded Segments
Interview 1	4	5
Interview 2	8	11
Interview 3	1	4
Interview 4	3	4

Table 4. How often higher rents in the West End were mentioned vs coded segments.

Tenant Diversity

Tenant Diversity was mentioned by three of the four Interviewees and has shown there is far more diversity represented by the West End market than the City. Interview two stated "Private investors historically were more attracted to the West End because it had a more diverse tenant base and wasn't the monoculture that the City was". Interview three stated "the City market is very polarised, in that it only attracts a certain type, and puts off a lot of potential tenants". Another theme to have emerged and mentioned by Interview one was "The City is actually diversifying over time" and also stating "the City is a bit more diversified than it once was".

Planning

All four Interviewees commented on planning policy and were of the opinion that this is a key reason behind the differential in Yields of the City and West End of London. Interview one stated "this is probably what people say the key difference in yields between the West End and City" and then related this to the supply of office space in the West End being severely restricted due to planning regulations. There were four key themes to come out of this section in all interviews. The first of which is that planning in the West End is far more regulated than that in the City. Further, restrictions on the height of buildings in the West End are far greater than those in the City. As a result of these stringent planning regulations, the second factor is the supply of office space in the West End has been restricted compared to that in the City, and as a result of this lack in supply, land values have then been driven up as stated by Interview 3, this is factor three. Finally the fourth factor, is the more relaxed planning regulations on the recycling of space between office and residential land use in the West End which is also demonstrated by table three, where Planning and Residential Land use have a high co-occurrence.

Use/Type of Building

When looking at property use/type a key theme to emerge was the variance in the type of space available between the City and the West End. The West End also suffers from

residential land use, which is supported by Table Three showing a strong co-occurrence between these drivers and all four Interviews mentioned this as a factor. It would seem a lot of space in the West End is recycled between Office and Residential use, and as a result of this, residential land uses has affected the amount of office space available. This has then caused there to be a lack of office space available within the West End driving prices up.

Residential Land use

As mentioned in the Use / Type section of the research, Residential land use is heavily associated with the West End of London rather than the city. All four interviews mentioned this as well as the co-occurrence between Property Use / Type mentioned afore. Interview two stated "The West End's seen 2 to 3 million feet of office space converted to residential" attributing this to the permitted development rights on conversion from office to residential , this would also correspond between the co-occurrence of Residential Land Use and Planning detailed in table three.

Risk Presented to Investor and Investor Risk set

When considering Risk presented to Investors and the Risk set of Investors, the findings of my research were the same. There was no particular risk set found to be corresponding to a type of Investor, instead Interviewees responded regarding the particular risk set of the City vs West End, where the West End was regarded as less risky than the City. This is also represented by the co-occurrence between Tenant Business Sector and Economic Factors, Tenant Diversity and Risk in table three and mentioned in Tenant Diversity section of this report. Further to this, The West End was seen as a safer market due to it being more predictable, due to its alternative use and the tenant demand for space within this sub market.

Lot Size

When considering lot size the key theme to arise was the lot size in the West End seemed to be far smaller than that of the City, Interviews 1- 4 all shared this view.

Asset Price

Asset price has conformed to the co-occurrence presented by Table Three between type of investor and asset price and type of investor and lot size. This research has shown the West End usually attracts private Investors due to the smaller lots size resulting in a cheaper price point which represents this price differential between the two submarkets. Whereas the City, has much larger lot sizes and therefore higher prices, a comment supported by Interview four and two.

MODEL 1.

From the factors highlighted by this research, those believed to be the cause of the divergence in yields have been identified. These have shown the strongest occurrence and interrelationships between factors in the research. In order to clearly demonstrate these factors and the interrelationship between them a novel model has been Developed 'Model One' shown in Figure 5.

