MARKET ANALYSIS STUDY OF THE VALUE TECHNOLOGY SYSTEMS TO HOME OWNERS

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Abstract

Smart Technology involves the integration of a variety of home systems including lighting, climate control, security etc. to enhance the comfort, convenience and economy of the home for its users. It is currently unknown if homebuyers believe that these systems add value to the home. This study used the market value of home sales and an attitudinal survey of homebuyers, to determine the increased value of homes containing Smart Technology. The results demonstrated that a significant price premium was paid by for the incorporation of the technology into new homes. In addition, the research suggests that the use of this technology is not limited to high-income earners or other demographic stereotypes. Instead it has broad market appeal and the potential to save energy for the community at large.

Keywords: Intelligent buildings, building technology, home automation

Introduction

Smart services technology was originally developed for automation of commercial buildings, and has subsequently gained widespread acceptance to the point where it is almost taken for granted (Boyd 1994). Although intelligent buildings are now an established part of commercial property, smart services technology is a relatively rare inclusion within newly constructed Australian homes.

Very little technological change has occurred to the traditional Australian suburban house in the post-war era. Although technically advanced appliances within the home are relatively commonplace, very little integration between appliances and their functions has taken place.

Australians have consistently displayed a positive approach to adopting new technology. This is confirmed by the use of high technology appliances in most Australian homes However, these appliances are separately installed and do not communicate with each other. In general, they function independently, and require manual activation, adjustment and control and often are not integrated into the house infrastructure.

The development of a smart home involves more than simply plugging in yet another hi-tech appliance. Substantial alterations are required to standard wiring and switch systems, central control systems may be required, and the systems can be further enhanced by the inclusion of smart appliances which are beginning to emerge in the market place. (Smith 1998)

It could be argued that smart systems for residential housing add some intrinsic value through the incorporation of increased security, safety, convenience and comfort within the home. Other possible benefits include reductions in insurance premiums, and enhanced prestige. These attributes could be of enormous benefit to groups such as women, the elderly or people with handicaps, enabling them to maintain a larger degree of independence with increased safety and security through the use of automated and/or remote control of the various functions within the home environment.

An examination of these concerns provides the following implications:

- an unwillingness by the market to pay a premium for the inclusion of smart systems within residential housing;

- perceptions of a high rate of technological obsolescence due to the incorporation of centralised computer controlled systems within the house infrastructure.

These concerns could promote reluctance by developers to depart from their traditional products. However, research by (Von Hoffman 1998) suggests that under many circumstances properly marketed smart home systems can have a broad market appeal to new home buyers. This situation could create market opportunities for some firms who recognize the potential of the technology and incorporate it into new homes.

Aim of the Research

Recognition of the benefits associated with smart home technology for energy, security, safety, convenience, and communications management within residential housing is still quite low. This lack of understanding may be exacerbated by the technology suppliers who have often focused their marketing efforts on the prestige housing market by highlighting aspects unrelated to the practical benefits available from smart home systems.

Whether the market recognises these intrinsic benefits and is prepared to pay an appropriate premium for them is currently unknown. Therefore, this paper examines the monetary value added (if any) by the inclusion of smart technology in new homes. In addition, this research seeks to understand how new homebuyers value the use of "Smart Technology" and its associated capabilities. The aim of the research was to establish whether inclusion of smart technology adds to the market value of new houses.

- To provide an indication of the likelihood of the future acceptance of "smart technology" within the residential market, enabling the development of more effective strategies to encourage its inclusion into new housing;

- Determine the characteristics of those homebuyers who have demonstrated an interest in the use of "smart technology"

- Discover the impact of Smart technology on home purchasing decisions.

Background

Smart service technology aims to integrate the control and operation of domestic appliances and systems in order to increase convenience and efficiency within the home. This technology has emerged as a result of the successful development of "intelligent" commercial buildings that incorporate a range of proven integrated and automated systems.

According to (Atkin 1988)intelligent buildings can be summarised as "high technology spaces containing their own sophisticated technology to monitor and control the internal environment."

