CHAPTER 2: THE NATURE OF ROAD INFRASTRUCTURE

2.1 INTRODUCTION

The aim of this chapter is to discuss the nature and characteristics of road infrastructure. This is necessary to determine whether roads and economic activity are interrelated. This chapter will thus partly investigate the first two goals of the thesis, namely to analyse the relationship between road infrastructure investment and economic development, and to determine under what conditions this investment will maximise economic returns at spatial locations. This chapter is theoretical, and analyses the public good characteristics of roads. It is also necessary to identify the externalities associated with road infrastructure, as well as its supply and demand characteristics.

There is an ongoing debate between economists and planners about which comes first, the development of land (and associated economic development) or the provision of transport infrastructure. This is known as the "chicken or egg" problem (Button 1993:18). In Chapter 1, economic development was defined as introducing more business sales, employment, personal income and population growth to a region. In this instance, Floor et al (DOT 1993:3-1) identify the impacts of economic development on various types of land development, which in turn increase property values. From this it is evident that the "chicken or egg" problem can only be clearly explained if the demand and supply characteristics of property development are also considered.

2.2 DEMAND AND SUPPLY CHARACTERISTICS OF ROAD INFRASTRUCTURE

As mentioned in section 2.1, the question arises whether development follows the provision of road infrastructure or whether intensified land usage and development result in a demand for improved transport infrastructure. Section 1.1 stated that two schools of thought exist on the influence of road infrastructure on economic development. The first school of thought maintains that roads play a leading role in development – in other words, they are a prerequisite for development, while the second accepts that roads should be regarded as one of the elements of a development plan, but not necessarily the principal one.

The implication of the aim of this thesis, namely to maximise the economic returns of road infrastructure investment, is that the correct approach must be followed when making investment decisions. Should the wrong approach be followed, poor investment decisions will be made. This thesis thus investigates the conditions under which road infrastructure investment maximises economic returns. It must thus be apparent that economic development was in fact caused by the improvement in road infrastructure. This will ensure that road infrastructure investment decisions will maximise economic returns.

An alternative view is postulated by Ueda (2001:3) who states that infrastructure development causes two types of economic effects:

(1) Investment in infrastructure per se creates a demand for commodities/services in the process of construction – the so-called **"flow effect"**. This is similar to the first school of thought.

(2) The second effect, the **stock effect**, occurs where economic agents use the infrastructure more efficiently.

There are both positive and negative views on infrastructure investments. According to Ueda (2001:3), in Japan, the negative views relate to the problem that huge amounts of infrastructure investment have not contributed to increases in production and in employment – hence the flow effect has not been achieved. Alternatively, there are inefficient infrastructure projects which result in less demand than the estimates, the upshot being a poor stock effect. The above two approaches describe a supply-side approach (the flow effect) and a demand-side approach (the stock effect) to infrastructure provision.

In order to explain these views, it is necessary to assess the supply and demand of transport. According to Sampson (1998:220), one needs to refer to the basic relationship between the activity system and the transport system. The activity system is directly related to the land-use system – hence the size, strength, economic make-up and location of the activity system determine the demand for transport. The supply of transport is determined by the transport system which includes road infrastructure. This means that the demand for transport is related to the activity system, while the supply of transport is a function of the transport system.

Sampson (1998:221) further argues that transport system improvements are typically demand led, with roads and public transport trying to catch up with developments. The relationship between the activity system and the transport system is manifested in the flow that results. From this one may infer that the condition of elastic demand is needed to comply with the first school of thought. In this scenario, small cost decreases (or transport supply improvements) result in

greatly increased flows. Thus the demand of the activity system is sensitive to small changes in transport supply.

One of the primary characteristics of demand for transport is its fluctuation over time (Button 1993:39). In urban areas, the demand for road space and transport services is markedly higher during the morning and afternoon peak hours than during off-peak hours. According to Sampson (1998:222), fluctuations in demand during off-peak periods are easily handled as flows are generally elastic and well below capacity. In peak hours, when saturation is neared, small increases in traffic result in congestion, queues and long delays. However, for planning purposes, the peak hour demands are of greater significance to transport economists. These peak hour demands are relatively consistent over weekdays. One of the fundamental aims of transport planning is to determine the future travel demand. As such, transport supply cannot be ignored.

The above discussion of Sampson's (1998) work highlights the relationship between supply and demand. However, it is also necessary to analyse the supply and demand characteristics of transport individually.

2.2.1 Framework for analysing transport supply

Supply is defined as the quantity of goods or services offered on the market at various prices (Smit, Dams, Mostert, Oosthuizen, Van der Vyfer & Van Gass 1997:115). From this it is evident that price plays a vital role as one of the determinants of supply, which determines consumption. Kanafani (1983:57-58) identified the following three important deviations of consumption of transport services, which require elaboration regarding the application of supply:

(1) The supplier is not clearly defined when it comes to transport. Thus his or her actions cannot be fully investigated. For instance, intercity road transport is provided at a massive aggregated scale – hence it is almost impossible to identify the supplier or the price being charged. When no toll levies are charged, payment occurs indirectly by way of taxes or other indirect costs (Shahia & Smuts 1993:4). The classical supply curve is applicable in certain instances such as in air transport or urban bus transport.

This study focuses on road infrastructure investment and it is thus necessary to identify what conditions apply to the supply of roads. Road infrastructure is usually provided by the government, and is regarded as public goods. The supplier is thus easily identifiable. The focus of this study is not on tolling, and payment should thus occur by way of taxes or indirect methods. This characteristic of transport supply, namely that the supplier is not clearly defined, is therefore not entirely relevant to roads.

(2) Certain nonmonetary aspects of transport are just as important as the price being charged by the operator. These aspects include travel time, convenience and safety. According to Shahia and Smuts (1993:5), travel time is the principal characteristic of supply of many types of transport. However, one should bear in mind that travel time has a cost implication that is influenced by the price of the transport service.

Regarding road infrastructure, the discussion by Sampson (1998) is applicable because transport supply improvements such as price decreases (or cost savings in travel time) impact on road usage. The nonmonetary supply characteristic of transport is thus not seen as an impediment to determining road supply.

(3) The supply characteristics of transport can, in certain instances, be ascribed to the actions of the transport users rather than those of the suppliers. The level of service of transport dictates the usage. Various elements that are not solely ascribed to the actions of the transport supplier determine level of service. These include factors such as speed and delay, traffic interruptions, comfort and safety. Transport users have the discretion to use transport services that provide adequate levels of service.

This characteristic of transport supply, namely that transport supply is sometimes influenced by the actions of transport users as opposed to suppliers, is not entirely true of road supply. As shown by Sampson (1998), because of improved levels of service, road supply improvements result in greater road usage. The price elasticity of these improvements will impact on the usage.

From the above it is evident that the supply and usage of roads do not comply entirely with the three deviations identified (see points (1), (2) & (3) above) by Kanafani (1983). It was shown that government is the main provider of roads – hence the supplier is clearly identifiable; secondly, it was explained that certain nonmonetary aspects of road supply (viz those that of travel time) have cost implications that are influenced by the price of road supply; thirdly, it was shown that road supply improvements will result in greater road usage. This can possibly be ascribed to Kanafani's (1983) focus on transport operators and not transport infrastructure. This study will accept the findings of Sampson (1998) as being representative for the purposes of this study.