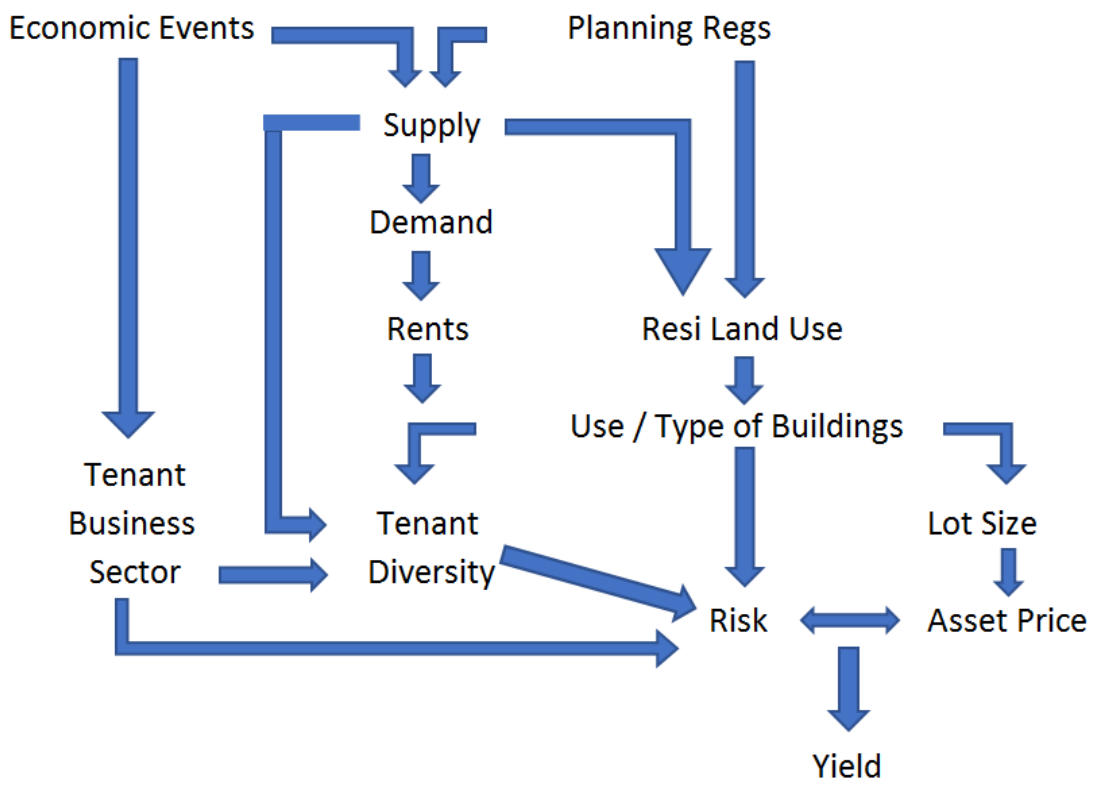

Figure 5. Model One – The relationship between driving factors and Yield in City and West End of London.

When considering Model One, there is no weighting to the individual factors, therefore no one factor is more important than the other, however as the initial driving factors of the shift is Planning regulations and Economic Events it could be argued these are the key reasons for the divergence in yields. Model One demonstrates the relationship between each factor and the effect it has on the eventual yield of a property in the City or West End of London.

CONCLUSION

To conclude the research project, the following quote from an interviewee seems apt. "So it's, again like every other argument in property, it's a mix effect and they're not necessarily the most rational ones, which coming back to the yield split explains it as well as anything". This work has found not one but 12 possible causes for the divergence in yields between the two submarkets that you would not necessarily relate to one another. The initial aim of the research was to determine the factors that cause the difference in yields between submarkets in a global market, using the City and West End of London as a case study for analysis. The cause of the shift in yields has been determined by this work which focussed on the City and West End of London. In the process a model of the driving factors has been created, i.e. Model One.

Model One demonstrates the twelve factors that cause the divergence in yield between the City and West End of London, or on a greater scale, two submarkets in a global market.

Further research is now needed to validate the Model presented, not only within the City and West End of London but also at a global level between submarkets in global cities. Model One can then be amended and refined, depending on the findings of further research conducted between other sub markets.

ACKNOWLEDGMENTS

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AN INVESTIGATION INTO 'COMMUNITY ACTION GROUPS' AND THEIR IMPACT ON DEVELOPMENT

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The focus of this paper is an investigation into community action groups (CAG) and their impact on development. All primary research analysis has been collected via two key methods. The first was a questionnaire which was distributed to the public in and around Sheffield. The second method involved conducting two semi structured interviews in relation to a specific development case.. In addition, secondary data has been collected via conducting a literature review, highlighting the similarities between Community Action Groups (CAGs) and the phenomenon "Not in my backyard" (NIMBY). The literature helped to define what these are and how they have a proportional effect on development. This also provided the opportunity to research previous cases documented in the literature that have seen both development prevented and continue subject to CAG's. The research concluded that there is a good understanding of CAG's and NIMBY from those who participated in this study, of which the majority agreed that this issue can have an impact on development. The research suggests that the location of a development has a significant bearing on approval. CAGs would appear to be more effective in areas of higher valued property.

Keywords: [NIMBY, CAGs, Development,].

INTRODUCTION

This paper is an investigation into 'Community Action Groups' (CAG) and how they have an impact on development. Construction projects suffer the effects of many complaints from the initial concept design right the way through the construction process and even after completion in some cases. Objections to development usually occur at the design stage when the initial idea is put forward to all stakeholders who may be affected by the development. This can be anyone from neighbouring properties or an entire village or town depending on the scale of the development. These adverse reactions are often due to fear that should a development go ahead it will directly impact them or their property in a

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negative way. (Wynne-Edwards, 2004, p5). The research presented aimed to understand the motivation behind CAG's and to consider different cases where a reaction of this kind has occurred and been both successful and unsuccessful in preventing development.

RESEARCH METHOD

Questionnaires were used within this research project as they are simple and straightforward for both the creator and participants. Large sample sizes can be achieved in a short space of time and the data collected can be analysed more scientifically than other forms of research. The most important reason for questionnaires within this study was the ability to deal with sensitive issues that may not be appropriate for interviews - this is an important benefit as this project is a sensitive issue.

Questionnaires are not considered the perfect form of research and can have disadvantages; for example, it is impossible to understand any changes in emotion, behaviour or feelings of participants. Participants could have filled out the questionnaire untruthfully and there was potential for low response rates making it difficult to get primary data. Having used a mixture of questions that may be interpreted differently by participants there was potential for important information to be missed.

Case Studies / Interviews.

This research project focuses on one key case study which is based in Dore, Sheffield. "As the nature of the case study focuses on one aspect of a problem, the conclusion drawn will not be generalised but, rather, be related to one particular event." (Naoum, 2013 p.46) In this project 'the event' being the NIMBY case in Sheffield. Secondary research was also carried out during this research project in the form of a literature review; during this the researcher focused on different cases where CAG's have prevented development and cases where development continued.