The concept of an intelligent building is further defined in a report published in 1987 on the Japanese construction industry (Atkin 1988)which identifies three attributes that an intelligent building should possess:

1. Buildings should "know" what is happening inside and immediately outside.
2. Buildings should "decide" the most efficient way of providing a convenient, comfortable and productive environment for the occupants.
3. Buildings should "respond" quickly to the occupants' requests.

Market Issues

The market for smart wiring and home automation systems is still in its infancy in Australia. Understanding of the capabilities of these systems is currently very limited within the housing industry. Some industry experts believe that the bulk of the current market is made up of a combination of wealthy individuals and technophiles (Von Hoffman 1998). These groups have become aware of the technology through travel and/or industry exposure.

Some of the major impediments to market expansion include perceived costs and payback periods, user interfaces (central controllers/computer software), and mistrust of technology. Because the market is only now beginning to develop, it may be reasonable to suggest that marketers and practitioners be aware that attempts must be made to encourage a common focus and to ensure compatibility between systems.

The best way of ensuring compatibility is by using systems incorporating open architecture that will enable interoperability between disparate systems. Open architecture also allows further development of systems (including using "add-ons") at a later date for enhancements and updates if required, with minimal disruption. By observing these parameters, obsolescence and compatibility problems should be minimised, enhancing both the acceptance and usefulness of smart systems.

It is also interesting to note that anecdotal evidence has shown that the two groups who would derive great benefits from smart home technology, women and the older age groups, currently have little interest or hold negative views towards its installation. It is believed that this presents the possibility of strong growth once the benefits of the technology are more widely understood.

Surveys conducted by (Phillpot 1998) suggested that older age groups may have a slight interest in information technology but this interest currently does not extend to home automation systems. This opinion is confirmed by the results of market research undertaken in 1999 on behalf of the Victorian government[1] which indicated a great uptake in the use of technology by people aged over 55, especially the use of resources such as the Internet. The surveys indicated that people in this age bracket tended to have the time and inclination to investigate technology and were prepared to pay for it.

Costs for smart systems vary considerably depending on the system type, complexity, capabilities and home size. Promotional material available at the time of compilation of this research (Gerard Industries 1999) indicated that the installation of low voltage Category 5 wiring together with a basic security system will add around $1,500 to the cost of a new home. This option enables a basic modular system to be enhanced with the addition of extra features as desired at a later date. Systems including a full range of intelligent security, lighting, HVAC, home entertainment, and garden watering systems, all with remote accessibility via telephone networks, will add around 5% to the cost of a new home.

Methodology

The objective of this research was to discover if consumers value the inclusion of Smart Technology in residential construction. Anecdotal information has shown that a premium of about 5% of the capital cost of the building is required before a reasonable level of integration of technology can achieved. Thus, the question is what premium will homebuyers pay for the inclusion of Smart Technology, and what are the characteristics of those consumers.

Stonehenge Homes Pty. Ltd. “Williams Bay” estate is the first multi-lot residential development in Australia to include Smart Technology as part of the basic specification of all properties within the development. Stonehenge obtained Federal and State government grants to research the concept of integrating technology into residential developments. All homes feature basic home automation systems and wiring as a standard inclusion. In addition, the standard system can be readily upgraded if the purchaser wishes. The Williams Bay development adjoins the recently completed Rifle Range estate which is a development similar in all characteristics except that it does not offer Smart Technology.

[1] The research involved investigations and focus groups conducted by Acumen Multimedia to underpin the design and development of a web site for the Victorian government. An internal report “Evolution of www.vic.gov.au” has been produced but had not been released for public perusal at the time of writing.

The research comprised two parts:

1. Market analysis to establish the value of premium paid for buildings containing Smart technology. This was undertaken using an analysis of recent sale prices of properties in "Williams Bay" and comparing that with the sale prices of homes having similar amenity in the Rifle Range estate nearby.

2. Comparison of the demographic and motivational characteristics of Smart Technology homebuyers with those of other similar homebuyers nearby.

The surveys comprised a multiple-choice questionnaire for individual completion by household decision makers. Provision was made within the questionnaire for clarification of the aims of the research, and technical definitions. Respondents were able to provide individual written responses to certain questions to enable clarification of responses.