Given the above discussion of road supply it is necessary to focus on the general factors influencing supply. These factors are listed below and their relevance to transport supply will also be discussed (Smit et al 1997:114-115):

(1) **Financial factors.** Financial factors relate to the financial position of a business. From a transport perspective this factor is relevant only in that changes in the financial position of road users may result in changes in the use of transport mode, or with transport operators where they may change the prices of their transport services. However, financial factors do not really impact on road infrastructure unless they restrict the ability of the transport authorities to provide road infrastructure.

(2) **Real factors.** Real factors affect the entire industry and not a specific business. They may be related to changes in the price of fuel, which impact on the entire transport industry.

(3) **Technological changes.** These changes can influence market supply. Technology is usually associated with increased production or efficiency. Technology can provide efficiencies in transport such as intelligent transport systems which are used to manage traffic on roads efficiently. However, this factor cannot be associated with changes in the supply of road infrastructure, unless new technology improves road construction activities or results in capacity improvements.

(4) **Prices of other products**. This factor may refer to price differences between transport modes or between toll and nontoll roads.

(5) **Changes in input costs.** A change in the price of any production factors may lead to a change in the supply on the market. This also applies to roads, as increases in the price of labour and construction materials adversely affect the road space being built, if the budget allocation for road construction is limited.

2.2.2 Framework for analysing transport demand

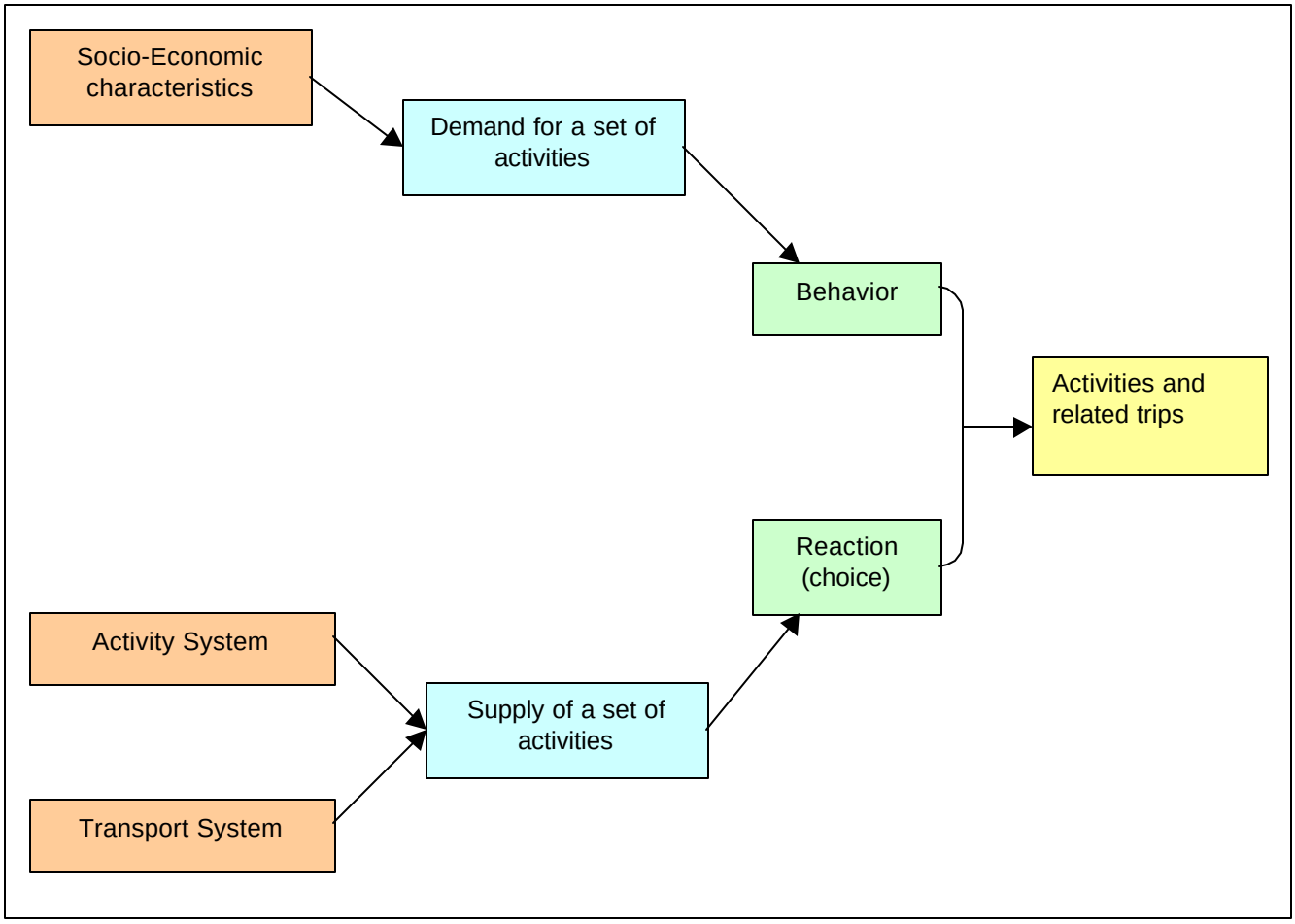
The previous section highlighted factors that may influence road supply. This section will focus on the factors that influence road demand.

Demand refers to the products and/or services required by the market during a specific period (Smit et al 1997:103). Demand is largely determined by the price of products or services. In this regard, the law of demand states that, all other things being equal, consumers will buy more of a product if the price of the product decreases, and less, if the price of the product increases.

Kanafani (1983:92) developed a theory on the basic approach to urban transport demand. This is depicted in figure 2.1.

According to this approach, the demand for urban travel is directly linked to and derived from the demand for urban activities. Households have a demand for activities such as work, shopping, business or recreation. The demand for these activities is generally determined by the socioeconomic characteristics of households, such as their size, income, number of workers, etc. Not all of the activities are undertaken, because this is determined by the opportunities available to perform them. The availability of activities is not only determined by their existence but also by their availability at a given distance and a given transport cost. The supply of a set of activities is thus quantified in terms of land-use patterns and the characteristics of the transport system. To the transport user, this represents all the urban activities at different transport costs. The urban traveller therefore has to make various choices about the number of urban activities he or she wishes to undertake, and subsequently, which urban trips he will make (Shahia & Smuts 1993:8-10).

Figure 2.1: The basic approach to urban transport demand



Source: Kanafani (1983:92)

From the above it is clear that the urban traveller has many choices, which is also complicated by the choice of transport mode. Various nonroad transport modes are also available such as those by air, railway or water. However, the focus of this thesis is on roads, which will now receive further attention.

A study in Australia found that the relative importance of roads in terms of resource use is determined by its distinct characteristics (Allen Consulting 1993:12-13). These are as follows:

(1) Roads are ubiquitous. They offer virtually total connectivity of land, providing links between countless pairs of origins and destinations, and offering wide choices for many users.

(2) The road system acts as a distributor of feeder roads, providing access to other modes. It thus provides connections with and between other modes of transport.

(3) Roads are multi-purpose in the sense that business and commercial travel, social activity, freight transport and passenger and private transport or common carrier transport services all use the same network.

(4) Roads are also distinctive in that they provide open access, are widely available to all users and flexible in their use.

These characteristics impact on the demand for road usage. Button (1993:40-50) identified the following factors which influence travel demand:

- price of the good
- prices of other goods
- level of income

Button (1993:40) cautions that whilst this simple framework is valid for transport, there are refinements and details which need to be highlighted if one is to comprehend the way in which the transport market operates. Price, for instance, is not only reflected in the fare but also all the other costs in obtaining the transport service. Furthermore, there is a need to be clear about what is demanded, say a trip between points a and b, or what mode will be used for the trip. This also relates to

road infrastructure. The three factors will now be discussed, and their relevance to roads shown where appropriate.