Two interviewees were contacted regarding their involvement in the case study previously discussed. Semi structured interviews were designed and carried out to obtain qualitative data which was then transcribed, coded and analysed. The interviews were based around a range of questions related to the issues raised in the existing literature; the aim of this research method was to achieve the attitudes of both a developer and a member of a CAG. The two interviewees were selected as they were believed to have contrasting opinions on the given topic.

Research Ethics

When carrying out a research project it is important to act ethically. This is to ensure that the research doesn't cause any harm to participants and the researcher, whether this be of a physical or emotional nature. (Farrell, Sherrat, & Richardson, 2016) To ensure that the researcher was aware of the ethical considerations throughout the project, SHU research policies were followed. An ethics proposal was carried out before any primary research commenced. This highlights certain areas such as bias, confidentiality and debriefing of participants. All participants within this study were made aware of their rights to remain anonymous and were reminded that they can withdraw themselves and their data from the study at any time. This information was disclosed via participation sheets attached to questionnaires and interviews.

LITERATURE REVIEW

According to VAL, 2015 CAG's are also known as "Voluntary and Community Groups" and they define these as groups or organisations working for the public benefit. Action groups involve people working together to try and achieve change (Cambridge Dictionary, 2017) or to fight for a particular cause (Collins English Dictionary, 2017), this may also be referred to as a political campaign on a particular issue.

A healthy community is described as having supportive neighbours, attractive buildings, public spaces to hang out and meet, minimal traffic, no crime, green spaces, trees, jobs, and public transport links etc. This is deemed to be an economic, social and environmentally sustainable community. (Clay, Madden & Potts, 2007) This may be what CAG's seek to maintain or create for their communities.

NIMBY is a term commonly used to describe action groups protesting local developments. (McClymont & Hare, 2016) NIMBY and Nimbyism can be defined below:

"A person who objects to the siting of something perceived as unpleasant or hazardous in their own neighbourhood, especially while raising no such objections to similar developments elsewhere." (Oxford Dictionary, 2016)

According to Muir, 2005 Nimbyism is considered a socio-political pressure and is said to be having more of an impact on development than in the past. These "pressures emanate from adjacent property owners and the public at large, including existing businesses, institutions and residences adjacent to the constructed facility." Muir then goes on to state that the "…NIMBY syndrome stymies growth and development and generally hampers construction. The obstacles caused by the NIMBY syndrome typify the challenges facing todays " 88 percent of developers feel that community opposition negatively affects their projects with delays said to be the most frequent problem. (Tighe, & Scally, 2017)

Nimbyism can be the reaction to a variety of different projects, whether this is new homes, social housing, wind farms, airports, prisons, waste facilities or a new railway line etc.

Tighe, & Scally, 2017 discuss different strategies of countering NIMBY opposition, in a study they carried out, nearly all respondents claimed to have participated in public hearings. However, only 12% said these were effective, they go on to state that meetings with community leaders and the public are the most effective way of engaging with locals and mitigating any risk of objections.

Planning related thoughts

According to PDNP Authority, 2017 only certain reasons for objecting are considered during a planning application, these are referred to as material considerations, objections that are received that don't meet their criteria are known as non-material considerations. The authority provides guidance on what they deem as valid reasons for objecting, a summary of these can be seen in Table 1.

Valid Reasons	Non-Valid Reasons
Impact on Landscape	Loss of view
Non-compliance with national and local policies	Speculation about what an applicant intends to do in the future
Design and appearance of the development	A better suggested use for a site
Layout and density of buildings	Devaluation of property
Loss of Light	Moral or religious objections
Health or crime fears	Commercial Competition
Noise and disturbance	Concerns about the character of an applicant
Overlooking or loss of privacy Smells Loss of Trees Etc.	Private issues between neighbours - Such as boundary disputes, damage to property, rights of way and covenants etc.

Table 1 Information retrieved from (PDNP Authority, 2017)

This is a crucial point raised as this suggests councils do not refuse applications based on individuals (and what they see as being important) they refuse due to potential impact on the land. Similar considerations are also provided on the Sheffield City Council website. Petitions are considered a means of expressing the views of widespread community on a development proposal, however these petitions are only considered on valid planning reasons and not by the number of people opposing a development. (Sheffield City Council, 2016). In 2011, the government introduced The Localism Act which aimed to provide individuals, communities and councils with more influence on decisions that affected their neighbourhoods. (LGA, 2015) According to an article by Wiles, 2014 the act promised of a more democratic planning system and gave communities a say on where new houses and businesses should be designated. This then states that "well-off and the well-housed are using it to resist, rather than promote, the development of new homes." (Wiles, 2014) This would suggest that poorer community's opinions aren't acknowledged as of 30 representatives examining local plans for development in Cambridge no poorer neighbourhood was represented to express opinion (Wiles, 2014). Although Nimbyism can be reported in a bad light and can receive a bad name a contrasting article by Coney, 2015 express that we may end up thanking these protestors in the future as they are preventing new development which preserves our greenbelt sites. The article also goes on to say that locals should be asked of what they want from developments rather than development being landed on them which may neither be necessary or desired, therefore it is suggested that developers make attempts to improve infrastructure and the environment to compensate.

