

Nordic Journal of Surveying and Real Estate Research, Special Series, Vol. 3 (2008)

Received on 8 June 2007

and in revised form on 01 August 2007

Accepted 1 August 2007

Property values and infrastructure provision: A conceptual model of risk perception, amplification and worsenment.

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Abstract: *There are numerous conflicts between stakeholders and suppliers in Australia and elsewhere about the placement of infrastructure. The general aim of suppliers involved in land acquisition and infrastructure provision is to be more effective, efficient and equitable. Hence, a better knowledge of the impact of externalities on people and communities as stakeholders is required if public concern about threats to their financial and general wellbeing, perceived or otherwise, is to be ameliorated. To this end, this paper develops a conceptual model that facilitates understanding of the attitudinal component of stakeholder concern in terms of risk perception which is ultimately seen to govern outcomes involving the stigma of place and depreciation in property value. An important input into the conceptual model is the externality of property interference and the land acquisition process itself. Individuals react to coercion and will resent the intrusion of an authority for fear of falling property values. In addition, the land acquisition process itself is crucial to risk perceptions of affected land owners since, from previous studies, the severity of risk and its impact are accentuated in cases where measures are involuntary and imposed. It is proposed that the model as outlined above can be applied to many types of infrastructure provision. The provision of High Voltage Overhead Electricity Lines (HVOTL) is analysed within the model provided.*

Keywords: *Conceptual model, infrastructure hazards, risk perception, stigma of place and property value.*

1 Introduction

The placement of infrastructure has serious impacts on people, communities and property values. Consider this recent report taken from the suburban

press in Brisbane, Australia. Plans outlined by the Mt Lindesay-North Beaudesert draft investigation area report will effectively "wipe Chambers Flat out". This claim was made by a Chambers Flat resident, who did not wish to be named. She told *The Leader* that the combination of 110kV power lines and the intersection of the proposed extension to the Gateway Motorway and the east-west arterial road would destroy property values and leave residents "in limbo". "Property around the intersection that will either be completely resumed or badly affected will have virtually no market value." She said a conversation with the Office of Urban Management had left her in doubt about the possibility of compensation. "(I was told) the plans were conceptual and a long way off, perhaps up to 15 years, so there is no hope for compensation or a buy-out anywhere in the near future that would enable people to buy into a similar rural lifestyle anywhere else," she said. Her concerns added weight to those voiced by Ray White real estate agent Michelle Reginato, who agreed that land owners would be the "big losers" (*Logan West Leader*, October 26, 2005). Such a report is no doubt typical of similar experiences in both Australia and overseas.

A prevalent characteristic of the proposed placement of linear infrastructure is the spill over effects on the community and local property owners who see their amenity or business operations as likely to be impacted. Such effects can also be demonstrated in the post placement scenario of infrastructure. They are classified as real or perceived externalities, regarded in microeconomics as non market benefits or costs which accrue to an individual, group or firm as a direct result of consumption or production by another individual group or firm for which no price is paid or payment received (Balchin et al, 1995). Understanding the impact of these externalities is important to the suppliers of infrastructure and those affected by the establishment or extension of infrastructure who want greater certainty about the process and outcomes, and how their economic or domestic operations are likely to be affected.

What is required is a conceptual model that incorporates a comprehensive dissection of the causes of the depreciatory effect in property value and facilitates an analysis of worsenment. It is recognised that infrastructure provides essential services that provide significant benefits to the community and providers are required to meet legal obligations and take reasonable care when undertaking infrastructure developments. However, the reasoning is that, if worsenment and its roots could be further understood, it might be possible for authorities responsible for infrastructure provision to better inform and advise individuals and the community in the lead up to their infrastructure placements and hence ameliorate the adverse effects of infrastructure provision and the associated processes compulsory purchase. In addition, the links between property value variations and real estate market behaviour need to be fully clarified. How variations in patterns of property value are shaped by the processes of worsenment need to be explained. For the purposes of this paper worsenment is defined as the decrease in land value created by the provision of infrastructure.