2.2.2.1 The price of transport

The price of transport comprises more than the money paid for fares or haulage fees. According to Button (1993:40), there are other components of price such as time costs, waiting and insecurity. Here, the focus is on money prices, particularly on transport users' sensitivity to the price of transport services. In many instances, it is clear that price changes within certain limits, have a relatively limited effect on the transport services demanded. Various studies indicate that transport services have low price elasticities (Button 1993:41). This holds true for South Africa where the high private car usage indicates extremely low fuel price elasticities.

However, it is necessary to assess the price elasticity of transport in a road infrastructure context. The work of Sampson described in section 2.2 contains examples on elastic demand for roads. The example of a toll road versus a nontoll road is indicative of the price elasticity of roads. Thus the generalisation that the demand for transport services is price inelastic is not entirely true.

2.2.2.2 Income levels

According to Button (1993:45), while there is ample evidence that transport is a normal good in the sense that more is demanded at higher levels of income, this generalisation does not apply to all modes of transport or to all situations. The rise in income gave rise to private car usage with a reduction in public transport usage, thus emphasising the fact that public transport is an inferior good. However, Button (1993:46) does conclude that the income elasticity for many other modes of

transport is relatively high. For instance, air travel is expensive in South Africa, and increases in income may therefore be associated with more air travel.

An argument that impacts on the income elasticity of transport demand relates to the total trip-making requirements of people. For instance, increases in income may result in changes of travel mode, but may not necessarily lead to more trips or a higher demand for transport. The relevance of income levels to road demand is not clear. It can be argued that higher income levels lead to higher private car ownership and trip making, hence a higher demand for road space.

2.2.2.3 The price of other transport services

The demand of any particular transport service is likely to be influenced by the actions of competitive and complementary suppliers (Button 1993:46). These comparisons are more relevant to different public transport modes and operators. For instance, bus and taxi operators compete for the same captive market of commuters. Should one of these operators offer lower tariffs, then there will be a shift of commuters to that operator. In these circumstances it is clear that the demand for transport services is price elastic.

This factor is not entirely relevant to roads. The only comparison is the cost associated with the usage of nontolled and tolled roads, say if two parallel roads area are the only alternatives for the residents of a certain area. If one road falls under the jurisdiction of the national government and is tolled, while the other is under the jurisdiction of the local government and is not tolled, one can accurately assume that the tolled road will not be an attractive alternative.

The above discussions provided a framework for analysing transport supply and demand, and also focused on road infrastructure. The next section investigates the

impact of road provision, from a supply versus a demand approach, on the economic returns associated with it.

2.3 THE DEMAND VERSUS SUPPLY APPROACH TO ROAD INFRASTRUCTURE PROVISION

The above discussion highlighted some of the differences between the elasticities of transport infrastructure supply and demand. In this regard, Meier (1995:344) contends that we

> ... may distinguish between the developmental social overhead capital which provides for a hoped for but uncertain future demand and the rehabilitation social overhead capital which caters to an unsatisfied demand of the past. The first with its excess capacity will necessarily have a big sectoral capital-output ratio (10-15:1); the second, through breaking bottlenecks, has certain high indirect productivity and much lower capital-output ratio.

These two approaches to infrastructure (developmental and rehabilitation social overhead capital) investment will be studied in detail in this discussion. Two road infrastructure investment programmes, namely that of road K8 and the MCDC corridor (also known as road PWV9) will be used as case studies. The MCDC represents the so-called “developmental social overhead capital” example, while road K8 represents the so-called “rehabilitation social overhead capital” example, as described by Meier above.

The first investment approach, that of developmental infrastructure, is known as the doctrine of **balanced growth.** The investment approach which focuses on rehabilitation infrastructure, is termed the **unbalanced growth** doctrine. There are two schools of thought on the above two approaches to capital investment and

development strategy. On the one hand, there are those who believe that the balanced growth doctrine is the only choice for a development strategy. This opinion is largely supported by economists such as Rosenstein-Rodan and Nurke. Then there are those who believe that the unbalanced doctrine should be the preferred development strategy. Hirschman was one of the foremost exponents of the unbalanced growth doctrine. These doctrines will now be discussed separately.

2.3.1 The balanced growth doctrine

The balanced growth doctrine is also known as the "big push" or "critical minimum effort" approach because it takes the form of a planned large-scale expansion of economic activities (Thirlwall 1999:234). Todaro (1989:615) explains the big push theory of development by stating that all that developing countries need to "take off" into a period of self-sustaining economic growth is a massive investment programme designed to promote rapid industrialisation and the building up of economic infrastructure.

The need for this big push approach is that a "bit by bit" approach will not add up in its effects to the sum total of the single bits. A minimum quantum of investment is thus a necessary, although not sufficient, condition for success (Meier 1996:343). He contends that this theory seems to contradict the conclusions of the traditional static equilibrium theory. He advances the following three reasons for this:

(1) This theory is based on more realistic assumptions of certain indivisibilities in the production function – for example, the indivisibilities of inputs, processes or outputs give rise to increasing returns or economies of scale, and may require a high optimum size of the firm. This even applies at the

level of static equilibrium theory. These indivisibilities give rise to increasing returns and technological external economies.

(2) In dealing with problems of growth, this theory examines the path towards equilibrium, not the conditions at a point of equilibrium only. It is known that at the point of static equilibrium net investment is zero. However, this theory of growth is largely a theory of investment. It is furthermore stated that the allocation of investment occurs in an imperfect market which implies a market on which prices do not signal all the information required for an optimum solution. Given the imperfect investment market, pecuniary external economies have the same effect in the theory of growth as technological external economies.

(3) Markets in underdeveloped countries are even more imperfect than in developed countries. The price mechanism in such imperfect markets does not provide signals that guide a perfectly competitive economy to conditions of optimality.

These indivisibilities of inputs, processes or outputs give rise to increasing returns or economies of scale, and may require a high optimum size of firm. This therefore implies large investment into one or a few firms because of limited demand. The same applies to road infrastructure investment. For instance only one road may be built to connect a city with a rural area. According to Thirlwall (1999:234) the term “balanced growth” is used in many different contexts, but the original exponents of this doctrine had in mind the scale of investment necessary to overcome the indivisibilities on both the supply and demand side of development. Gilles, Parkins, Roemer and Snodgrass (1996:62) state that development can be referred to as **balanced growth on the demand side** if industries which are developed are determined by the demand or expenditure patterns of consumers.

Alternatively, **balanced growth on the supply side** refers to the need to build a number of industries simultaneously to prevent supply bottlenecks.

Indivisibilities on the supply side refer to the so-called "lumpiness" of capital, and more specifically social overhead capital or infrastructure, and the fact that investment in a large number of activities can simultaneously take advantage of various external economies of scale. Indivisibilities in the demand side refer to the limitations or restrictions imposed by the size of the market on the feasibility of economic activities (Thirlwall 1999:235). The balanced growth has a horizontal and vertical side. Thirlwall (1999:235) explains this as follows: "On the one hand it recognises indivisibilities in supply and complementaries of demand, and on the other it stresses the importance of achieving balance between such sectors as agriculture and industry, between the capital-goods and consumer goods industries, and between social capital and directly productive activities."