The questionnaire was mailed to 42 purchasers of homes that had been sold within the Williams Bay development at the time the surveys were conducted (November 1999). A total of 23 responses were received from the case study group. A similar questionnaire was sent to 100 other purchasers of “normal” new homes within the greater Rifle Range estate (i.e. control group). A total of 87 responses were received from the control group, consequently the response rate for the whole study was 70% (100/142).

The aim was to compare the responses obtained from buyers of homes containing some smart technology, with those of a control group. Survey responses from both groups were then subjected to statistical analysis and the results compared. The questionnaires aimed to classify respondents into various demographic categories from which certain behaviour, attitudes and opinions could be identified.

Results

The main aim of the research was to measure the price premium that a group of new homebuyers would pay for Smart Technology. The objective was to determine if the value of Smart Technology is reflected in the market price of the new homes. In addition, it is important to identify the characteristics of that group in order to compare them with the total population of homebuyers in Melbourne, Australia. The respondents of the control group were randomly selected and were considered to be typical of other middle-income homebuyers elsewhere in the community.

Market Research & Analysis

Analysis of market transactions was then carried out to examine whether prices were being paid for homes within the Williams Bay development (case study group) were similar to with prices achieved within the greater Rifle Range estate (control group).

Property values were established by examining land sales data from within the Rifle Range estate for the period January 1996 – September 1999. Sales of larger allotments were discarded, to avoid creating any subsequent distortions within the analysis. The data consisted of 118 sales of building lots of 550 square metres or less. This was done to reflect the allotment sizes contained within the home sales data set, from which a median price per square metre for each year was then calculated. This median value was then compared against each individual sale from the relevant year to adjust for price variations from year to year.

In other words, this allowed the sale price of each piece of land to be calculated as a proportion of the median, similar to an index. The median land prices from the data for each year, together with the standard deviations, are displayed in Appendix 1. Most of the price variations within specific periods can be related to the variables referred to previously, i.e., location, outlook, access, lot shape, and size.

Table 1. *1999 Home Sales Analysis Summary*

Control Group						**Case Study Group**					
NO. OF SALES	19	**LAND AREA (m^2)**	**LIVING AREA (m^2)**	**GROSS SALE PRICE**	**BLDG. AREA**	**NO. OF SALES**	25	**LAND AREA (m^2)**	**LIVING AREA (m^2)**	**GROSS SALE PRICE**	**$/$m^2$ BLDG. AREA**
MEAN		363	188	$397,421	$2,130	**MEAN**		245	189	$420,033	$2,251
MEDIAN		346	166	$349,000	$2,095	**MEDIAN**		256	188	$430,000	$2,218
STANDARD DEVIATION		74	57	$128,966	$336	**STANDARD DEVIATION**		55	47	$93,977	$280

The next step was to attribute a rating score of between 1 (Poor) and 10 (Excellent) to each vacant allotment to reflect the Location and Outlook, and Access and Lot Shape variables. Using a regression equation a predicted Y value representing the apportioned land value compared to the median, where the median value = 1. The results of the regression equation are shown in Table 2.

Table 2. Summary of the Regression Equation to Home Sales Rating Scores

Control Group			Case Study Group		
	PREDICTED $\hat{Y}$	**ESTIMATED LAND VALUE ($/m^2)**		**PREDICTED** $\hat{Y}$	**ESTIMATED LAND VALUE ($/m^2)**
MEAN	1.292	$495	**MEAN**	1.448	$554
MEDIAN	1.187	$454	**MEDIAN**	1.434	$549
STANDARD DEVIATION	0.354	$136	**STANDARD DEVIATION**	0.169	$65

The Standard Error of the Estimate, SE is relatively low indicating that the observations are not widely dispersed from the estimate (Flaherty 1990). Further examination of the outcomes show a very high coefficient of determination (r^2) of 0.9422, and a corrected coefficient of determination of 0.941. This indicates the 94.1% of the variation in land values are attributable to variation in location, outlook, access, lot shape and size.

