

GATEWAY BRIDGE :
SHORT TERM IMPACTS ON INDUSTRIAL ACTIVITY

Associate Professor Trevor Grigg,
Graduate School of Management,
University of Queensland,
Brisbane.

ABSTRACT:

Road networks are usually changed incrementally so that it is difficult to isolate and quantify the impact of the changes from other factors influencing location choice and adjustment, industrial activity and, in particular, commercial vehicle movements. Consequently, when a major change in a network such as construction of the Gateway Bridge spanning the Brisbane River occurs, this presents a unique opportunity to focus on network impacts. The aim of this paper is to report on certain aspects of the short-term impact of the opening of the Gateway Bridge link on manufacturing industry. Specifically, the paper examines the relationship between the organisational 'setting' (ownership and control) of a manufacturing establishment and its pattern of spatial linkages and associated locational and transportation management choices. These relationships will be shown to be fundamental in assessing the short-term impact of completion of the bridge link. In an era when many industry commentators are arguing that increased road investment will enhance industry competitiveness, it is crucial that research which might assist in exploring the existence of such a link be undertaken. The Gateway Bridge opening has provided such a research opportunity.

BACKGROUND

The Gateway Bridge over the Brisbane River was opened in January 1986. The bridge, operating under franchise as a toll facility, spans the river some 9.5 kilometres from its mouth - refer to Figure 1. Brisbane's city centre and the nearest bridge crossing, the Story Bridge, are some 7 road kilometres upstream. No tolls are levied on any of the other six bridges crossing the river within the Brisbane metropolitan area.

The Gateway Bridge link represents a major change in Brisbane's road network because it provides an alternative route for river crossing north-south traffic on the eastern side of the city to bypass the inner city. The location of the Brisbane airport, the concentration of industry on the northern side of the bridge and the port facilities at Fisherman Island encouraged the expectation that the bridge link might reduce the need for road freight traffic to travel through the inner city. It was also anticipated that the river crossing would stimulate industrial activity and development on the southside. (It should be noted that a cross-river link in the form of the Queensport vehicular ferry operated one kilometre downstream of the Bridge from April 1966 until the Bridge opening. Ferry crossing time, including waiting time, averaged around 35 minutes with a toll structure similar to that of the Gateway Bridge.)

Proposals for a crossing at this site were mooted as early as 1960. Indeed, tenders were called for a north-south river crossing in that year but none were received. In 1965, the Queensland State Government commissioned 'Brisbane Transportation Study', conducted by consultants Wilbur Smith and Associates, recommended a north-south river crossing east of the city centre in the vicinity of the now completed Bridge. Acting on this recommendation, the Queensland Government set aside land for the Bridge approaches and approach corridors. Preparation of pre-tender documents commenced in 1970. Following a decision that the crossing (bridge or tunnel) would not be financed from public funding sources but rather would be operated under franchise as a toll facility, tenders were called in 1978. A bridge design was selected in 1979 and the Gateway Bridge Act was passed by the Queensland Parliament in April 1980 to permit the formation of the Gateway Bridge Company - a consortium of an engineering company, a construction contractor and an investment company. Construction of the Bridge commenced in November 1980. The Bridge was opened as a toll facility in January 1986. The northern and southern arterials links to the Bridge were completed in December 1986. From January to December 1986, access to the Bridge was via the existing network of roads.

Under the franchise, the Gateway Bridge Company is permitted to operate the Bridge as a toll facility for 30 years. The structure and level of the tolls levied is presented in Table 1. Travel time savings which can be achieved by using the Bridge instead of the other river crossings are substantial for some journeys. For a trip from one end of the Gateway Bridge to the other via the nearest river crossing, the Story Bridge, the travel time would be 25 minutes greater than that involved in crossing over the Gateway Bridge. (The travel distance is 14.5 kilometres greater.) By September 1986, when the data to be described in this paper