The balanced growth doctrine thus proposes to address various aspects, including that of supply and demand. Meier (1996:350) highlights the relevance of this doctrine to this thesis in stating that through a big push: "… the limitations of the small size in the domestic market are overcome, provided that there are increasing returns, demand spillovers, and that pecuniary externalities are created. **This situation may be especially important for stimulating investment in infrastructure which has high fixed cost**" (author's highlighting). This argument can be related to the proposed MCDC corridor with the associated investment in road PWV9 which forms an integral part of the project. In this instance, the expected construction cost of road PWV9 is in excess of R350 million (GPMC 1997). The location of this road is in a relatively undeveloped market, and the planners hope that the construction of this road will stimulate the local economy to such an extent that a development corridor will be created.

The view of Thirlwall (1999:235-37) on the application of the big push doctrine will now be summarised and briefly explained. Firstly, the economic arguments for a large-scale investment programme will be outlined, followed by a discussion of the desirability of achieving a balance between different sectors in the economy.

On the **demand side**, if the market is limited, certain activities will not be economically viable. However, this doctrine argues that if several activities are established simultaneously, each could provide a market for the other's products. Hence these activities that are not profitable in isolation, now become profitable because of the large-scale investment programme. This implies that the onus would be on government to organise such a programme, and that planning would supercede the market system for such a programme to be initiated.

On the **supply side,** the doctrine of the big push is bound up with the existence of external economies of scale. It is held that the external economies of scale in this instance go beyond the external economies of the traditional theory of the firm. In the traditional equilibrium theory, external economies refer to the fact that the nature of the production function in one activity may be altered by the existence of other activities. However, in the context of this theory, these external economies of scale refer to the impact of a large investment programme on the profit functions of participating firms. If external economies exist, the social return of an activity will exceed the private return. In order to eliminate this divergence, it is necessary to make each activity part of an overall programme of investment expansion. The result is that enterprises that do not appear to be profitable in isolation, now become profitable as part of a comprehensive plan for industrial expansion embracing several activities. Several firms are required to provide a market for each other's products.

When analysing the big push theory it becomes clear that this approach was largely followed with the MCDC project. Section 1.4.1 indicated that the MCDC forms part of the spatial development initiatives of government with the goal of unlocking inherent economic potential of certain areas by means of large-scale investment programmes. This implies that the market in its current form is not viable or profitable for individual firms. The location of the MCDC corridor in the Pretoria area is mainly along an area that is not characterised by major development or a demand for development. It is argued that by building road PWV9 (ie the large-scale investment programme) the area will be opened up for development and the firms locating in this corridor will create a market for one another's products. These enterprises would in future become profitable, as part of the investment programme of the development corridor. Government thus initiated this programme and as a result, the planning of the project superseded the market system.

From the above discussion, it is clear that the big push theory tries to change the market system with its investment strategy. This resulted in the approach being severely criticised. Meier (1996:62) contends that the balanced-growth argument in its purest form, is a counsel of despair: "A poor country with little or no industry is told that it must either start up a wide range of industries simultaneously or resign itself to continued stagnation. This across-the-board program … is discouraging advice for a poor country that is taxing its managerial and financial resources to the limit just to get a few factories started." Thirlwall (1999:235-36) is also critical, and contends that the doctrine of the balanced growth for demand reasons may lose much of its force in an open economy. On the supply side, it is argued that under the impact of the big push, the price of capital goods and the cost of capital may rise substantially, as well as wage rates. The case for this approach, to eliminate discrepancies between social and private returns of an activity, is weakened if factors of production are not in elastic supply. Lastly, it is contended

that if developing countries possess the resources for a big push, they should not to be described as developing in the first place.

The applicability of the big push doctrine to road infrastructure investment can only be measured against the success or failure of an appropriate project, that is, the MCDC. Although still in the planning and development phase, the spinoffs of this programme have been less than satisfying. Development along this corridor has to compete with development in other parts of the metropolitan area. Since this area has no natural development stimulus (associated with an inelastic demand for development), it is argued that the construction of road PWV9 will add this stimulus. However, other areas with a high development demand attract development to those areas, hence restricting the growth potential of the MCDC. The MCDC might have been more appropriate in a region where there was no competition for development, and any strategy for development would be advantageous. The supply-side approach of road infrastructure being provided, with the expectation that this action will create the required demand for development, is thus seen as an unsuccessful measure to promote development. Hence one may argue that developmental social overhead capital is not a foolproof recipe for successful short-term development.

Thirlwall (1999:236) aptly explains the argument against the use of the big push approach for road infrastructure investment:

> The fact remains, however, that certain investment must be of a minimum size to be economically worthwhile. It may be uneconomical to build roads … to meet the current level of demand. Ideally social-overhead capital of this type must be planned and built on a large scale to achieve long-run economy in the use of resources. But this argument hardly qualifies for the special label ”balanced growth”. The case for the “big push” for supply

reasons seems to be quite weak in the absence both of resources to attempt such a strategy and of detailed knowledge of precise magnitude of net economies that are likely to accrue.

2.3.2 The unbalanced growth doctrine

According to Thirlwall (1999:237), critics of balanced growth do not deny the importance of a large-scale investment programme and the expansion of complementary activities. Their argument is that in the absence of sufficient resources, especially capital, the pursuit of balanced growth may not provide a stimulus to the spontaneous mobilisation of resources or the inducement to invest, and will certainly not economise on decision taking if planning is required.

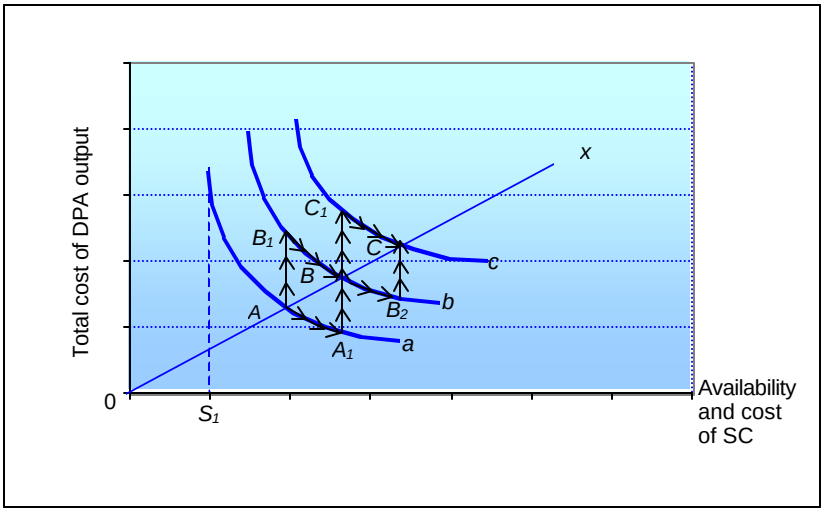
According to Thirlwall (1999:237), Hirschman was one of the foremost exponents of the unbalanced growth doctrine and attempted to answer the following question: "… given a limited amount of investment resources and a series of proposed investment projects whose total cost exceed the available resources, how do we pick out the projects that will make the greatest contribution to development relative to their cost? And how should 'contribution' be measured?" Thirlwall (1999:237-242) goes on to discuss these questions and possible answers, as elucidated below.