Objectors Comments

Local councils provide opportunity for the public to issue comments regarding planning applications. This can be accessed via respective authority's websites. For example, Sheffield City Council (SCC) allows you to search, view or object to any planning application; However, all comments are to be made public. They also highlight that only comments regarding planning matters will be considered. (Sheffield City Council, 2017)

Table 2 'NIMBY' Cases where development stopped/prevented or continued

Coventry Airport	The first case involves Coventry airport where an application to build a new airport terminal got refused by the UK government in 2007	Waddington, 2013	prevented
Ashtead, Surrey	2007-an armed forces charity who wanted to buy a £1.7 million home to provide accommodation for injured soldiers. This would then provide a place for families to visit their loved ones.	BBC, 2007; Evening Standard, 2007	Development originally prevented, later granted
High Speed 2	HS2 is a proposed rail service to significantly improve commute times, aimed at connecting Birmingham to Manchester and Leeds.	BBC, 2016; StopHS2, 2016; Dakers, 2014; Collins, 2014; Wharf, 2016; Department for Transport et. al, 2017	Granted Royal Assent which paves the way for construction to commence in the spring 2017
Portfield, Christchurch	development of a small estate consisting of 9 new builds 8 letters of objection from residents and a total of 12 are required for an application to be considered	Clarke, 2001	

RESULTS

Primary Research Case Study

Within this chapter, the focus will be on a case study in relation to a site which is situated in Dore village on the outskirts of Sheffield. This was a residential development site with a single 1970s house currently occupying an acre plot The first proposed use was for 8 detached dwelling houses. there was then a second proposal of 6 slightly larger properties. This was sent for approval but residents raised their concerns. The design for the plot then changed for a third time to accommodate the 2 blocks of apartments. It is evident from the applications that the original application was validated in September 2008 with the last submission currently being decided in 2017. However, the applications of interest to this CAG case are dated from 2008- 2013. This will be the primary case study for this research project; this is due to the project being subject to a CAG. Therefore, primary interviews (see Section 6) were undertaken with a principal member of the CAG to help determine the motivation for objecting and to understand the developer's thoughts on the campaign. Figure 1b and 1c are photos of ongoing construction works at the site. These images both show the large dwelling house currently occupying the site, this development received minimal to no objections during its design. This is interesting as although the property is more in keeping with the area by being a single dwelling it over shadows the neighbouring properties in terms of size. An evaluation of why this design is preferable is provided by i02 throughout the following section.

Figure 1 a (top left) Overview of Site (Google Maps, 2017)

Figure 1b (top right) Large Dwelling Occupying Site

Figure 1c (bottom right) Front elevation of development

Both interviewees were contacted via a phone call invite them to participate. This was followed by an email to confirm the location and timing of interviews. Both participants were quick to respond to my invitation and were enthusiastic to provide their experience in dealing with this case study.. I01 is the Managing Director of a Development company in Sheffield. It is clear from the interview that he has experienced working on numerous developments that have either received objections or been totally clear of protests. This therefore suggests the quality of the interview is high as they have strong opinions on this topic whilst still understanding the views of those objecting. I02 has lived in the village of Dore for over 20 years and is a qualified architect and a former academic. As a trustee for the local village society he has experience of numerous developments within the village.

Coding

From analysing Figure 2, it is clear that most of the codes were mentioned by both parties. However, 'NIMBY' and 'CAG' codes were used by i01 more than twice as many times as i02, this could be as a direct result of i01 being subject to the impact of a CAG and potentially has strong views. 'Fear of change' returned the highest number of hits. However, this was totally one sided – i01 mentioned this code 17 times compared to i02 (0 times). It is therefore apparent that these are the opinions of the developer and their explanation as to why the development was prevented. Further analysis of the interviews can be found in the following sections.