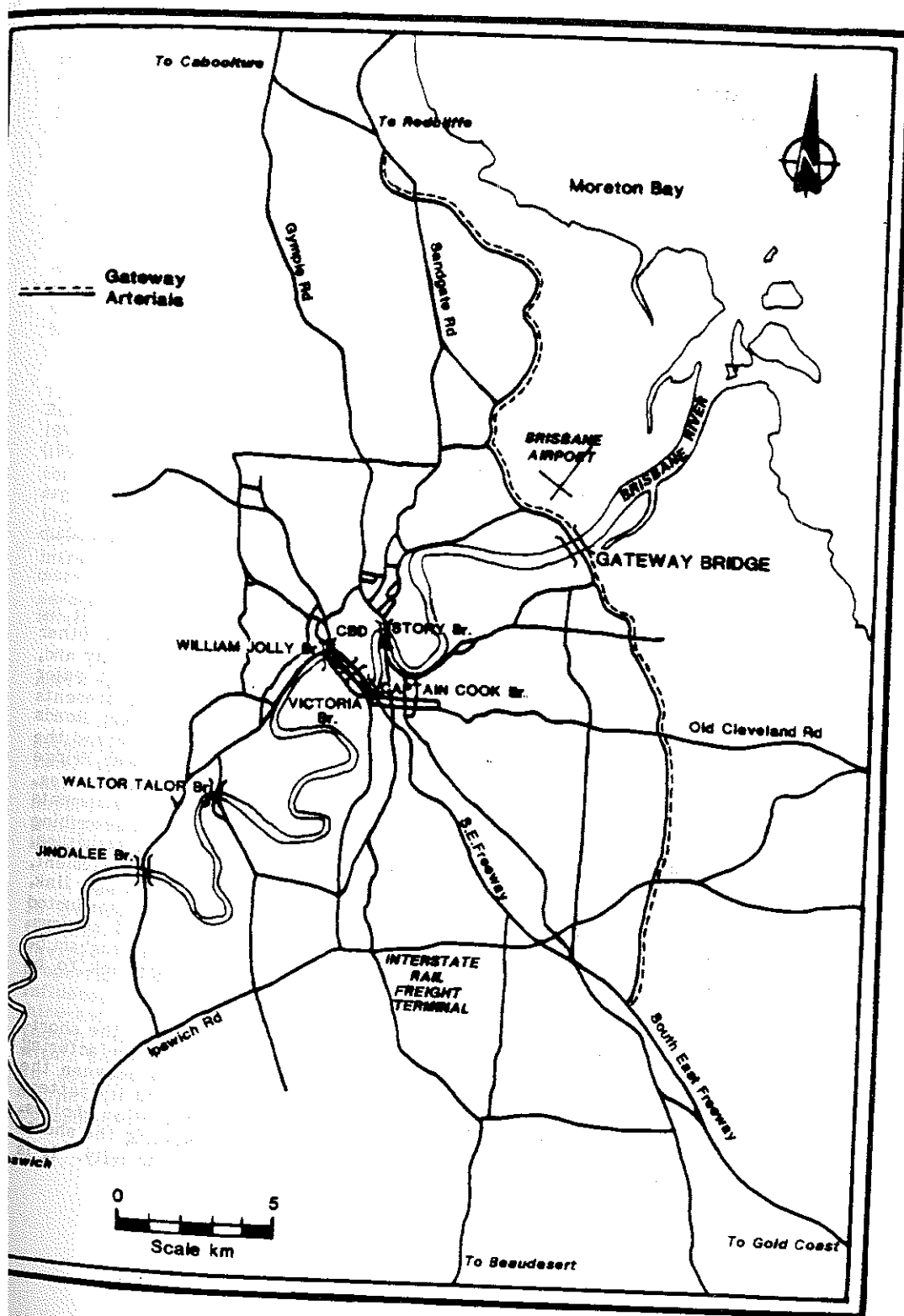


Figure 1. Location Map
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GATEWAY BRIDGE IMPACT

was collected, some 103,400 vehicles per week were using the Bridge, of which 5.7 percent were commercial vehicles.

Table 1. Gateway Bridge Tolls

VEHICLE TYPE	TOLL (One Way)
Motor Cycle	\$1.00
Car	\$1.50
Car and One Axle Trailer	\$2.00
Car and Two Axle Trailer	\$3.00
Truck - Two Axle	\$3.50
Truck - Three Axle	\$4.50
Truck - Four Axle	\$5.50
Truck - Five Axle	\$6.50
Truck - Six Axle	\$7.50

Road networks are usually changed incrementally so that it is difficult to isolate and quantify the impact of the changes from other factors influencing location choice and adjustment, industrial activity and, in particular, commercial vehicle movements. Consequently, when a major change in a network such as a new bridge crossing occurs, this presents a unique opportunity to focus on network impacts. The Main Roads Department (Queensland) recognised this opportunity and commissioned the author in February 1986 to investigate the impact of the Gateway Bridge link on industrial location and activity in the Brisbane metropolitan area. As the first stage of this project, some 400 industrial establishments throughout the metropolitan area have been surveyed and data describing establishment and company characteristics and organisational structure, location history, spatial linkage, physical distribution management, together with short term responses to the opening of the bridge link, have been assessed and analysed. Further interviews are to be conducted in mid 1987 to 'follow up' on issues raised in the first round of surveys. In addition, part of the commission requires that a monitoring program be designed to enable assessment of the impact of the Bridge link to be continued in the longer term.

The aim of this paper is to report on certain aspects of the short-term impact of the opening of the Gateway Bridge link on manufacturing industry. Specifically, the paper examines the relationship between the organisational 'setting' of a manufacturing establishment and its pattern of spatial linkages and associated locational and transportation choices. This relationship will be shown to be fundamental in assessing the short-term impact of completion of the bridge link on industrial activity. It is

suggested that, in an era when many industry commentators are arguing that increased road investment will enhance industry competitiveness, it is crucial that much more attention be given to industrial organisation and structure in research of transport and urban form. The opening of the Gateway Bridge has provided an appropriate research opportunity in this regard.

PREVIOUS AND RELATED BRIDGE CROSSING STUDIES

Concurrent with the study to be reported in this paper, the Australian Road Research Board have conducted interviews with trucking companies whose fleets use the Gateway Bridge. The focus is understood to be on the route decision making process and, in particular, the use of the travel time savings and the travel time/bridge toll trade-off.

There are a few reported impact studies of estuarine crossings. These include the Humber Bridge (Mackie and Simon 1986), the Forth Road Bridge (Macgregor 1966), the Tay Road Bridge (Jones and Pocock 1966) and the Severn Bridge (Cleary and Thomas 1973). Just as Simon (1984) concluded that none of the latter three bridges were directly comparable in their impact to the impacts of the Humber Bridge, so it is argued here that the Gateway Bridge link is not directly comparable to those four United Kingdom bridges. The major, and an important, difference is that the Gateway Bridge's major function is as a link in an intra-urban road network. The other bridges referred to perform a far more significant role as inter-regional links. There are never-the-less several useful findings from these earlier studies which can assist in the interpretation of the Gateway Bridge impacts.