The resulting equation

$$\hat{Y}= 1.363 + 0.0816X_1 + 0.1672X_2 + -0.0036\ X_3$$

Where: $\hat{Y}$ = Predicted value per square metre of land
X_1 = Rating score of location and outlook (1-10)
X_2 = Rating score of access and lot shape (1-10)
X_3 = Allotment size in square meters

The predicted $\hat{Y}$ values for the individual properties were then used as a multiplier against the 1999 median land value of $382.78 per square metre, to estimate the underlying land value. The summary reveals a lower estimated average land value on a $/m^2 basis, combined with a greater variation in values for properties for the control group. This is related to the wider range of properties and the larger average lot sizes in the Rifle Range estate. However, the summary also indicates that the overall price range is reasonably similar in both data sets.

Minor rounding adjustments were then applied to the predicted land values. These adjusted values were used to provide the final calculation of the underlying land values (See Table 3).

Table 3. Summary of Underlying Land Values

Control Group			Case Study Group		
	ADJUSTED LAND VALUE ($/m^2)	**UNDERLYING LAND VALUE**		**ADJUSTED LAND VALUE ($/m^2)**	**UNDERLYING LAND VALUE**
MEAN	$501	$178,856	**MEAN**	$554	$132,562
MEDIAN	$460	$169,650	**MEDIAN**	$550	$138,240
STANDARD DEVIATION	$129	$49,415	**STANDARD DEVIATION**	$65	$20,398

The underlying land value is removed from the sale price to reveal the added value of the improvements. The value of other improvements such as garages, carports etc. is then removed, revealing the added value of the home itself. In order to achieve a more accurate comparison between properties, where applicable the value of a garage was subtracted from the gross added value. The added value of garages was assessed as being $20,000 for a single garage and $30,000 for a double garage. (See Table 4)

Thus, The "Added Value of Improvements" (AVI) for each property is:

AVI = Gross Slae price -[Adjusted Land Value ($/M2) x Land Area (M2)] - Value of Garage ($)

These calculations revealed the net added value of the improvements (See Table 4).

Table 4. Summary of Net Added Value of Improvements

Control Group			**Case Study Group**		
	ADDED VALUE OF IMPROVEMENTS	**ADDED VALUE OF IMPROVEMENTS ($/m^2)**		**ADDED VALUE OF IMPROVEMENTS**	**ADDED VALUE OF IMPROVEMENTS ($/m^2)**
MEAN	$193,302	$1,003	**MEAN**	$260,441	$1,371
MEDIAN	$171,750	$1,022	**MEDIAN**	$226,260	$1,348
STANDARD DEVIATION	$88,466	$209	**STANDARD DEVIATION**	$67,710	$164

These results show (Table 4) that the net added value of the improvements within the case study group is considerably higher than is found elsewhere in the control group, even after allowances have been made for variations in location, outlook, access, lot shape, and house and land size. As a result the major differentiating factor between the two groups is the inclusion of smart home technology within the case study development. Thus the difference between the mean values of Smart Technology homes and other similar properties is $368/m^2 ($1371 – 1003/ m^2)

Some minor differences in house values between the group may still occur due to slight variations in the quality of finishes and other intangibles. However, the results (Table 4) suggest that the use of Smart Technology is a significant contributing factor to the price premium paid by new homebuyers. In addition, the value premium of the Smart Technology 27% ($368/$1371) seems to substantially exceed the cost of installation by a significant margin, the manufacturers have suggested that installation to be about 5% of the cost of house construction costs (Gerard Industries 1999)

Distinguishing characteristics of Smart Technology Consumers

The results of the sale price research above demonstrate that a premium is paid for homes that have Smart Technology. The next stage of the research is to determine the nature of the people who purchased Smart technology homes and compare them to other homebuyers. A questionnaire was developed and sent to household decision-makers, from residents in the Williams Bay development, ie the case study group, and a control group consisting of residents of the greater Rifle Range estate. The aim was to analyse the responses from both groups separately to ascertain whether any discernable differences between the two groups emerged.

Demographic Factors

The first section of the survey investigated the demographic background of respondents. This information was used to forecast demographic characteristics of the various groups in relation to smart home technology. Appendix 2 summarizes the comparative classifications based on analysis of the respective survey responses from both case study and control groups. Responses from both groups reveal a very similar profile in most classifications.