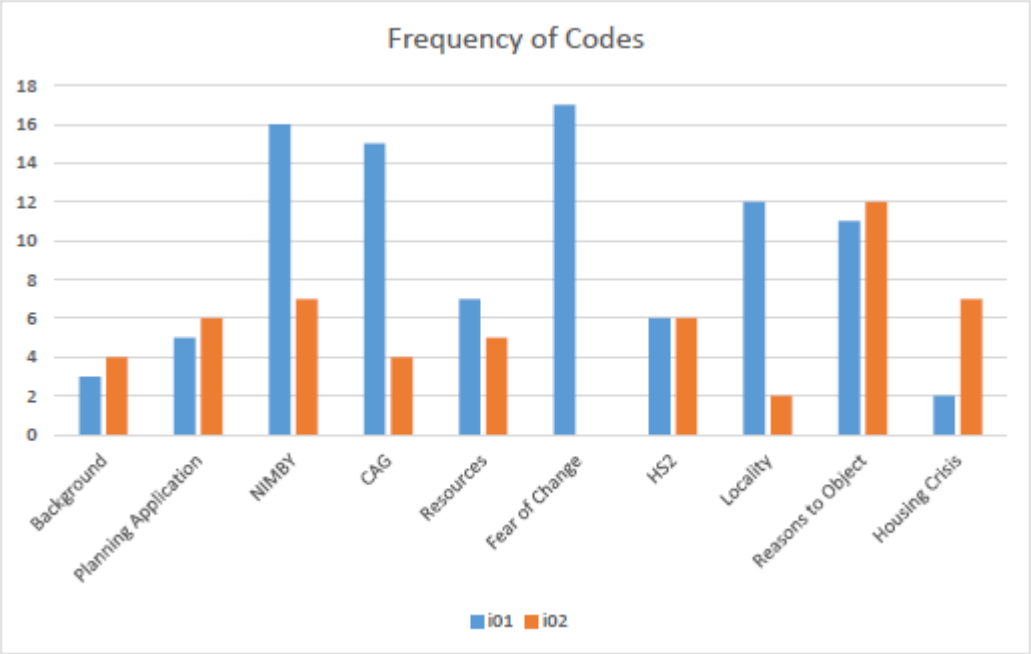

Figure 2 Frequency of Codes

Results, Discussion and Analysis

The first question presented to both participants was to provide the researcher with a background to the case study. This involved providing their views and thoughts on what occurred during the case. Both participants provided similar accounts of the case with the developer expressing more detail about numerous planning applications that were submitted for this specific site. The original proposal was to demolish the existing dwelling on the site to provide space for 8 dwellings, this was then reduced as "they weren't really good houses for the area so we reduced it down to 6 larger houses." (i01) The final proposal was to construct two apartment blocks as the developer had success with another site so "transplanted the idea to Dore." (i01) i02 agreed with this describing the planning application as 2 blocks of apartments with around 14 apartments each. This case ran for a long time, "over a period of 2-3 years" (i02) and was subject to numerous objections particularly on the third application for apartments as is supported by both participants with i01 describing the final application being the point when "neighbours became quite pestiferous." i02 appears to back this statement by claiming there was a "public uprising" surrounding the application. It is apparent to the researcher that at this point in time it is perceived to be the forming of a CAG.

Community Action Groups

Both interviewees highlighted principal factors surrounding the formation of this CAG that impacted development. I01 discusses two adjacent neighbours as being the catalyst for forming the CAG, claiming they "stirred up objection from the general area… formed an action group and geed everyone else up to object." (i01) The same message was evident when questioning i02 who discusses the involvement of the Dore Village Society (DVS), a conservation group and "two local residents who were very high" (i02) on the idea of fighting the application. I02 mentions that the involvement of these parties' efforts was co-ordinated to object the application, which resulted in its refusal. This is a key point made as

this supports comments made by i01 who claims people living in Dore as being "intelligent, middle class people who have the time, money, abilities and skills to create an objection and they are very well organised." However, the developer (i01) feels "in this occasion the planners themselves were against the development… because of their perceived concern that they suffer greatly from objections in that area." This is important as it highlights the potential for objections to have been made in the past, which leads on to the following topic regarding previous objections.

Previous Objections

I02 was asked whether Dore Village had objected to developments before, which they replied "yes, many things." A similar question was proposed to the developer (i01) the researcher asked if they had ever appealed against a development, in which they replied "absolutely, planners are not in my mind the best people who decide on planning applications…rather than try and help you… they try and stop you." After looking back at the transcription, it appears this question was perceived as appealing to a decision rather than its original intention which was whether they had opposed to a development in their area. However, important data was collected from this question with i01 expressing strongly that planning should look at applications with the following mind-set - "yes, all development makes changes, is this one so poor as to refuse? - they should start from a point of how we can help this development succeed." I02 explains that DVS don't just object to developments - some planning applications they don't comment on claiming they only comment when developments that are "too large or out of character" or "there is some issue of principle that shouldn't be approved either in the conservation area or in the village as a whole." To conclude their response i02 discusses representing two or three public enquiries on other developments which they also won which highlights their commitment to preserving the local environment.

Motivation

Both participants were questioned on the motivation of people objecting, i01 was asked for their thoughts on what directly motivates complaints and i02 was asked what motivated Dore to object to the development. I01 simply replied "NIMBY, Not in my back yard, people don't like change." In contrast I02 explained that it was the "completely unacceptable character of the development, it was too big." Further questioning lead to i01 revealing that they feel it is the fear of change using an example on a previous site where residents had just moved into a brand-new development but once they had moved they were against any other development taking place in that same area. Interestingly 'fear of change' is a code generated by the researcher beforehand from the existing literature, Wynne-Edwards, 2004 explained that NIMBY reactions are generated from fear. When discussing the character of the area i02 describes the area as largely comprising of "single houses on quite large sites." Therefore, any alternate forms of development could be seen as too big of a change, this may be why i02 avoided the term fear of change.

Although i02 mentioned that the main reason for objection was the building being out of character, when asked i01 presented to me the letter highlighting the full extent of reasons in which people objected. I01 reveals that this was the letter used to generate support for their campaign to prevent this development by getting people to sign as a means of reinforcing the objections. This leads to I01 discussing the reasons and providing their thoughts on each, describing the buildings in that area as being as big as a block of flats.

I01 declares that people have a "fear of flats… yet that is the future of living." I01 refers to the reaction of objectors as being "human nature."

"It all comes down to human greed which both drives development and stops development." (i01) This quote taken directly from the transcript was in reference to the neighbours of the property being in a different mind-set when development affects them and the mind-set of not wanting anything to change.

I02 highlights that the main reason for objecting to i01's proposals was due to lack of character and that the developments were too big. However, as previously mentioned in Section 5.0 and can be appreciated in Figures 11 and 12 the current use is a large dwelling that is significantly larger than neighbouring properties.

NIMBY

Both participants were asked if they were aware of the NIMBY phenomenon and what their views were. I02 referred to it as being a "pejorative term that is meant to dismiss the notion of people objecting to local developments of any kind. Not necessarily housing, but, I think sometimes that's why we try to focus people's attention on a rational reason, a rationale for objecting rather than just going for a knee-jerk reaction." Stark contrast to the response received from i01 who compares NIMBY (objections to planning applications) to "property racism" referring to "fear of the immigrant and fear of the new… that drives people."