ANTICIPATED ADJUSTMENTS BY INDUSTRY

The nature of the adjustments by existing manufacturing establishments to the opening of the Bridge link will no doubt vary over time. Some adjustments may involve locational changes. However, in the short-term, it is unlikely that locational adjustments will be a major impact, rather the adjustments will probably be largely confined to transport and market reorganisation - that is, buyer and supplier material linkage changes.

Transport costs typically represent only a small fraction (less than 10 percent) of total manufacturing establishment operating costs. Consequently, no matter how major is the change to a road network, the saving in transport costs to an establishment will be a very small proportion of its total costs. The level of savings could be further influenced by the extent to which an 'own account' as opposed to a 'hire-and-reward' truck fleet is used by an establishment. However, even though the savings may be relatively small, in a competitive situation within an urban area where input factor costs are spatially fairly uniform, an establishment's profitability may well be very dependent upon minimisation of the costs of accessing buyers and suppliers. Consequently, adjustments to transport routes used and scheduling to

achieve increased vehicle productivity, etc. might be anticipated in the short-term.

In the medium-term, adjustments in the form of increased (decreased) market penetration or market expansion (contraction) are likely to occur. The relative significance of these adjustments will be influenced by the pre-existing pattern of spatial linkages of an establishment, which in turn are likely to be heavily influenced by establishment's ownership and control, age, size and organisational setting (McDermott and Taylor 1982). Finally, in the longer-term, it is anticipated that certain locational adjustments will occur. These adjustments might include relocation, expansion at the same or another site and/or contraction of activity at the existing site. It would also be expected that the location choices of new enterprises in the Brisbane area would be influenced by the presence of the Gateway Bridge. The responses of existing and future enterprises will no doubt ultimately lead to a restructuring of Brisbane's industrial spatial linkage patterns.

DETERMINANTS OF SPATIAL LINKAGE STRUCTURE AND CHANGE - AN OVERVIEW OF PREVIOUS RESEARCH

Theoretical Approaches

Conventions from normative economics dictate that, within a free enterprise economic system and a perfectly competitive market environment :

- . all firms are treated as undifferentiated rational maximisers in search of a single goal, profit maximisation;
- . the factors of production are perfectly mobile;
- . the entrepreneur and owner of the enterprise are the same person;
- . the entrepreneur has perfect knowledge or information and is perfectly capable of using the data to minimise costs or maximise profits.

Profit maximisation is assumed to occur by achieving optimality with respect to scale and technical decisions, together with optimality of location. Early location theorists were concerned with the optimum location of firms in economic terms. It was the spatial attribute of linkage which interested location theorists because of the apparent relationship between minimised linkage length, external economies and industrial agglomeration. The theoretical explanation of agglomeration as both a product and a cause of external economies began with Weber. Although later authors have reformulated or embellished Weber's ideas, the essence of this framework remains the direct costing of production at various locations, with the minimisation of transport costs seen as a rational economic goal. Since linkage length will determine transport cost, linkage is considered an important locational determinant, in conjunction with factors such as proximity to raw materials, markets, labour force, etc. Many other studies have adopted this particular conception of the manufacturing firm being run by 'economic man', together with the implication that only the cost characteristics of material linkages (and to a lesser extent, service linkages) are important for location decision making.

Since the mid 1960's there has been a progressive shift in studies of industrial location away from the economic determinism imposed by the adoption of maximising principles. The less restrictive behavioural approach assumes that the organisation is controlled or operated by a coalition of 'boundedly rational' individuals making 'satisfying decisions' in order to cope with the uncertain and dynamic environment which confronts them (Pred 1969). Multiple goals are likely, especially where there are a number of decision makers. Most firms seek some level of profitability and some may strive for maximum profit. Many firms also seek to achieve other goals, such as

- . growth of the firm;
- . large control of the market for particular products;
- . diversification of interests;
- . entrepreneurial satisfaction;
- . security or the minimisation of uncertainty and risks and self preservation (Pred 1969).

The behavioural approach to this topic recognises the suboptimal aspects of behaviour and that individuals' perceptions and goals will affect the operation of the modern organisation.

Role of Establishment Characteristics

Based on this behavioural approach, the spatial linkage structure of manufacturing plants have been partially explained by internal plant characteristics, namely, ownership and control, size, age, methods of production and organisational dynamics. These variables have been assessed to influence linkages and also the nature and extent of linkage change.

Ownership and control concerns the degree of decision-making autonomy enjoyed by the management of an establishment. Also, enterprises with single site plants may have different goals and behaviour patterns from enterprises with multi-site plants. Organisational dynamics includes three kinds of organisational changes :

- . technological change (involving new input on service requirements)
- . management change (alteration of the personnel decision-making structure) and
- . growth of the firm.

Nature of Linkages

Although linkages have been discussed mainly in terms of distance, the nature of linkages is far more complex than this. Linkages may be analysed in terms of where they are made, the relationship they represent between organisations, and the type of goods, information or services involved.

Linkages may be either internal or external to the firm. The relationship between ownership and control and service linkage internalisation is important. For example, branch plants may obtain services internally or through inter-firm or intra-firm transactions.