This paper outlines a conceptual model which facilitates the explanation of variations in worsenment associated with infrastructure provision and links these value impacts to factors that cause variations in public perceptions of infrastructure hazard. It is based on the precept that social processes drive residential property price patterns, and that market behaviour and property prices will vary from place to place and will be shaped according to the social settings and risk profiles of participants in the market. The starting point for the model is that the provision of infrastructure is an externality cost. It can generally be viewed by the public as a technological hazard and perceived as one of many risks to be considered in making decisions about life and, more particularly, choices about real estate purchase.

2 Infrastructure hazard, risk perception and declining property values.

The provision of new infrastructure can be seen as a hazard and a danger to people and the community whose backyard is affected. Infrastructure hazards can be classified as technological hazard which are generally defined as threats to humans and what they value. (Hohenemser, 1983). Measuring the impact from technological hazards involves a risk evaluation process. Whilst the more quantitative approach to risk evaluation is normally undertaken by experts in the field and could be labelled “risk assessment”, most people or “non experts” rely on intuitive judgements and a more subjective interpretation of the hazard’s attributes: these judgements are commonly referred to as risk perception (Slovic, 2000).

Risk perception and its assessment influence buyers’ and sellers’ attitudes to decisions about real estate price and value. Property prices are determined not solely by actual utility but by buyers’ and sellers’ perceptions, including any about environmental or technological risk that could affect that utility. Property prices, then, are construed and constructed by people and predicting price involves predicting how people will behave in the market context and its social settings. Factors which drive the market are numerous and are significant only in how they influence the behaviour of buyers and sellers (Ratcliffe, 1979). Technological risk is just one of many factors which contribute to market behaviour. Residential real estate is considered as an investment asset as well as consumption good and is particularly sensitive to social settings, (Adams and Cantor, 2001). Hence, purchase decisions involve not only the personal perceived loss of utility as a consumption good in terms of lost views and compatibility of adjacent land uses, but also a loss of investment value if prospective purchasers in the future perceive the place as stigmatised. The process of stigmatisation involves more than personal anxiety about risk attributes of infrastructure. Social amplification of risk contributes to the stigmatisation process and, hence, would add to the reduction in property price. This further reduction in price can be referred to as investment depreciation.

Technological risk, stigma and depreciating property value, as far as infrastructure such as roads, railways and utilities are concerned, can be directly related to risk perceptions and attitudes towards their negative externalities. They can be seen as the potential 'causes' of variations in real estate values. However, as much as these 'causes' are necessary determinants, the proposed conceptual model argues that they are not in themselves sufficient completely to explain changes in real estate value. Other factors such as community or individual attitudes govern effects on property values and need to be analysed. Hence the proposed conceptual model incorporates cultural theory which argues an individual's risk perception is formed by their world view or ideology (Adams, 1995).

3 Risk perception, stakeholder attitudes and cultural theory

Attitudes with respect to risk acceptability and tolerance can be set within typologies of human nature (Adams, 1995) and differentiated by the nature of stakeholder as described in Figure 1. Perceptions of risk could be expected to vary, as far as infrastructure provision is concerned, according to the private property rights affected and the nature of property rights. Also risk perception might be affected by levels of knowledge and information available to the stakeholder. In addition people will form groups such as resident associations which have different collective perceptions of risk from environmental protest groups. There will be planners and representatives of corporations who also have perceptions of risk based on different social constructs. On the basis of cultural theory, then, responses to individual risk perceptions vary systematically across different types of individual according to their world view or ideology. As such, perceptions of how the provision of infrastructure influences purchase and sale decisions and, hence, real estate value requires an investigation into attitudes towards property risk and the role of property ownership in wealth creation. Cultural theory suggests some populations will be more risk averse than others and