Direct links to the NIMBY phenomenon could be related to a statement made by i01 in reference to the neighbour at the site They discuss that one of the neighbours' works as a director for a development company, therefore involved in large scale projects but when a development affects them they don't want a development over their "back garden wall." I01 refers to this as being like "gamekeeper turned poacher" which provided the neighbour with "contacts and knowledge that helped him to create a campaign."

Both participants were asked whether they perceived NIMBY as an unpleasant term, both were in agreement that it wasn't. I02 believed the term to be "too flip" and "doesn't take into account the knowledge and understanding of what people might think about a development." I01 simply responds "it's what they are" then expresses that "NIMBY's won't admit to their self-interest."

Influence of the type of Development

Both participants agreed that the type of development should influence people objecting. I01 said "of course, it's a business of self-interest" and i02 agreed "Yes, I mean there is a lot of development that we've agreed on." This was the participant referring to previous planning applications that had taken place over the "past 50 years" with "new developments being accepted quite regularly probably to the tune of about 30 dwellings a year." (i02)

		I01	I02
Pre-Development	Seeking thoughts of communities at planning stages to help reduce the number of objections	Have done in the past but this "doesn't mean that you won't still get objections."	Occasionally happens "Yes if possible… we welcome that if possible."
Location/Locality	Does the locality of the project play a part in people objecting	"Absolutely, we do work in Chapeltown no one really wants to object." [whereas those in Dore are] "liberal minded, intelligent, reasonably well off people who know how to organise, they're educated and they see their values are the ones everyone should abide to.	[Of the people of Chapeltown] "don't have that ability or care or [have] interest or time and people don't object in the same way,"
Number of Complaints	how many objections the selected case received	"probably around 500" [some representing groups with members]	"in affect it was over 1000 objections."

Table 3

Location/Locality

When asked if the locality of the project played a part in people objecting, both participants agreed. I02 replied "Yes, very much" and i01 replied "Absolutely, we do work in Chapeltown no one really wants to object." Chapeltown is a town located on the opposite side of Sheffield to Dore. I01 advances to describe the people of Dore as "liberal minded, intelligent, reasonably well off people who know how to organise, they're educated and they see their values are the ones everyone should abide to." Compare this to i01's description of Chapeltown "you don't have that ability or care or interest or time and people don't object in the same way," it is clear there is a difference.

Number of Complaints

To help determine the extent and size of the CAG during this case the participants were asked to provide a figure on roughly how many objections the 135 Dore Road case received. The developer replied, "probably around 500" (i01) however i02 only recognised 50 - 60 nevertheless it was later confirmed that the DVS represents over a 1000 members and the conservation group "had a petition of about 40 or 50" people so i02 confirms "in affect it was over 1000 objections." This therefore shows the public backing towards preventing this development.

According to participant i01 planning officers have a rule that if they don't receive a certain number of objections then the application can be passed, they go on to clarify that they believe this to be "purely a council function" to cover their backs "so they can't get blamed".

Housing Crisis

A question was posed to both participants in relation to whether they thought CAG's could be having an impact on the UK's housing crisis, to which both interviewees were in agreement. I01 replied "Yes, politicians scare them" suggesting that they use this as a

means to buy votes and as a way of getting into power. I02 was in agreement that CAG could be having an impact replying "Yes, I mean they can be." However, I02 goes on to discuss the positive effect of neighbourhood planning claiming it doesn't affect Dore as they "are not aiming to achieve a lot of development we're only aiming to achieve very minimal development" (i02) This suggests that although i02 is aware of the housing crisis Dore as a village isn't currently planning to further increase the scope of their neighbourhood plan. This is supported by a statement made previously in the interview where "1 dwelling being replaced by 1 large dwelling was more in keeping with that area." when asked if this was preferable to multiple dwellings i02 replied "that was much more preferable yes." Although schemes need to fit within the character of an area it could be argued that more houses are more beneficial in terms of the housing crisis issue, however it is important that the scheme is in keeping with local area. The government set a target to build 240,000 new homes a year by 2016, it is believed the country is still not meeting that target. This is said to be directly linked to the planning system and local opposition objecting. (De Castella, 2015)

Questionnaire Results and Analysis

The research questionnaire was distributed to 150 potential participants with a total of 77 providing a response. This provided the researcher with a response rate of 51%.

The majority of respondents (82%) had not been involved in a CAG dispute although the majority of participants believed that a CAG had an impact on development (FIGURE 2). For the selected case the objections were due to developments not fitting in with the local character or skyline. Privacy and developments being in close proximity of others is also an issue raised in the above responses.