Linkages may also be classified by the relationship they represent between different organisations in the production process. Estall and Buchanan (1961) described linkage in terms of economic integration as follows :

- vertical linkage : the inter-relationship of separate firms each forming one stage in a series of operations. One firm might process an article; its output then becomes an input to another firm;
- horizontal linkage : separate but related firms produce individual parts and accessories that come together to be assembled as the finished product;
- diagonal linkage : firms produce a product or provide a service required at various stages in the vertical process but do not form a link in a given chain of processes.

Three types of linkages can be identified - material, service and information linkages. Material linkages involve the movement of goods, both inputs and outputs of the manufacturing process. Service linkages relate to the supply of machinery and equipment and of ancillary parts, as well as repair and maintenance requirements when supplied by separate firms. Information linkages are concerned with the supply of facts, ideas and technology. Most research studies have dealt with material linkages and to a lesser extent service linkages. Few have incorporated the 'important' information linkages.

Linkage Attributes

The linkage pattern of a manufacturing plant has certain attributes which determine its relationship with other organisations in economic and spatial terms. They include linkage strength, complexity and spatial arrangement.

Linkage strength

- Links are considered strong if they are critical in supporting a manufacturing plant. Linkages could also be considered strong if they are efficient. The efficiency of the linkage involves factors such as price and cost competitiveness, quality, convenience, and the benefits of a long standing working relationship.

Linkage complexity

- This refers to the absolute number of external linkage contacts a plant may possess. This is obviously related to the degree to which manufacturing organisations internalise the service and production functions they require. The more sophisticated a plant's product mix and actual products, the more linkages it is likely to have with suppliers and sales outlets.

Spatial patterning of linkage

- . This refers to the direction and length (local or non-local) of the forward and backward spatial links of a plant.

Regional policy implications

Spatial linkage structure and the factors which influence or can influence linkage change and adjustment and therefore location choice are obviously of regional policy interest. Indeed, a commonly stated objective of major road investment is regional development. Some of the research of spatial linkage at the establishment level has been examined for its regional policy significance.

Moseley and Townroe (1973) have identified three areas where attention has been given to the role of linkages, namely,

- . in inhibiting or guiding the process of industrial movement;
- . in the determination of small area multipliers; and
- . in discussions of the concepts of the growth pole and the growth centre.

Moseley and Townroe are of the view that "patterns of inter-firm linkages are important in the evaluation of the potential impact of new investments in an area". This view could be readily argued to include major road investment.

STUDY DESIGN

The brief consideration of anticipated adjustments by industry to the major change in their external environments that the opening of the Gateway Bridge represents and the overview of previous spatial linkage research suggests that the speed, type and extent of adjustments may well depend on how the change is perceived by management and the ability of the establishments, given their characteristics, to respond to the perceived change. The relevant establishment characteristics could include ownership and control, age size, method of production and organisational dynamics (Steed 1971). Therefore, it may be useful to view the decision-making process of an establishment's management as a filter modifying external cause into internal effect, so that the observed transport, market and locational adjustment of an establishment could be interpreted as the internal adaptation of the establishment to the change in its external environment (Le Heron and Schmidt 1976). The desire to explore further the nature of the relationship between spatial linkage changes and the internal characteristics of manufacturing establishments guided the design of the study. It was considered that this relationship would be of key interest to road investment authorities. Consequently, the analysis framework portrayed in Figure 2 was adopted.

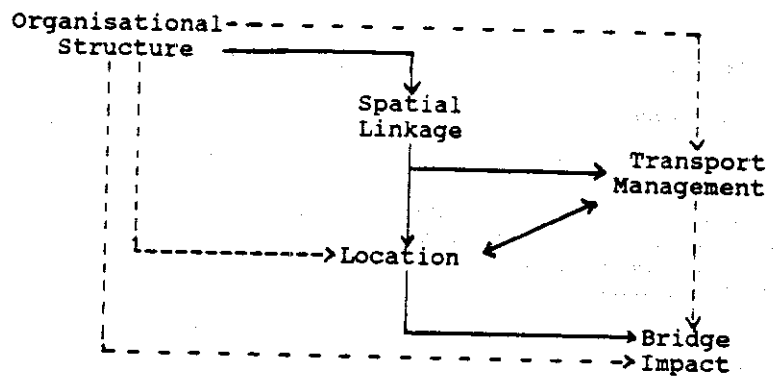


Figure 2. Analysis Framework

To guide questionnaire design and analysis, it was hypothesised that manufacturing establishments' internal characteristics (based on the earlier discussion) would have a major influence on spatial linkage structure and a somewhat weaker influence on spatial location, management of the transport function and the type and speed of response of the establishment to a road network change. Further, it was hypothesised that spatial linkage structure would have a major influence on location and transport management. Finally, response to the new bridge link - in the short-term particularly - might be anticipated to be influenced by spatial linkage structure, location and transport management, as well as, but indirectly, by the characteristics of the establishment under study. (Management of the transport (distribution) function was given special prominence because of the specific interests of the research sponsoring agency.)

In essence, it was argued that, while there is obvious value in interviewing Bridge users to establish the reasons underlying their transport route decisions, etc., it is also important in studies of transport, spatial linkage and locational change and adjustment to take an organisational perspective. The nature of the adjustments of an organisation to its task environment are a function of organisational internal structure as well as the nature of the environment (McDermott and Taylor 1982).