The results show that the Smart Technology homebuyers are slightly more likely to be professionals or para-professionals and have slightly higher levels of income. The demographic information shown in the appendix was subjected to Chi-tests at the 95% level to determine if significant differences occurred. Although there are minor differences between the means of the two groups, the results of the Chi-tests showed that no significance difference occurred at the 0.05% level. The results confirm that it is possible to be 95% confident that the demographic characteristics of the two groups are the same. (See Table 5)

Table 5. Results of Chi Test between case study group and control group

Demographic	chi-square Statistic	Critical Chi Statistic	Chi Probability*
Gender	0.14	3.84	0.71%
Age	5.91	12.59	0.43%
Education Level	3.39	7.81	0.33%
Occupation	1.69	15.5	0.98%
Income	2.67	9.48	0.61%

* Chi Probabilities exceeding 0.05% indicates is no significant difference between the groups

Interpretation of the survey responses suggests that, properly marketed, smart home systems could have a broad market appeal to new home buyers. This situation could create market opportunities for developers and builders who recognise the potential of the technology. By developing a strong understanding of the systems and offering it as part of their new home packages, developers and builders could obtain a marketing edge over their competitors.

The results of the two groups show that there are no significant differences in; gender, age, education, occupation or incomes. The case study group seems to be similar to the control group, except that they chose to pay a premium for Smart Technology. It may be reasonable to suggest that the case study group paid a premium for the Smart technology because they believed it has a high intrinsic worth to them. However, they did not seem follow the stereotypes suggested by earlier research i.e. wealthy technophiles

This somewhat surprising results shows that high incomes are not a prerequisite for the adoption of Smart Technology. Marketers of the technology should be aware that this study suggests that there was no significant difference between the demographics of the control group and the case study group respondents. Consequently, an individual attitude or other issues may influence the choice.

However, a recent investigation by (Phillpot 1998) concluded that factors hampering acceptance of the technology include:

- Perceived excessive cost and lack of savings over life cycle of the system;
- Waiting for further advances in the technology before accepting it;
- Lack of knowledge of the availability of the technology and a lack of understanding of its applications;
- Dislike or distrust of new and unfamiliar technology, especially among older age groups.
- Concern over the implications of failure of a centralized control unit;
- Desire to distance self from work whilst at home.

The next section of the research considers the type of attitudes displayed by the purchases of Smart Technology homes.

Factors Influencing Purchasing Decisions

In addition to the above demographic data, the survey respondents were also asked to rate the importance of a number of factors that impacted on their new home purchasing decision. Respondents were required to rate their attitudes to factors considered to be important in use of Smart Technology, using a 5 point Likert scale the level of importance of these factors play was collected for both groups.

Once again the responses from both groups were reasonably similar with Location; Value for Money; Layout, Accommodation and Usability; and Quality, being rated highly by both groups. All categories except Adaptability for Home Office returned a mean score of 3 (of 5) this relates to "Reasonably Important" or better.

Discernable differences emerged in the classifications

It is interesting to note that the case study group, being purchasers of homes featuring the Smart technology placed a higher degree of importance on; Investment Potential, Builder's Reputation; Security Features; Comfort & Convenience Features; Communications Facilities; and to a smaller extent, Quality. While all these categories carried a mean score over 3 "Reasonably Important" the scores were slightly higher in the case study group than was evident in the control group. "Other" factors viewed by some respondents as having some degree of importance included Home Orientation, and the inclusion of Integrated Systems.

In order to show what factors were considered the most important scores and ranks for each category are listed in Table 6. This clearly shows that; Location, Quality; Investment Potential, Value for money, Accommodation & Layout, were clearly very important issues to both groups.

Issues that may potentially grow more significant in the foreseeable future include; Energy Efficiency; Comfort & Convenience Features; Security Features; and Communications Facilities; were not rated highly by either group. This is interesting because Smart Technology offers considerable potential benefits in precisely these areas. In addition, these factors can have some influence on Investment Potential, Price, and Quality.