Hirschman (Thirwall 1999) identified two types of investment choices, namely substitution choices and postponement choices. Substitution choices involve a decision on whether project A or project B should be undertaken. Postponement choices relate to the sequence of projects, namely which projects should precede others. Hirschman focuses on the latter choices. It is argued that the question of priority must be resolved on the basis of whether progress in one area will induce progress in another. A case in point is whether the construction of a certain road

will lead to more land development and growth of an area, compared with another road. Preference should thus be given to a sequence of projects that maximises so-called "induced" decision making. Hirschman's point is illustrated by considering the relationship between social capital (SC) and directly productive activities (DPA). The situation where SC precedes DPA is referred to as **development via excess capacity**, and where DPA precedes SC, **development via shortages**. Figure 2.2 illustrates this point.

The theory is based on the principle that both sequences create inducements and pressures conducive to development. Thirlwall (1999:238-239) explains figure 2.2 as follows:

Figure 2.2: Relation between social capital and directly productive activities



Source: Thirlwall (1999:238)

If the total cost of DPA is measured on the vertical axis, and the availability and cost of SC is measured on the horizontal axis, curves can be drawn (a, b, c) showing the cost of producing a given full-capacity output of DPA, from a given amount of investment in DPA, as a function of the availability of SC. The successive curves, a, b, c, represent different levels of DPA output from

successively higher investment in DPA. The curves are negatively sloped and convex to the origin because DPA will decrease the greater the availability of social capital, but there is a minimum amount of SC necessary for any level of DPA output (for example OS1, corresponding to curve a), and as SC increases its impact on the cost of DPA output becomes less and less.

Now assume that the objective of the economy is to obtain increasing outputs of DPA with the minimum use of resources devoted to both DPA and SC. On each curve, a, b, c, the point where the sum of the coordinates is smallest will represent the most desirable combination of DPA and SC in this criterion. The line OX connects the optimal points on the different curves and this represents the most "efficient" expansion path, or "balanced growth" path between SC and DPA. But suppose that "optimal" amounts of SC and DPA cannot be expanded simultaneously to keep balance with one another. On what criteria is that postponement choice made? One possibility is the sequence AA_1BB_2C, where the initial expansionary step is always taken by social capital. This sequence is called "development via excess capacity".

The other (opposite) possibility is the sequence AB_1BC_1C, where the initial expansionary step is taken by DPA. This sequence is called "development via shortages". According to Hirchman the preference should go to the sequence of expansion that maximizes "'induced" decision making. It is difficult to tell a priori which sequence this is likely to be. If SC is expanded, existing DPA becomes less costly, encouraging further DPA. If DPA is expanded first, costs will rise but pressures will arise for SC facilities to be provided. Both sequences will set up incentives and pressures, and ultimately, in Hirchman's view, the sequence chosen must depend on the relative strength of entrepreneurial motivations on the one hand, and on the response to public pressure of the authorities responsible for social capital on the other.

According to Hirchman (Thirlwall 1999:239), the tradition (or balanced growth approach) that SC must precede, or even be kept in balance with DPA if development is to progress smoothly, is not the optimum solution. Although a certain minimum of social capital is a prerequisite for the establishment of DPA, it is argued that development via excess capacity is purely permissive, and striving for balance is equally dangerous because there are no incentives to induced investment. Alternatively, development via shortages will compel further investment – hence the most efficient sequence as far as "induced" decision making is concerned is likely to be that where DPA exceeds SC. The latter argument implies those circumstances where a development demand already exists, and the provision of road infrastructure will stimulate further productive activities or economic growth.

The planning of road K8 followed this approach. As stated previously (see section 1.4.1), this road is planned in an area inundated with land development activities and proposals. The DPA is thus already in place and a demand for more DPA exists. However, owing to insufficient road infrastructure (or social capital) the growth of DPA is limited. The construction of road K8 will ultimately unlock this restriction on DPA and more investment in DPA will occur because of the further land development. This is the development via shortages approach, and it is clear that the road construction will compel further investment. It is clear that in this doctrine, demand precedes supply, which is the total opposite of the big push doctrine.

According to Thirlwall (1999:239-242), the following concerns about the unbalanced growth doctrine should be addressed:

- The important question here is: If DPA should precede SC, is there any guarantee that SC will be provided? Thirlwall argues that indivisibilities in social capital may be so large that private investors are not induced to supply at any price, in which case government should then step in.
- The inherent danger of the unbalanced growth doctrine, according to Thirlwall, is that it leaves too much to chance. The concern is that the pace of development rests solely on the whims of entrepreneurs and whether or not individuals are induced to invest.
- He also argues that the role of shortages in promoting development is probably overrated.
- The unbalanced growth doctrine may further lead to the concentration of production of one or two commodities, with harmful effects on the balance of payments if the goods are price and income inelastic.

The greatest strength in the unbalanced growth doctrine, however, is that it does not imply the abandonment of the market mechanism, because it decentralises decision making (Thirlwall 1999:240).

The above discussion distinguishes between the demand and supply approaches of infrastructure provision. What is also evident is that infrastructure cannot be used effectively without both demand and supply conditions being met. In this instance, Landau (2000:2) contends that in a

> … paradigm for economic development, establishing a basic transportation system allows private industry to locate in previously remote areas at competitive or advantageous costs for access to markets and suppliers. Sewer and water systems are then needed to augment the transportation network. **Although this theory is easy to understand, the effect of**

> **infrastructure on real world business locations is much more complex** (author's highlighting).

This argument of the effect of infrastructure on real world business locations is supported. Chapter 3 will also address the issue of location decisions.

In conclusion it is apparent that increased levels of infrastructure are at times generated by a demand for services. This emphasises the provision of infrastructure based on actual demand for the service (the demand-side approach). Lastly, it is argued that the proponents of the supply-side approach should take cognisance of Landau (2000:3-4) who cautions infrastructure investors that a

> … small, non-affluent community seeking to expand a modest tax base by developing infrastructure on speculation – that is, channeling public investments in hopes that the presence in roadways, transit or waterworks will entice development – is gambling. Overestimating demands will burden initial users, as a relatively small community will be forced to pay for a capital plant far beyond its needs.

2.4 ROADS AS ECONOMIC INFRASTRUCTURE

Johnson (Thirlwall 1999:159) has the following to say:

> The condition of being "developed" consists of having accumulated, and having established, efficient social and economic mechanisms for maintaining and increasing large stocks of capital per head in various forms. Similarly the condition of being "underdeveloped" is characterised by the possession of relatively small stocks of various kinds of capital.

The above statement hints that a country's level of development is measured against its stock of capital. A country's capital stock (which includes road infrastructure) increases through the process of net investment, which is the difference between its net income in the accounting period and how much it consumes out of that income in the same period. The essence of capital accumulation is that it enhances a country's capacity to produce goods in the future and stimulates growth (Thirlwall 1999:158).

Infrastructure is generally defined as the physical framework of facilities through which goods and services are provided to the public. According to Akatsuka (1995:7) the definition lacks an important attribute of social overhead capital (infrastructure), which is referred to as intergenerational transfer of resources. He states that the primary beneficiaries of social overhead capital investment, which takes a long time to mature, may be the next generation. This implies that infrastructure investment also has a time characteristic. Banister and Berechman (2000:35) describe infrastructure as the durable capital of the city, region and the country and its location is fixed. In the transport sector it includes roads, railways, ports, airports and other infrastructure. A key characteristic of the services offered by this infrastructure is their spatial dimension which is manifested by their network structure. In the case of roads, this implies the road networks of cities and countries.