SURVEY AND QUESTIONNAIRE

In September 1986 a survey of manufacturing establishments throughout the Brisbane metropolitan area was undertaken. In all, 364 completed mail questionnaires were returned following an earlier, almost identical, phone survey of 78 establishments. A response rate of

63 percent was achieved. The survey sample consisted of all the establishments in Dun and Bradstreet's 'Dunsfile' with an employment greater than five, located in areas adjoining the Gateway Bridge, along the approach arterials to the Bridge and in the central city area (areas 1, 2, 3, 4 and 7 on Figure 3). The sample for areas 5 and 6 remote from the Bridge consisted of all manufacturing establishments in these areas with an employment greater than 5 listed in the Queensland Department of Industry Development's 'Manufacturing Industry Directory'.

The survey questionnaire was divided into two parts. The first part sought information about an establishment's organisational characteristics, location, spatial linkages and transport arrangements. In completing this portion of the questionnaire respondents were unaware that the second part of the questionnaire would seek information concerning the impact of the Gateway Bridge on their establishment.

Specific data sought in the first part of the questionnaire included :

- . establishment characteristics - legal entity, industry and major activities, head office location, location and number of firm's other branches and size;
- . establishment location - reason for seeking location, location/site attributes sought, period of site occupancy, tenure and relocation intentions (including factors which are motivating or might motivate relocation and where the relocation search might proceed); and
- . spatial linkage - primary source and transport mode used for inwards movements, primary destination and transport mode used for outwards movements, size of 'own' truck fleet, use of 'hire' trucks, level of transport costs relative to establishment operating budget, truck route decision maker.

In the second part of the questionnaire, respondents were first asked whether the opening of the Gateway Bridge link had had any effect on their firm's activities. Respondents answering in the affirmative were asked to describe the nature of the effect. All respondents owning trucks were asked if their trucks made use of the Bridge, the frequency of use, and the impact of the Bridge on the establishment's transport budget. Truck-owning non-users of the Bridge were asked to specify the reasons why this was the case. All truck owners were asked how their use might alter with the completion of the northern and southern arterial approaches to the Bridge in December, 1986.

STUDY AREAS

For purposes of presenting summary information and results, a seven area zoning system was adopted for the Brisbane metropolitan area - refer Figure 3. The choice of the areas was guided by several considerations, but with the major concerns being proximity to the Bridge and its approach corridors, and major areas of concentration of manufacturing activity. Two areas adjoining the northern and southern approaches to the Bridge were selected, with the boundary of the northern area defined by the Brisbane airport. Two further areas north and south of the Bridge and straddling the approach arterials to the