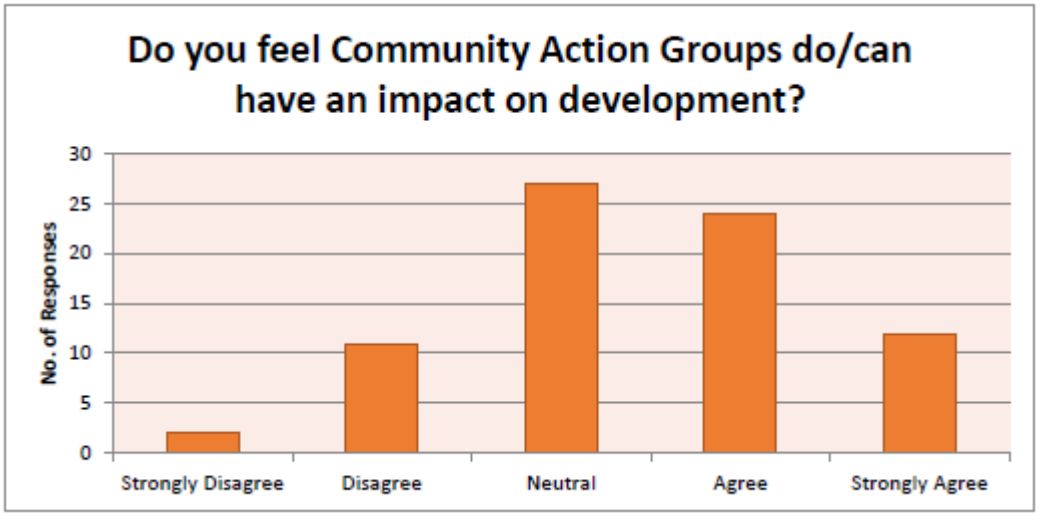

Figure 3 CAG Impact on Development

When asked 83% of respondents agreed to have a protective nature with regard to their neighbourhood/property. When asked to consider the impacts of development in terms of personal priorities (Figure 4) 'Enhancement of Local Area' was the most important factor, followed by protecting the environment and 'Improved Economy' ranking lowest. This is reflected in the findings shown in Figure 5 where 'Additional Noise and Traffic' over all other options as the main concern in relation to development, followed by the concern for property values and the detriment to picturesque views the least concern.

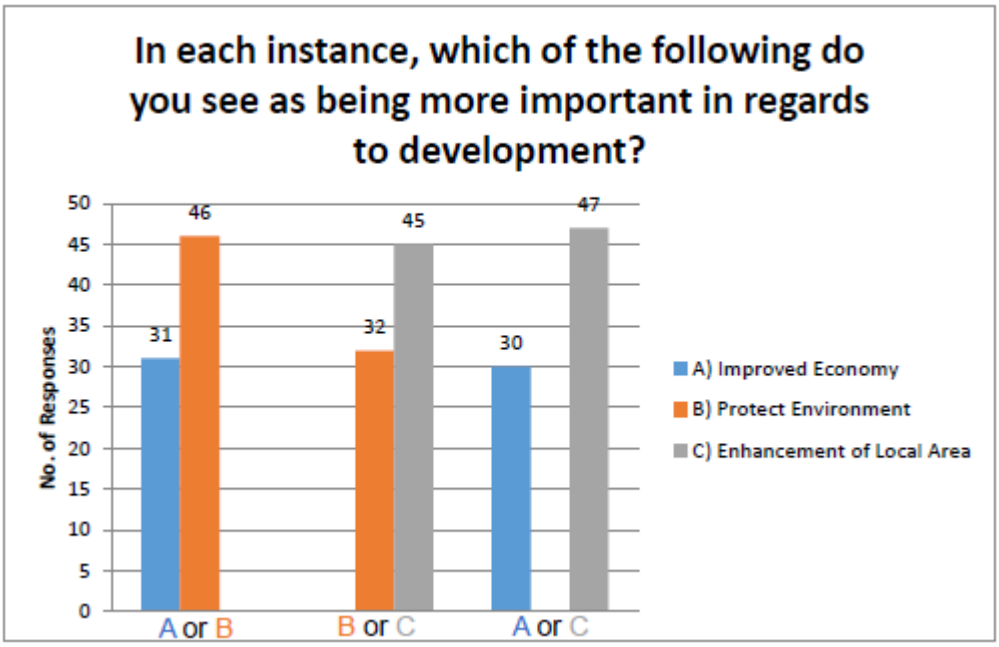

Figure 4 Ranking Scale - Importance

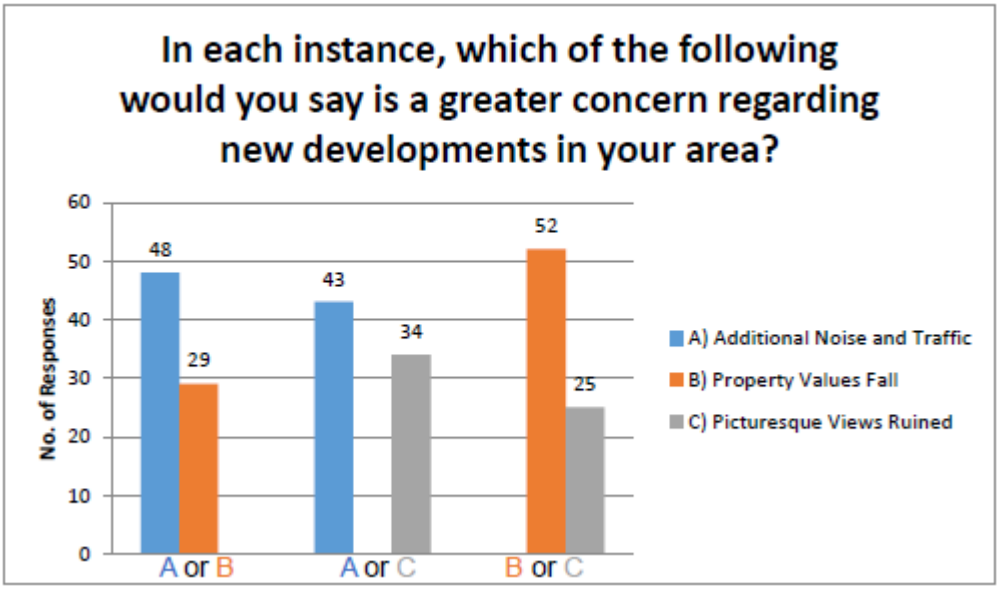

Figure 5. Ranking Scale - Concerns

Additional Noise and Traffic' is considered as a valid reason for objecting where the others are not. However, property values are a reoccurring theme within the literature, interviews and questionnaire and although this isn't seen as a valid reason people generally perceive this to be a concern.