Figure 1 provides one basis for classifying such populations

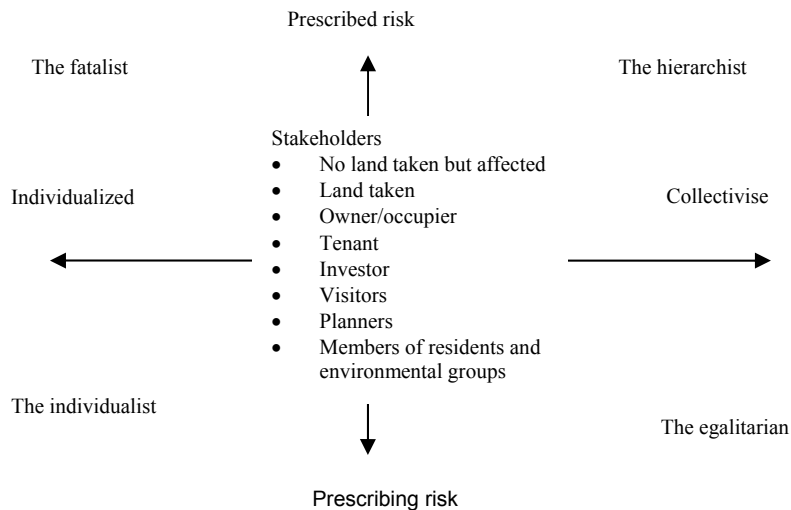


Figure 1. Risk perception and infrastructure stakeholders. Source: Based on Adams (1995: 45)

prescribed moving from bottom to top of the vertical axis. At the top of the axis, risk is perceived as predictable to a degree and regulation is required to prevent major excesses. At the bottom, risk is something that can be accounted for in personal decision making. In this context, egalitarians might be described as cautious and risk averse and individualists risk takers, or at least, willing to make decisions on their perceptions of risk. In either case risk can be seen as driven by the makeup of individuals or controlled by rational decision making about environmental factors, rather than dependent on social context and determined largely by the individual's stance to risk positions. Stakeholder attitudes and responses to infrastructure provision, then, can be related to whether risk is perceived as prescribed and imposed, or the opportunity exists for making rational decisions based on risk profiles.

Risk perception of infrastructure provision will relate to concerns about compensation and investment, acceptable levels of impact on public and private goods, fears about personal health and trust in government processes to be equitable. All these factors, although possibly subjective, can be considered as cause of stigma and loss in property value often associated with the provision of infrastructure. Understanding the stakeholder stance to risk perception might assist corporate utilities to formulate strategies that involve different forms of compensation and different approaches to participation in decision making. Prescribed risk might be linked to corporate utility strategies that improve trust and manage media communications in certain ways.

Existing frameworks of analysis

A significant literature already exists relating to risk perception and stigma. In particular Kasperson et al (2005: 172) advances a risk stigmatisation framework with respect to the siting of hazardous activities which proposes

that the stigmatization of place develops in three stages. Central to the process is the role of perceived risk which individuals and communities associate with the threat of technological hazards.

This framework can be adapted, as indicated in Figure 2 below, to specifically apply to infrastructure provision. It proposes that the perceived risk of place induced by the externalities of technological hazards results in changes to real estate market behaviour. Further, it argues that the social amplification of risk and marking associated with the provision of such hazards alter the identity of place in close proximity to the proposed siting of the hazard. To summarize, the infrastructure itself becomes the stigmatized object, marking place and the physical focus for the stigma of place and devaluation of real property.

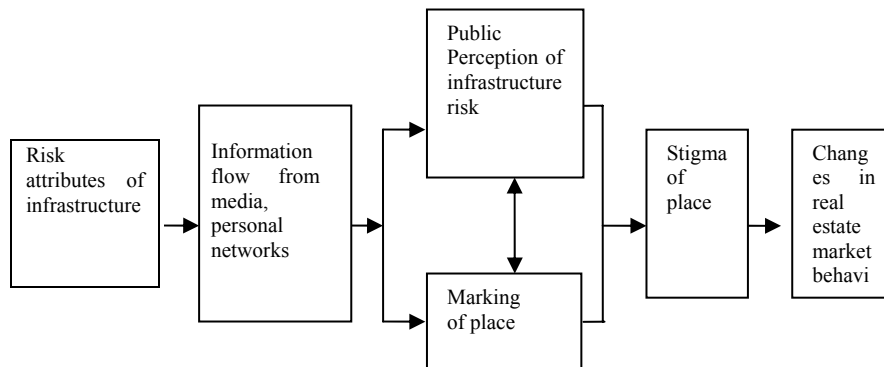


Figure 2. *The role of infrastructure in the stigmatisation of place. Source: Based on Kasperson et al (2005:172)*

The conceptual model proposed in this paper further develops the framework in figure 2 so that it:

- identifies and dissects the externalities / risk attributes associated with the provision of infrastructure.
- sets out the driving forces and factors causing variations in risk perceptions towards the provision of new infrastructure.
- proposes factors influencing the patterns of property value changes in the pre and post placement of infrastructure.