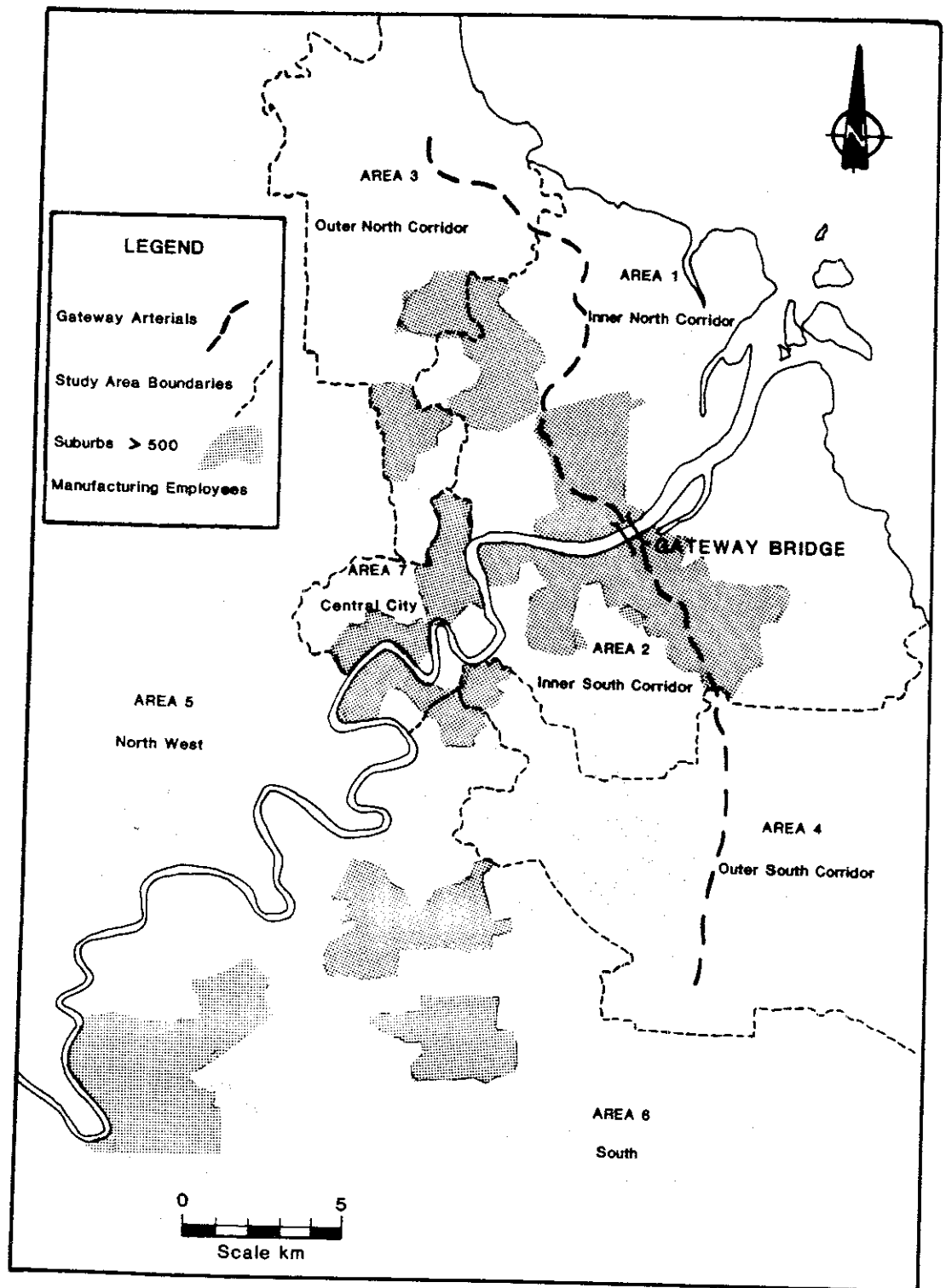


Figure 3. Study Zones
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Bridge were also chosen. The other three areas were the central city, the north-west and the south. The southern area contains the major interstate road and rail freight terminals for the Brisbane area.

SURVEY RESULTS

At this stage of the impact study, the analysis of survey results has concentrated on the spatial arrangement attribute of spatial linkages. The linkage attributes of the linkage strength and complexity have yet to be analysed in detail and will require further surveys before the analysis is completed. Given that, from a transport perspective, the spatial arrangement of linkages is likely to be the linkage attribute of most interest, the absence of results for linkage strength and complexity is hopefully not a major concern.

As far as establishment characteristics are concerned, discussion in this paper will focus on organisational structure - legal entity, head office location and firm branch structure. While age and size characteristics have been collected they have yet to be analysed in detail. Further surveys are required to obtain information on methods of production and organisation dynamics. As the organisational structure of establishments is likely to be a major influence on spatial linkage arrangements while the other establishment characteristics of age and size are of more direct concern for linkage strength and complexity, this focus is satisfactory when taken with the linkage focus on spatial arrangement.

Bridge Impact and Use

In terms of the framework presented in Figure 2, the most appropriate point to commence consideration of the survey results is with the use of the Bridge. In Table 2, a collection of Bridge impact and use statistics by study area has been summarised.

The following observations are made -

- the proportion of establishments owning trucks is lowest in the southern area (an area centred on the major road/rail interstate freight terminals), the outer southern corridor area and the central city core;
- the spatial pattern of the proportion of truck owning establishments using the Bridge is largely as expected with the highest proportion in the two areas adjoining the Bridge on the north and south side of the river. The lowest proportion is in the central city area. Over three-quarters of the truck owning establishments not using the Bridge stated that the reason for this was that the Bridge was not on the routes they used. The level of the Bridge toll was mentioned by only 16 percent of these establishments;
- the spatial pattern of the proportion of the establishments stating that their activities had been affected by the Bridge when compared with the percentage of those who actually made use of the Bridge is quite revealing. In all areas, the proportion affected is noticeable less than the proportion using the Bridge. Consideration of the frequency of Bridge use does not alter the conclusion that, while transport route and

Table 2. Gateway Bridge Impact and Use
(Per cent of establishments)

Area	Establishments			Truck Owning Estab. Using Bridge	Bridge Using Establishments		Non - Bridge Using Estab. Impacted
	Truck Owners	Impacted	Bridge Users		Use > Day/Week	Impacted	
1. Inner North Corridor	78%	46%	57%	73%	66%	70%	15%
2. Inner South Corridor	76%	54%	64%	84%	69%	74%	20%
3. Outer North Corridor	76%	24%	43%	56%	62%	45%	7%
4. Outer South Corridor	64%	30%	38%	59%	38%	43%	23%
5. North-West	69%	25%	31%	45%	40%	60%	9%
6. South	62%	17%	34%	55%	29%	31%	10%
7. Central City	57%	0%	18%	31%	0%	0%	0%

perhaps even scheduling adjustments have been made by many firms, these adjustments have not been perceived by all such establishments as having any noticeable effect on their overall activities. (This is further supported by the fact that only 21 percent of the establishments using the Bridge reported any discernible decrease in their transport outlays.) While it is perhaps tempting to conclude that the medium to long term effects on industrial activity (market penetration and expansion) and locational adjustments have yet to occur (if at all), closer examination of the survey's responses reveals that these impacts may already be underway (refer to next observation); and

- the proportion of Bridge users reporting an impact of the Bridge on their activities is highest in the areas adjoining the Bridge and lowest in the outer areas to the south and in the central city. At the same time, the proportion of non-users reporting that the Bridge has had an effect on their activities is highest for establishments in the inner south corridor and the outer south corridor areas. This suggests that market area impacts are being perceived and responded to by some of the establishments in the areas through which the southern approach arterial passes.

Examination of the responses to relocation intentions, which will be discussed further in the next section, revealed no correlation between these intentions and the Bridge's impact on establishment activities. Given the short period of time that had elapsed since the opening of the Bridge link together with the fact that the approach arterials were not completed until three months after the survey was conducted, the result is not surprising.