A distinction is drawn between two types of infrastructure, namely social and economic infrastructure. The Development Bank of South Africa (1998:4) defines this infrastructure as follows:

> **Economic infrastructure** is that part of an economy's capital stock that produces services to facilitate economic production or serve as inputs to production (eg electricity, roads and ports) or are consumed by households

(eg water, sanitation and electricity). Economic infrastructure can be divided into three categories: public utilities (electricity, gas, and water, telecommunications, sanitation, sewerage and solid waste disposal), public works (water catchment in dams, irrigation and roads) and other transport sub-sectors (railways, roads, seaports, airports and urban transport systems). In the national accounts statistics these are found in two categories of the gross domestic product (GDP), identified by type of economic activity: electricity, gas and water are located in the secondary sector; and transport, storage and communication in the tertiary sector.

Social infrastructure provides services such as health, education and recreation and has both a direct or indirect impact on the quality of life. Directly it supports production and trade; indirectly, it streamlines activities and outcomes such as recreation, education, health and safety. The indirect benefit of improving primary health care, for example, is improved productivity, which leads to higher real incomes. Social infrastructure also facilitates investment in human capital by using some of the economy's capital stock to raise the productivity of the workforce. The impact on growth is similar to an increase in the supply of capital – a higher capital to labour ratio which enables a given number of workers to produce more per capita.

The previous discussions highlighted the difference between economic and social infrastructure, and showed that roads are part of the economic infrastructure. The next section will focus on the characteristics of roads as economic infrastructure.

2.4.1 Characteristics of roads as economic infrastructure

Infrastructure facilities are usually provided free of charge or at regulated prices – hence the traditional argument that government must provide infrastructure. The aforementioned can be ascribed to the limited participation of the private sector in the provision of infrastructure. According to Akatsuka (1995:7), investment in infrastructure is generally not suitable for individual enterprises mainly because of the large magnitude of capital requirement, long gestation period, and high risk involved in the investment. In addition, it is stated that, the profit-seeking objectives of individual enterprises may not tie in with the multiobjective nature of infrastructure primarily because of economies of scale and its inherent externalities. The government therefore usually provides infrastructure.

The economic nature of infrastructure implies that the provision thereof is a prerequisite for introducing private sector investments, production activities and sustained economic growth. This implies that economic infrastructure is a necessary, but not sufficient condition for economic growth. For example, rural development may not be successful if a road is not adequately provided to link the area with the market of the products. Infrastructure is thus a basic requirement for improved marketability, efficient resource allocation and increased opportunities for the public to participate in the development process, through which investment, employment and production can be realised (Akatsuka 1995:8).

Akatsuka (1995:8-9) maintains that another vital attribute of infrastructure is that the provision thereof has a long gestation period. This is especially true of road infrastructure – for example, the planning of roads may take a few years and their construction even longer. However, the completed facilities can be used for a long time. Thus the investment of infrastructure requires long term development perspectives, and also depends on the future level of economic activity. One must

ensure that the provision of infrastructure and road infrastructure, in particular is in line with the long-term development path of the economy. It is further maintained that without adequate infrastructure, the private sector may not be interested in investing in productive activities. As observed by Akatsuka (1995) in Asia, the smooth transition of an economy may require a substantial investment in infrastructure.

In 1993, Rietveld and Nijkamp conducted research into the unique characteristics of transport infrastructure. Their work was summarised by Banister and Berechman (2000:60-61). The following conclusions are drawn from this summary of transport infrastructure:

(1) Infrastructure is a generic term that needs to be carefully qualified to make it suitable for focused policy analysis. In this regard, it is stated that additional infrastructure in regions (where there are already good quality transport systems) does not have the same impact as where the existing network is sparse or of a poor quality. The term “transport infrastructure” may also require a more focused analysis. For instance, transport infrastructure has little meaning if it is not clear what is included in this definition – in other words, does it include roads, railways and airports? For the purposes of this thesis the focus is only on road infrastructure only.

(2) The link between transport and land use is a matter of cause and effect. For example, large-scale concentrations of business development may be a response to good road infrastructure in that specific region, but may also be a result of patterns which would have occurred in any case. It is therefore necessary to fully understand the economy of the urban area in which the new road infrastructure is to be constructed.

(3) Infrastructure is subject to decreasing marginal productivities. This implies that new additions to the road network of an area with good road links, will have a reduced impact proportionally. Road network additions may thus adversely impact on the attractiveness of the specific urban location. A quality transport network may make industries more footloose owing to increased access to other markets, hence reducing the location of a specific area as a decision factor for firms and industries. In this instance it is quite obvious that transport infrastructure also has a leakage effect to a region's economy.

(4) New types of high-quality transport infrastructure may have a significant impact on the economy. The introduction of high-speed railways had a significant impact on commuter travel in Europe – hence contributing positively to the economy as travel delays and time costs were reduced. Owing to less time wastage, these savings contributed to productivity improvements.

(5) Improvements in transport infrastructure may not be a sufficient reason for regional development. Many other intermediary factors also play a role. This factor is not considered in many cases, and government's SDIs have generally ignored these other issues.

(6) Improvements in transport infrastructure lead to a decrease in transport costs. These cost reductions have a significant impact in terms of increased profits, rent or even salaries.

(7) As stated previously, transport infrastructure is a multidimensional phenomenon and there are synergies between the various types. For

example, roads connect airports and other ports which, in turn, improve freight and passenger travel.

(8) Infrastructure analysis has focused mainly on firms and not households. Because it influences travel behaviour, it needs to be refocused to analyse the interrelationship between households and firms.

Banister and Berechman (2000:35) identified the following additional specific characteristics of road infrastructure:

- Road infrastructure is durable, which means significant sunk costs because roads often remain in place long after businesses and households have relocated.
- Roads have characteristics of indivisibilities which means that the capital investment costs are often extremely high, while the cost of additional capacity and maintenance is also considerable.
- Finally, there is a propensity for infrastructure facilities to generate social and environmental externalities either through their particular location or through the services they produce. The spatial location of roads may cause significant environmental impacts – hence producing negative externalities. For instance, a road may carry high traffic volumes through a residential area causing significant noise pollution.

The above section has shown that roads have specific characteristics and are part of the economic infrastructure of a country. Roads are thus vital for the effective functioning of the economy. They may also play a vital role in shaping the future economic path.

2.4.2 Indivisibilities of infrastructure

Indivisibilities of road infrastructure imply characteristics of lumpiness. According to Hensher and Brewer (2001:180) road capacity is highly indivisible because it is either over- or under-utilised. Meier (1995:344) contends that infrastructure is the most important instance of indivisibility because its services are indirectly productive and become available only after long gestation periods.

Social overhead capital comprises basic industries like power, transport or communications which must precede the more quickly yielding, directly productive investments and which constitute the infrastructure and overhead costs of the economy as a whole. Meier (1995:344) maintains that its installations are characterised by a sizeable initial lump and low variable costs. As the minimum size in these basic industries is large, excess capacity will be unavoidable over the initial period in underdeveloped countries. For example, the construction of a new road to a rural area will be associated with low traffic volumes that will only increase over time. Driver (1999:16) reiterates this problem of infrastructure and contends that infrastructure is "lumpy" because it is expensive, takes a long time to plan, and once in place, is not easily removed. This lumpiness of road infrastructure must also be seen from the perspective of its sunk costs. A sunk cost is one that has already been incurred and cannot be changed by any decision made now or in the future (Garrison & Noreen 1994:49). For instance, the construction of a road, at a cost of R10 million, at a poor location cannot be changed, nor can any future decision relieve government of the poor decision or cause the cost to be avoided. Sunk costs are historical, and according to Mohr, Fourie and Associates (2002:291), have zero opportunity cost and should be regarded as bygones. These opinions, however, should be seen in perspective. The actual investment of the road is a historical cost. However, if this investment was inefficient it may impact on the costs (eg transport costs) of economic agents or firms which may influence

production costs. The sunk cost of a road is thus applicable if it is seen from the perspective of the economic life of a road that may exceed 30 years.