This conceptual model is set out in Figure 3 below.

4 A conceptual model of risk perception, amplification and worsenment

From Figure 3 it will be noted that the externalities form the inputs and hence the independent variables of the model. The outputs can be classified as either psychic or physical and are ultimately expressed in the pecuniary form of changes in real estate value. The mechanics of the perceptual model act as filters between the inputs and outputs which strive to explain a variety of concerns that might be expressed between and amongst the various stakeholders involved in the provision of infrastructure, as well as variations in property value. At the same time the provision of new infrastructure can also be viewed within two distinct phases, namely the antecedents of infrastructure provision in terms of the perceived risks of construction and the post placement impact on real estate value.

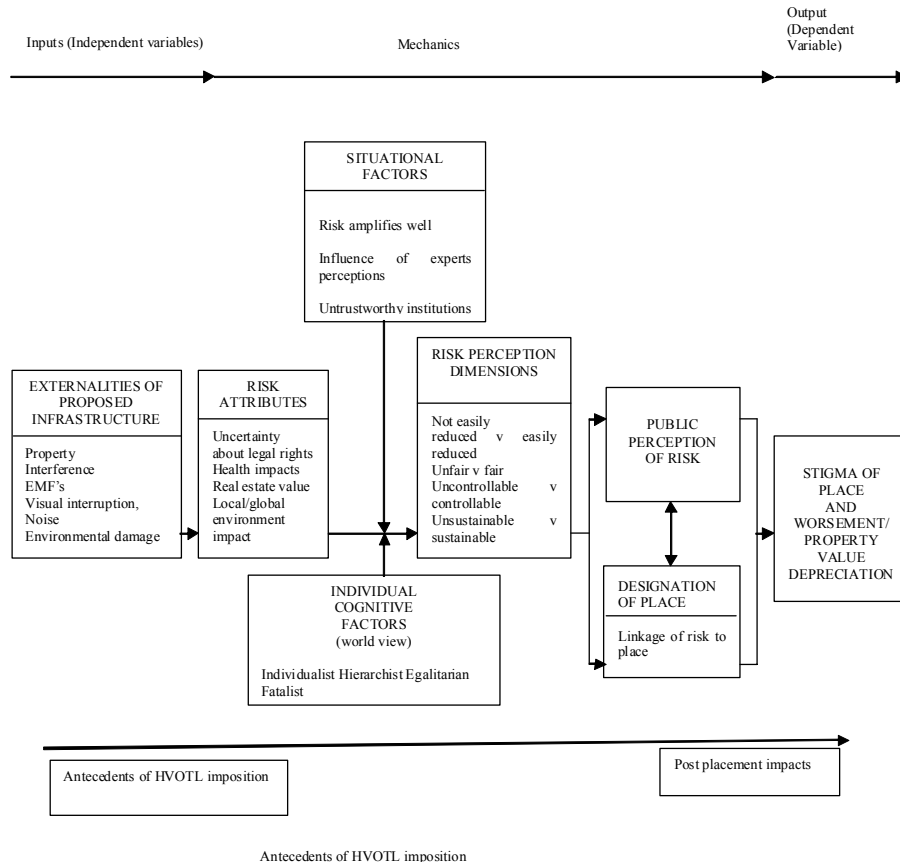


Figure 3.

Conceptual model of Externality Effects on Public Risk Perceptions and Worsenment.