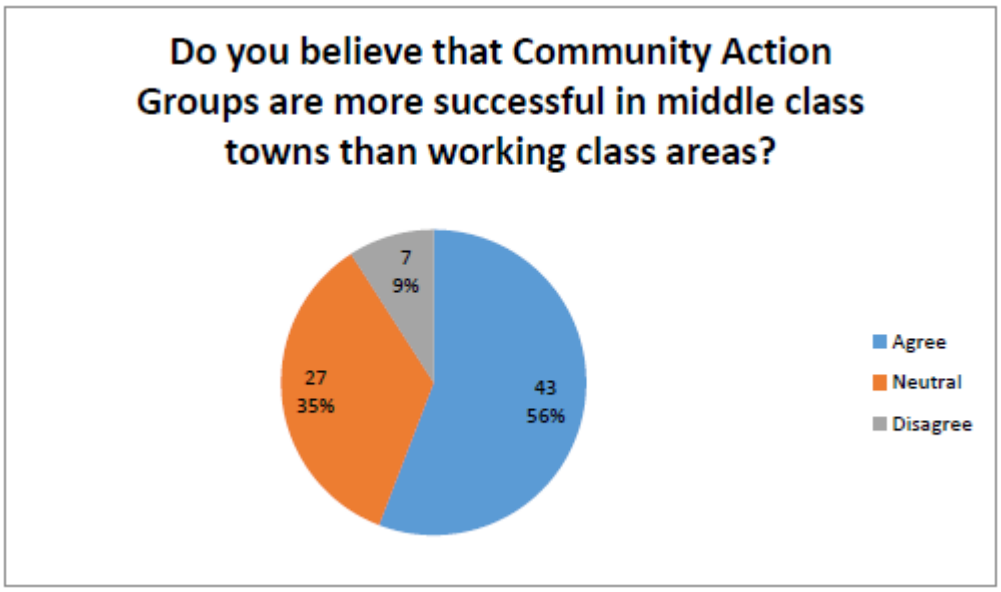

Figure 6 Does the location of a CAG determine success?

Figure 6 demonstrates that 56% of respondents agreed that CAGs were more successful in a middle class areas which may be due to seemingly better class status and/or greater resources. Those living in a middle-class area may have a higher standard of living than those in working class areas linked to concern with social issues including development and this may be the reason as to why CAGs are more successful in middle class areas.

DISCUSSION

- CAG's are created to work on behalf of the public benefit.
- The term NIMBY originated in the 1980's and is a term given to members of CAG's.
- Nimbyism stems from the NIMBY concept and is considered a syndrome for people objecting to development in their area.
- Objections are believed to be made as a result of fear of change.

Research of the literature lead to the discovery that the fear of change is the key driver for people objecting to any development perceived to negatively impact their area. This was supported by i01 who claimed their project was objected to due to fear of change and fear of flats.

- CM's highlight that socio-political pressures such as NIMBYism prevent development and generally hampers construction and is considered a challenge.
- Influence design

Substantial evidence highlights that the location of a development influences whether people object to developments. For example, the issue of developments seemingly in the local vicinity of others is a reoccurring theme in the data collected highlighting issues concerning privacy.

- Majority believe CAG's can have an impact on development
- CAG's more effective in Middle class towns than working class areas
- Majority feel the thoughts of CAG's should be consulted at the design stage
- The type of development has an influence

The public was asked to provide thoughts on whether middle class towns were more effective than working class areas which received a popular response agreeing to this statement. This is interesting as this further supports the idea that location has a bearing on CAG's; this is supported by i01 who used the comparison of two areas within Sheffield to differentiate the two in terms of their resources available and overall concern.

- CAG's typically object to developments using valid reasons however some invalid reasons are also of concern for objectors

CONCLUSIONS

Having discussed each objective and concluded how these have been achieved, an overall conclusion can be completed in relation to this investigation of CAG's and their impact on development.

The initial aim of this research was to try and determine if and how CAG's directly impact construction projects/developments. It is evident from this study that CAG's can have an impact as highlighted during the different forms of research; both primary and secondary data support this.

Data retrieved from the questionnaire analysis emphasised that the majority believed that CAG's are more successful in middle class towns than working class areas. This could be directly linked to comments made by i01 in relation to location having a bearing on the level of opposition. Not only does this provide the public's perception it suggests CAG's have various levels of impact in certain areas.

Having conducted two semi-structured interviews the researcher has been able to investigate two contrasting opinions relating to the selected case study. This revealed the motivation behind the formation of the CAG whilst also presenting the developers viewpoint. By investigating this case study and highlighting what prevented development a comparison to the existing literature could be accomplished. For example, the interview process revealed that i01 believed the motivation for objecting was Nimbyism, comparing the phenomenon to property racism i01 labels the reaction as people fearing change; this was supported by the existing literature. The main reason for objecting to a development based on i02's comments is to preserve the local character. Furthermore, 83% of respondents revealed they are protective of their property which further suggests a protective nature towards their neighbourhood.

It should be concluded that although the aims and objectives of this research have been met, this was only achieved on a limited scale. Therefore with this in mind the researcher has provided recommendations for further research.

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