According to Meier (1995:345), infrastructure is characterised by the following four indivisibilities:

Firstly, it is indivisible or irreversible in time. It must precede other directly productive investments. In the case of roads, this implies that land development cannot occur if there are no roads to link the developments to external markets. Economic interaction will take place if the road infrastructure linking different economic regions is provided. **Secondly**, its equipment has long durability. Less durability is either technically impossible or less efficient. Roads are usually designed and constructed for an economic life of 20 years. Any time less than this is inefficient because of the expensive construction activities involved. **Thirdly**, infrastructure has a long gestation period. Many roads carry initially low traffic volumes after construction, which increase over time. **Fourthly**, at least a minimum mix of infrastructure is required to stimulate the economy of an area. This characteristic implies that roads in isolation will not lead to development, but that other infrastructure and activities are also required to stimulate development.

These indivisible characteristics of infrastructure, and of roads in particular, have to be considered and their impacts clearly understood when considering road investment proposals.

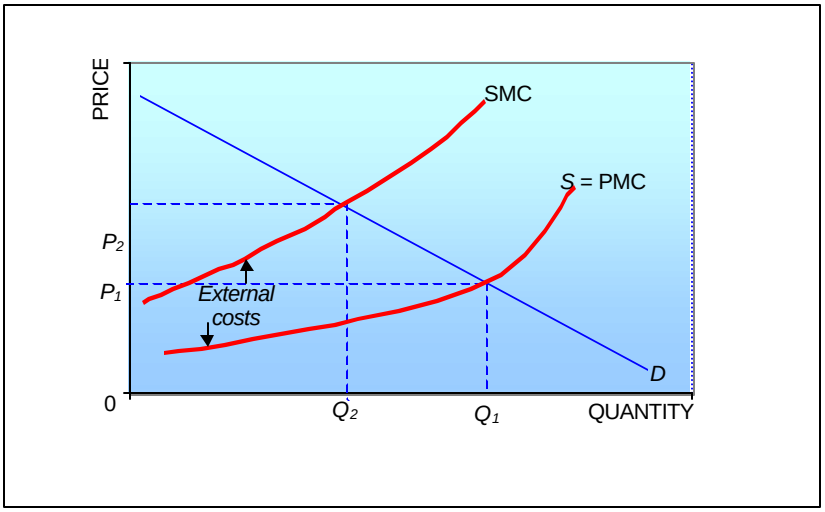
2.5 THE EXTERNALITIES OF ROAD INFRASTRUCTURE

Rosen (1992:66) describes the occurrence of externalities as follows: “The activity of one person affecting the welfare of another in a way that is outside the market is termed an externality. In the presence of an externality, the market may fail to

allocate resources efficiently." Tresch (1981: 90) defines externalities as "… third party effects, meaning that activity by a set of economic agents affects other economic agents, 'third parties', not directly engaged in that activity".

In this regard, Gillis et al (1996:158) state that external costs and benefits are the common core resource problem. This problem is explained in figure 2.3.

Figure 2.3: External diseconomics of traffic congestion



Source: Gillis et al (1996:158)

Motorists impose costs on each other during peak periods when congestion occurs. These are known as external costs. If these costs were considered by motorists, the social marginal cost curve (SMC) would prevail, the market price or cost would be P2 and the traffic flow would be Q2. However, because motorists do not bear the external implications of their trips, the traffic flow will rise to Q1 and the private marginal cost (PMC) will be lower. Hence congestion increases as more vehicles are added to the traffic stream.

Externalities should not be regarded as having negative consequences only. Positive spinoffs also occur. In this regard, Glahe and Lee (1989:509) refer to an

external cost as a negative externality and to an external benefit as a positive externality. It is necessary to identify the positive and negative externalities as well as the types of externalities of road infrastructure because road externalities may impact on economic efficiency. In a study on the concepts of external effects, Scitovsky (DOT 1993:7-1), distinguished between two types of externalities, namely technological and pecuniary externalities. According to Button (1993:93), the formal difference between these two categories of externality is that when technological externality effects occur in production (or consumption) they must appear in the production (or utility) function, while this is not the case with pecuniary externalities. Tresch (1981:91) maintains that pecuniary externalities refer to the pure market price affects. This is explained below.

2.5.1 Technological externalities

These externalities occur when firms or households receive goods, services, money or satisfaction which increase their level of output or utility, but for which they do not pay, or pay less than the equilibrium price. This is explained in more detail below. The implication is that the interdependence between the economic units concerned lies outside the market mechanism (DOT 1993:7-1).

Floor et al (DOT 1993:7-3) argue that the externalities of road infrastructure that contribute to economic development and improvements in welfare are largely technological externalities. An example of this is the effect of the expansion of road capacity in a road network congested with traffic. If the scheme results in the diversion of traffic from other congested roads to the improved road, then both the users of the new road and nonusers (ie the new users as well as those using the other roads) will benefit. The benefits to the new road users relate to them using a new road that provides improved levels of service, while the users of the other roads will benefit from reduced congestion because of the diversion of some

traffic. This positive externality constitutes a technological externality. The argument that this leads to economic development because of the increases in welfare is not disputed, but it is felt that it does not reflect the entire impact on economic development since these externalities relate only to road user benefits. No other positive economic impacts are considered. Although important, it is felt that these externalities play a less significant role in maximising the economic returns of road investment schemes because they relate only to road user benefits. Dodgson (1972:172) adds that it is not always clear how large the technological externalities will be.

Technological externalities may also cause negative externalities when road infrastructure is considered. These relate specifically to environmental impacts such as noise and air pollution and traffic congestion.

2.5.2 Pecuniary externalities

Pecuniary externalities can be defined as occurring whenever the costs of factors to some firms are raised or lowered by the expansion of another firm (DOT 1993:7-2). Button (1993:93) concurs when he states that pecuniary effects occur when a firm's costs are affected by price changes induced by other firms' actions in buying or selling factors of production. For example, pecuniary externalities occur when a new road is constructed that diverts traffic from one road to the new road, since traffic volumes are reduced on the old road this may also impact on the fuel sales of filling stations along this road. The reduced income of filling station owners (due to the new road) is a pecuniary externality because its effect is indirect.

According to Dodgson (1972:173), the major (or positive) pecuniary externality for the investment of roads is the increase in land values and rentals. With regard to pecuniary externalities Floor et al (DOT 1993:7-2) argue that the externalities

stemming from transport investments do not constitute benefits or disbenefits. Mohinry (1961) supports in stating that increases in land values are merely the capitalisation of the reduction in travel costs and that these increases cannot be included in the benefits of roads projects because it would amount to double counting. Weisbrod and Weisbrod (1997:3) support these arguments in the sense that it would be double counting to add property value impacts to income or other value-added impacts. These arguments need to be placed in perspective. Increases in land values imply that certain changes in the market system occurred as a result of increases in market demand or supply. Property development and subsequent economic development are dictated by changes in market demand. Weisbrod and Weisbrod (1997:3) argue that a rise in property values as a result of increasing demand for property, may be a direct consequence of increasing aggregate income or investment of business profits. These arguments appear to exclude property development or business expansion. Any new development taking place in an area may change the cost of factors of other firms in the area. Positive pecuniary externalities may thus also promote economic development since reduction in costs to firms should increase economic activity and income.