The perceptual model first specifies the nature of the negative externalities to which people might react and express their displeasure in the form of depressed property values. The task of interpreting responses to these negative externality inputs of the model can be ordered into a number of subtasks that link the observable input to a person's behaviour and the stigma of place. For example, the publication of plans to construct infrastructure might be established as the key point in exposure to information flow about infrastructure risk. It can be interpreted by various affected individuals to mean that it could or would be difficult to sell their house for various reasons. They include possible health threats to children, and the fact that property values would be impacted. However, the model also argues that this interpretation relies heavily on prior knowledge stored in memory derived from such sources as media reports relating to environmental risk in general and infrastructure hazards in particular. Moreover, public perceptions about diminishing property values will be influenced by expert advisors such as real estate agents, valuers and real estate developers. Individual risk perceptions are not purely a function of exposure to information. Cultural factors or filters come into play in terms of an individual's world view or ideology so that some people are more likely to develop a more negative risk perception than others (Adams (1995: 37). Asymmetry of knowledge and self interest may also place undue weight on certain risks.

The newly-encoded information, therefore, together with knowledge stored in memory about infrastructure and other similar environmental hazards will provide the content of an individual's risk perception and the basis for further processing and behavioural responses which might range from acceptance to acts of protest and, ultimately, the stigma of place. As such, perceptions of how the provision of infrastructure influences purchase and sale decisions and, hence, real estate value requires an investigation into attitudes towards property risk and the role of property ownership in wealth creation. Cultural theory once again suggests that some populations will be more risk averse than others.

It is proposed that the conceptual model as outlined above can be applied to many types of infrastructure provision. By way of example, the provision of High Voltage Overhead Electricity Lines (HVOTL) is analysed below.

5 A conceptual model for the analysis of HVOTL hazard, risk perception and worsenment

Inputs. From past perceptual studies, it emerges that the bearing of HVOTL towers, lines and corridors as a direct influence on property value is understood in three domains: electric and magnetic fields, design and engineering. The interests in these arenas are respectively: health; visual impact; and noise and other possible outcomes. In addition, there are the externalities of property interference and various impacts on the environment

as a public good (Elliott and Wadley 2002). These externalities can also be classified at different levels, namely a micro and macro level. Micro level externalities are those whose impact is limited spatially in terms of proximity to the infrastructure.

The most publicised externality is electric and magnetic fields (EMF). The use of electricity produces two kinds of fields: electric and magnetic. The former occurs when an electric charge or voltage is present and is a product of the force which electric charges exert on each other. Magnetic fields are produced by the flow of electric current and are the basis of electromagnets and electric motors. Consequently, electric and magnetic fields arise from anything which produces, carries or is powered by electricity.

The possible health effect of electrical and magnetic fields on humans are matters of continued concern. The focal health outcome is, naturally, cancer and a fairly copious literature has emerged. The most frequently cited health risks are childhood leukaemia and neurodegenerative disease, although there are studies probing the effect of EMF on livestock, with obvious implications for rural property valuations near power lines. Still further works have investigated impacts on plants, insects and wildlife. While, overall, the literature about health effects remains inconclusive, it is clear that public concern continues as evidenced by HVOTL utilities adopting precautionary measures in relation to the siting and operation of infrastructure (Elliott and Wadley 2002).

Other micro level externalities listed in the perceptual model include the visual and sound intrusion of HVOTL. A number of studies have investigated the effects on adjacent property value. Other than this work and the strict engineering aspects of HVOTL, the literature on pylon and line designs and their visual impacts is comparatively underdeveloped. Virtually all high voltage transmission as opposed to low voltage distribution applications rely on steel rather than wooden structures. At higher voltages involving double circuitry, only tubular steel or steel lattices are practical construction options. There is little to suggest that alternative aesthetics have been tested on surrounding populaces, whether or not people's land is directly affected by line establishment. However, it is easily argued that the visual aspects of HVOTL are linked to the roots of stigma. Other reported micro level impacts have lines and structures acting as a large antenna, radiating electric and magnetic noise fields and interfering with nearby radio communications and television reception (Bigras, 1964; Delaney and Timmons, 1992; Dent and Sims, 2005) These possible externalities appear relatively insignificant in terms of public concern.