These general conclusions concerning short-term responses will be followed up in face-to-face interviews in mid 1987, as will any locational adjustments not in evidence at the date of conducting the first survey.

While these results concerning Bridge use generally conform with what might have been anticipated to be the spatial pattern of short-term impacts, the distinction between Bridge use and activity adjustment needs to be emphasised. Impact is not confined to transport route choice changes or transport fleet re-scheduling. Indeed, impacts are being experienced in the short-term by a proportion of non-truck owning and therefore non Bridge using establishments. A remaining, but fundamental, question is to what extent the spatial distribution of the proportion of establishments experiencing impacts is influenced by spatial variation in the internal characteristics of those establishments?

Organisational Structure and Location

Of the 402 establishments responding to the questionnaire, 21 percent had their head office located interstate or overseas. For the Brisbane establishments sampled, 70 percent were head offices of companies with no branches, 23 percent were head offices of companies with branches primarily out of Brisbane and 7 percent were branch offices. Twenty-two percent of the branches surveyed with company head offices interstate or overseas also had one or more additional branches of

the company in the Brisbane area. Establishments with a Brisbane head office are more likely to own their site (62 percent) than are establishments with head offices interstate (54 percent) and a greater proportion of the former (20 percent compared with 14 percent) indicated a current intention to relocate, the majority in both cases for reasons concerning need for increased space and desire for freehold ownership. Sixty-five percent of these establishments indicated a desire to relocate within the same general area as their current location. Transport related reasons for wishing to relocate were not mentioned by any respondents. Almost 39 percent of establishments had been at their existing site for less than five years, with the principal reason for choosing their particular sites being site factors - size and availability (60 percent). Transport or transport related reasons were mentioned in only 16 percent of the responses.

The proportion of establishments in an area with head offices interstate is not uniform across the metropolitan area. Above average representation of such establishments was found in the southern area (36 percent) - the area containing the interstate road and rail freight terminals, and the central city area (42 percent). The interstate, head office representation in the inner northern corridor area (17 percent) close by the Brisbane airport was just below the survey based Brisbane area average of 21 percent. As will be discussed in the next section, these location preferences reflect the nature of the spatial linkages that these establishments have with the local Brisbane economy and have significance for the management of the physical distribution function and, by implication, the impact of the Gateway Bridge on these establishments' activities and the likelihood that they will have need to use the Bridge.

Organisational Structure, Location and Linkage

In Table 3, a summary of the dominant types of spatial linkage for each establishment surveyed as a function of head office location is presented.* Spatial linkage arrangement was classified on the basis of the major origin of inputs (local or non-local) and the major destination of outputs (local or non-local). The importance of non-local input links for the branch establishments with head offices interstate is clearly evident from the table, as is the local Brisbane economy as the destination for the majority of outputs for all establishments. Establishments with head offices in Brisbane are far more dependent on the local economy for sourcing of their inputs than establishments with head offices elsewhere. Indeed, the major category of spatial linkage arrangement for the Brisbane head officed establishments is local inputs - local outputs, compared with non-local inputs - local outputs for interstate head officed establishments.

There is variation across the urban area in the spatial arrangement of linkages, as alluded to in the previous section on organisation structure and location. The nature of the variation is summarised in Table 4. The results demonstrate that -

- locally sourced inputs are more important to establishments with Brisbane head offices in all areas;

Table 3. Spatial Linkage and Organisation Structure
(Per cent of establishments)

Linkage		Head Office Location	
Input Origin	Output Destination	Brisbane	Interstate
Local	Local	38%	17%
Non Local	Local	29%	56%
Local	Non Local	15%	12%
Non Local	Non Local	18%	15%
		100%	100%

Table 4. Spatial Linkage, Location and Organisation Structure
(Per cent of establishments)

Head Office Location and Linkage	Establishment Location					
	Inner North Corridor	Inner South Corridor	Outer North Corridor	Outer South Corridor	South	Central City
Brisbane:						
Local input origin	54%	52%	60%	59%	50%	40%
Local output destination	67%	71%	73%	74%	42%	60%
Interstate:						
Local input origin	44%	33%	20%	0%	14%	27%
Local output destination	72%	50%	100%	100%	71%	64%

- local destinations for outputs are more important to establishments with interstate head offices in all areas;
- the southern area centred around the interstate road/rail freight terminals is an area where establishments with a Brisbane head office are more likely to locate if the major destinations for their outputs are non-local. In contrast, this is the area, together with the outer southern corridor area, where establishments with an interstate head office are more likely to locate if they have the large majority of inputs sourced non-locally.

This spatial pattern of linkages and its association with organisational structure manifests itself in the management of the transport function of establishments.

Organisational Structure, Location, Linkage and Transport

Survey respondents were asked to provide details of the principal modes of transport used for inwards and outwards movements of goods from their establishment. For all establishments, it was found that -

- 37 percent mainly used suppliers' trucks for inwards goods and their own trucks for outwards goods;
- 49 percent mainly used suppliers' or supplier arranged trucks for inwards goods and hired trucks for outwards goods;
- 14 percent grouped into a wide array of arrangements including no transport arrangements for outwards goods (customer collection) and all movements by own trucks.

A significant finding is the apparent lack of direct management control by establishments over their inwards goods movements. However, for outwards goods movements, organisational structure, location and linkage appear to have a major influence.