Button (1993:94) concludes that the distinction between these two types of externalities is important because technological externalities are real resource costs that should strictly be taken into account in decision making if efficiency is to be achieved, while pecuniary externalities have important distributional implications. These distributional implications also relate to economic development.

2.5.3 Externalities and economic efficiency

According to Perman, McGilvray and Common (1999:130-131), economic efficiency conditions do not apply in an economy in which externalities exist. It is argued that efficiency conditions can only be valid if they consider externalities in

a particular way. For instance, the equalisation of private marginal product ratios will yield a different allocation of resources from that which derives from social marginal product ratios. Since the latter is required for efficiency, private market behaviour will be insufficient in the presence of externalities. Although this is not always the case, Field (1997:80), who contends that market failures may result in the case of external cost and external benefits, supports this argument.

As stated previously, these externalities are costs and benefits imposed on third parties, they are unintentional and they are not conveyed through the price mechanism. Both negative and positive externalities occur which impact on efficiency. According to Nas (1996:37-39), the negative externalities lead to the over-utilisation of resources because of external costs, resulting in production being driven beyond its socially optimal level. Traffic congestion is a case in point. Regarding positive externalities, the source of inefficiency is the under-utilisation of resources. The social loss is the potential gain lost by not expanding the output to its socially desirable level. Nas (1996:39) concludes that efficiency can only be obtained if these externalities are internalised.

The above sections highlighted the difference between technological externalities and that of pecuniary externalities as well as its relevance to road infrastructure. The relationship between externalities and economic efficiency was also discussed. Since transport infrastructure is characterised by externalities, this aspect of externalities and economic efficiency is important to the outcome of this thesis.

2.6 SUMMARY

This chapter assessed the nature of road infrastructure in order to determine any relation to economic development. Two schools of thought are applicable, namely

the one that advocates that roads play a leading role in development, and the other which believes that roads are but one of the elements required for development.

2.6.1 Demand and supply characteristics of road infrastructure

Here, the basic relationship between the activity system and the transport system is of importance. The activity system is directly related to the land-use system – hence the size, strength, economic make-up and location of the activity system determine the demand for the transport system. The supply of transport is determined by the transport system which includes road infrastructure. This means that the demand for transport is related to the activity system, while the supply of transport is a function of the transport system. It was found that transport system improvement should be typically demand led, with roads and public transport trying to catch up with development. The relationship between the activity system and the transport system is manifested in the flow that results. The primary condition that is derived is that an elastic demand for development is required to comply with the first school of thought. In this scenario small cost decreases (or road supply improvements) result in greatly increased flows. Thus the demand of the activity system is sensitive to small changes in transport supply.

Transport supply is influenced by the following factors:

- financial factors
- real factors
- technological changes
- prices of other products
- changes in input costs

Transport demand is analysed by considering the following factors:

- the price of the transport service
- income levels
- the price of other transport services

2.6.2 Demand versus supply approach to road infrastructure provision

Infrastructure (including roads) is also known as social overhead capital. Two approaches to the provision of social overhead capital are distinguished, namely that of **developmental social overhead capital**, which provides for a desired but uncertain future demand; and **rehabilitation social overhead capital**, which caters to an unsatisfied demand of the past. From this it is clear that the first approach follows an infrastructure supply approach in the hope of stimulating sufficient demand and subsequent development. The second approach is based on the premise that infrastructure supply follows actual demand and certain economic productivity. These two investment approaches are based on two distinct doctrines, and are summarised below.

(1) **The balanced growth doctrine.** This doctrine is also known as the so-called “big push” or “critical minimum effort” approach because it takes the form of planned large-scale expansion of economic activities. From this it is evident that this approach focuses strongly on the supply of infrastructure to boost economic development. Proponents of this doctrine believe that this approach is vital for stimulating investment in infrastructure with a high cost. This implies that because of the costs involved, this approach may also be relevant to road infrastructure investment.

(2) **The unbalanced growth doctrine.** This doctrine is especially relevant to situations where limited resources are available for investment and only the projects that will make the greatest contribution to development relative to their cost can be undertaken.

2.6.3 Roads as economic infrastructure

Roads are classified as economic infrastructure because they form part of the economy's capital stock that facilitates economic production. Infrastructure (including roads) is characterised by the following four indivisibilities:

(1) It is indivisible or irreversible over time.
(2) Its equipment has high minimum durability.
(3) It has a long gestation period.
(4) An irreducible minimum social overhead capital industry mix is a condition for getting developmental momentum.

An additional characteristic of roads relates to their being described as lumpy – thus implying that roads are expensive, take a long time to plan and are not easily removed once they are in place. In summary, road infrastructure has the following characteristics: it forms networks, its capital costs are high, its running costs are relatively low, and the sunk costs necessary to establish it are substantial.

2.6.4 The Externalities of road infrastructure

Two types of externalities are classified, namely technological externalities and pecuniary externalities.

(1) **Technological externalities** of road infrastructure are primarily related to the road user or road usage and the third party effects related to it. For instance, a reduction in road congestion because of the construction of other roads is a positive technological externality, while pollution caused by road usage is a negative externality.

(2) **Pecuniary externalities** relate to the costs of factors to some firms or economic agents that are raised or lowered by the expansion of others. The reduction of traffic on a specific road on account of the diversion of traffic may reduce the fuel sales of filling stations along that road, and thus constitutes a negative pecuniary externality. However, the construction of a road in a certain area may promote land development with a subsequent increase in land values, which impacts positively on the economy.

It was also found that externalities influence economic efficiency and the existence of these externalities should be considered when seeking solutions.

2.7 CONCLUSION

The characteristics of road infrastructure complicate investment decisions. This is especially problematic for developing economies, such as South Africa, which do not have the luxury of adequate resources to make inappropriate investment decisions. This statement is based on the following arguments.

The lumpiness of roads, as stated previously, implies that they are expensive, take a long time to plan and are difficult to remove. This characteristic suggests that when making investment decisions about roads, they should be based on sufficient and reliable indicators and information. This is necessary because road infrastructure is expensive and cannot easily be replaced. In this regard, the

demand-side approach to road infrastructure investment seems more appropriate, since the demand indicators identify a need for the road.

The characteristic of high minimum durability implies that roads have a long economic life. It is thus essential to ensure that road investment decisions are made on the basis of an optimum usage for their entire economic life. Incorrect investment decisions imply that the durability of roads is reduced. Again indications are that the demand-side approach to road investment seems more appropriate.

Another characteristic of roads relates to their long gestation period. This characteristic may be used by the proponents of the supply-side approach to argue that initial low traffic volumes and concurrent economic development will be followed by higher traffic volumes and long-run development. This argument cannot hold water in countries with limited financial resources. The demand-side approach implies that the gestation period for road infrastructure should not be unnecessarily long. Lengthy gestation periods also tend to mask incorrect investment decisions.

The last characteristic, namely that of the requirement for a minimum social overhead capital industry mix, implies that certain market demand characteristics are a precondition for road investment decisions. A pure supply-side approach is thus not appropriate for road investment decisions because the nature of road infrastructure is such that meaningful economic activity can only be realised if the demand characteristics are carefully considered.