An important input proposed in the model is the externality of property interference and the land acquisition process itself. Individuals react to coercion and will resent the intrusion of a power authority for fear of falling property values. Whether libertarians or not, such individuals would value being left alone to enjoy their freehold or other rights. Moreover, they could resent the intrusion of a power authority for fear of the downzoning of land use and resultant falling property values. Such an attitude is rational, given

the results of prior studies that the severity of risk and its impact are accentuated in cases where it is involuntary and imposed. In addition, it is proposed that the land acquisition process is a vehicle for the social amplification of risk and therefore accentuates the perceived risk of new infrastructure.

A final externality can be identified at the macroeconomic level in that communities might express viewpoints about the environment or the 'public good', which run contrary to the intent of the power authority. An obvious example is the present concern about climate change and the need to generate and distribute electricity for economic growth. It can be assumed that externalities at the macro level will affect all individuals to a greater or lesser extent and, hence, will not impact on people and place differentially, an essential antecedent for stigma and the stigma of place.

In summary, the model proposes that externality effects combine in different ways for different people to cause individual risk perceptions. It assumes HVOTL is a technological hazard and a source of risk perception for information processing and the social amplification process, leading to inferences, judgements and decisions about the risk attributes which will be influenced by numerous factors now considered.

Mechanics

The mechanics of the model identify the various dynamic social and cultural influences that underpin risk perception and provide the source of the stigma of place. The initial influence is the information flow about the risk attributes of HVOTL provision. One vehicle for the information flow is the constructing authority and the land acquisition procedure itself. As such, the mechanics of the perceptual model recognises the role of institutions, and constructing authorities in particular, in the formulation of risk perception, since it is in these contexts that the risks of infrastructure provision are managed. Corporations, government authorities and social, environmental and political groups set the scene and reference points for society's debate about environmental hazards such as HVOTL provision. The behaviour of suppliers and the individual's perception of them are major sources of risk amplification and require investigation. The model, therefore, recognises that land acquisition procedures and the fear of property interference can be seen as a key starting point to the social amplification of risk.

Apart from the communications of the government or constructing authority, the model appreciates that people find out about technological risk associated with HVOTL provision through direct personal experience and the mass media. Communicators include the internet and more informal personal networks of friends and neighbours on whom individuals rely as reference points for reinforcing perceptions.

The model also assumes risk perception responses need to be considered in the social and cultural contexts of the individual and, specifically, the four rationalities or distinctive world views outlined by Adams (1995: 37). They include the view of the fatalist, individualist, hierarchist and egalitarian.

Additionally, it is argued that attitudes and responses to HVOTL are related to whether risk is perceived as prescribed and imposed or the opportunity exists for making rational decisions based on risk profiles.

Finally, the model identifies behavioural responses to individual risk perception in the form of the stigma of place and worsenment.

Output

Although perceptions provide a foundation for understanding changes in market behaviour and real estate price, they do not in themselves provide an insight into the stigmatisation of place. As cultural and social influences are the driving force underpinning the stigmatisation of place, it follows that variations in property price patterns will be shaped according to the social settings and risk profiles of participants in the market. Since they can be assumed to vary from one property sub market to another, the model suggests that post placement impacts on property value will differ according to the nature of the property market.

Further, apart from general variances in property value depreciation between property sub markets, there will be variances in property value patterns within sub markets depending on local factors such as proximity to the line, topography and design of both infrastructure and improvements effected.

Conclusions

This paper outlines a conceptual model which provides a basis for explaining the processes driving worsenment and moulding real estate behaviour in terms of real price outcomes. In brief, it seeks causality for public attitudes, perceptions and the formation of the stigma of place. It is proposed that hypotheses formulated from the model could constitute the basis for subsequent empirical impact investigations. With this in mind it is intended to undertake research through the application of the model to the provision of HVOTL in Australia. Large scale telephone surveys are to be undertaken to assess the public attitudes of externalities associated with HVOTL and identify the nature of potential threats generally perceived to exist from various forms of HVOTL infrastructure. The surveys will also probe public perceptions of electricity suppliers and HVOTL risk and the influence of experts on community perceptions.

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