Eighty percent of the establishments with Brisbane head offices owned and operated one or more trucks as an integral part of their activities. For establishments with interstate head offices, the corresponding ownership percentage was only forty-five. The size distribution of the truck fleets for each of these types of organisations is presented in Table 5. The fleets tend to be small with, therefore, not surprisingly, high levels of truck hire to supplement own truck fleet capacity - refer to Table 6.

The patterns of truck ownership vary with organisational structure and linkage (and by association location as discussed previously). This is clearly illustrated in Table 7 where for establishments with head offices in Brisbane the proportion of such establishments using their own trucks for outwards goods movements is -

- greater for local buyer destinations than for non-local buyer destinations; and
- greater if inputs are mainly sourced locally, *ceteris paribus*.

Table 5. Size Distribution of Truck Fleets
(Per cent of establishments)

Head Office Location	Trucks Owned						Total
	0	1	2	3 - 4	5 - 6	> 6	
Brisbane	20%	21%	20%	19%	10%	11%	100%
Interstate	55%	12%	6%	12%	6%	9%	100%

Table 6. Truck Hiring & Truck Ownership
(Per cent of establishments)

Size of Truck Fleet	Trucks Hired
0	80%
1	69%
2	61%
3 - 4	63%
4 - 5	66%
>6	62%

Table 7. Truck Ownership, Spatial Linkage and Organisation Structure
(Per cent of establishments using own trucks for outwards goods)

Linkage		Head Office Location	
Input Origin -- Output Destination		Brisbane	Interstate
Local	Local	72%	33%
Non Local	Local	52%	26%
Local	Non Local	36%	*
Non Local	Non Local	29%	25%

* only data for 3 establishments

In the same table, it is observed that, for establishments with interstate head offices, the level of use of own trucks is lower for all linkage categories (as might be expected from the earlier discussion) and with little variation across those categories. It is to be noted that, for establishments with non-local input origins and output destinations, the level of own truck usage (about 25-30 percent) of all establishments in this category is the same irrespective of head office location. It is concluded that organisation structure, linkage and location (and recall these variables are correlated) have a major influence on the nature of outwards goods movements from establishments in the Brisbane area.

Organisation Structure and Bridge Impact

The description of organisation structure, spatial linkage arrangements, location and transport arrangements of the manufacturing establishments surveyed has clearly demonstrated that the hypothesised relationship, schematically presented in Figure 2, has been found to apply in the case of the Brisbane metropolitan area. It remains to re-examine the findings concerning Bridge impact and use from a perspective which focusses on organisational structure.

Initial discussion in this paper demonstrated that the Bridge impacts and use patterns were influenced by establishment location and establishment transport arrangements (especially fleet ownership). Further examination of only those establishments who own trucks reveals that, within a given area, the level of Bridge use does not vary with differing spatial linkage arrangement characteristics. Consequently, while spatial linkage arrangement influences location and transport arrangements, it does not have a direct influence on Bridge usage.

With respect to any direct influence organisational structure may have on the nature of establishment response to the Bridge, it is too early to establish whether such a link exists in the absence of locational adjustments. However, organisational structure has been shown to have a major indirect influence through spatial linkage arrangement, location and transport.

In summary, it is concluded that the links in Figure 2 between one characteristic of establishments - organisational structure, one attribute of spatial linkage - spatial arrangement, location, transport management and Bridge impact provide a concise statement of the results of the survey. These links imply that the impact of the Bridge and the use made of it by manufacturing establishments can be explained and understood, in part, by reference to organisation structures and the associated spatial linkages that these structures imply. However, there is still need to examine the impact of the Bridge on trucking companies as many of these companies provide the truck hire services to many of the manufacturing establishments examined in this paper. (This, together with the intention to ascertain the medium-term impacts of the Bridge on manufacturing establishments, will be the subject of the second stage of the impact study.)

CONCLUSIONS

It is concluded that, while substantial research has been carried out on spatial linkage structure and adjustment or change, there are at least three areas in which further research is required, namely,

- . impact of major road network changes
- . impacts at the intra-urban scale
- . regional policy implications of linkage structures.

The preliminary results of the study of the short-term impact of the opening of the Gateway Bridge crossing reported in this paper emphasise the importance of the internal characteristics of manufacturing establishment - specifically organisational structure - in determining industry response to this major network change. This is as a result of the relationship existing between organisational structure and location, spatial linkage arrangement and management of the transport (distribution) function.

This relationship could be an important one for transport investment policy formulation in an era when many industry commentators are arguing that increased investment in strategic links in the road network will enhance industrial competitiveness. The link between such investment and increased competitiveness has not been well quantified (Mackie and Simon 1986). Case studies such as the Gateway Bridge can assist in exploring the strength of such a link through a study of linkage adjustment and location choice.

Only very short-term impacts have been able to be examined to date. Surveys to be conducted later this year will provide some insights into medium-term (market related) impacts. However, it will be many years before the full impact of the Bridge on locational decisions and linkage restructuring can be observed because of the inevitable adjustment lags. Consequently, it is important that monitoring on a long-term basis of traffic and development impacts continue so that the findings can assist in assessing the potential impacts and benefits of future major investment in road networks.

ACKNOWLEDGMENTS

The author wishes to acknowledge the support of the Queensland Main Roads Department in funding the research on which this paper is based and for their permission to publish this paper. The contribution made by Julia Saurazas in managing the survey of manufacturing establishments is also acknowledged.

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