Table 6. Ranking Scores of Motivation Factors in New House Purchase Decisions

Factor	Case Study Group	Control Group
Location	1	1
Quality	2	2
Investment Potential	3	7
Value for Money	4	3
Builders Reputation	5	10
Accommodation & Layout	6	4
House Style	7	6
Home Comfort & Convenience	7	8
Price	9	5
Security	10	11
House Size	11	9
Energy Efficiency	12	12
Communications	13	14
Land Size	14	13
Useability	15	15

Discussions and Conclusions

Smart Technology represents a major step forward in the development of Australian housing. As with any property decisions developers must make their own assessments on system choice and applicability, including the associated costs and margins. This research proves that the technology adds value to residential housing which indicates that suitable target markets may be larger than first thought.

This research indicated that most survey respondents were happy to use modern high technology equipment in their household. The research also indicated that "quality" was a highly rated factor in people's general purchase decisions. Respondents also indicated that "Value for money" and "Builders reputation" was the two important features they consider when choosing new homes.

Many property professionals and trades-people still do not fully understand the characteristics, capabilities and attributes of automated home systems. While this low level of understanding of the technology at a technical and professional level exists, the uptake of Smart Technology by the wider new home market may also remain at a relatively low level.

This situation could create market opportunities for developers and builders who recognise the potential of the technology. By developing a strong understanding of the systems and offering it as part of their new home packages, developers could obtain a marketing edge over their competitors. Interpretation of the survey responses suggests that properly marketed smart home systems could have a broad market appeal to new homebuyers.

The market analysis study showed that a considerable premium over normal housing was being paid for homes featuring elements of smart home technology. The results showed that there is a $\$300/m^2$ differential which emerged in the net added value of the improvements. While some minor differences between the homes may still occur due to slight variations in the quality of finishes and other intangibles, the results suggests that the use of Smart Technology is a significant contributing factor to the price premium.

Evidence from smart home technology suppliers suggested that there has been some reluctance from women and the elderly to embrace smart home systems, two groups who could derive significant benefits from the technology. However, the survey responses in this research indicates that there now seems to be widespread interest in the inclusion of a basic Smart Technology in a new home.

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APPENDICES

Appendix 1. *Rifle Range Estate Median Land Values for Lots Below 550 Square Metres*

YEAR	NO. OF SALES	MEDIAN LOT VALUE	MEDIAN LAND VALUE ($/SQ.M.)	STANDARD DEVIATION
1999	5	$160,000	$382.78	$29.22
1998	12	$155,000	$364.27	$164.55
1997	50	$158,500	$399.51	$94.59
1996	51	$75,750	$171.65	$93.93

Appendix 2. *Demographic Profile of Survey Respondents*

Demographic	Control Group	Case Study
GENDER		
Male	61%	65%
Female	39%	35%
	100.00%	100.00%
AGE		
<20 yrs	1.15%	0.00%
21-30 yrs	18.39%	4.35%
31-40 yrs	47.13%	39.13%
41-50 yrs	17.24%	34.78%
51-60 yrs	11.49%	13.04%
61-70 yrs	4.60%	8.70%
>70 yrs	0.00%	0.00%
	100.00%	100.00%
EDUCATION LEVEL		
Primary/some secondary school	6.90%	13.04%
Secondary school	17.24%	21.74%
TAFE/Vocational Course	18.39%	4.35%
University degree	57.47%	60.87%
	100.00%	100.00%
OCCUPATION		
Professionals	24.71%	26.09%
Para-professionals	47.06%	56.52%
Tradespersons	2.35%	4.35%
Semi-skilled	12.94%	8.70%
Unskilled	1.18%	0.00%
Retired	4.71%	4.35%
Home Duties	4.71%	0.00%
Other	2.35%	0.00%
	100.00%	100.00%
INCOME		
$0 - $29,999	20.25%	10.00%
$30,0000-$49,999	22.78%	25.00%
$50,000 - $69,999	24.05%	20.00%
$70,000 - $99,999	12.66%	25.00%
$100,000+	20.25%	20.00%
	100.00%	100.00%