A Benefit-Cost Analysis of the Wonder World Drive Overpass in San Marcos, Texas

by

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Abstract

The purpose of this paper is to two fold. First is to hold a detailed discussion about benefit-cost analysis and how it is used. The second is to apply the theory of benefit-cost analysis to a real project: the Wonder World Drive overpass in San Marcos, Texas. The discussion about benefit-cost analysis looks at how to identify costs and benefits that are involved in a project and then how to measure these costs and benefits in dollar amounts. The importance of time and discount rate is discussed and an appropriate discount rate established. Finally the types of decision criterion are identified and correlated with the appropriate policy type.

The City of San Marcos has approved funding to build an overpass on Wonder World Drive in order to bypass the frequent trains that plague the City. This will be the first train overpass in the city. Because this is the first overpass, there were many benefits to be considered. The costs and benefits of the project are identified and utilized in a conceptual framework table. This conceptual framework table is then operationalized to measure the costs and benefits in dollar amounts.

The Wonder World Drive overpass is a single decision model, meaning that there are no competing policies decisions. The best decision criterion is to find the Net Present Value of the project. The Discount rate that has been used is the same that is mandated by the Office of Management and Budget. Private and social rates are used to show what the project is worth using varying rates.

The costs and benefits are considered over the life of the project (25 years) and discounted accordingly to find the present value. Once the present value of each cost and benefit is know, the net present value of the project is established.

The results show the Wonder World Drive overpass is not a viable project. The costs exceed the expected benefits at both the private and social discount rates. This does not necessary mean that this is a poor investment for the City of San Marcos. This overpass is an important step for the City to bring its transportation infrastructure up to speed with its rapidly growing population. This benefit-cost analysis can be used as a model for future proposed overpasses in the area to improve the decision making policy makers are faced with.

Key words: Benefit-cost analysis, Net present Value, Wonder World Drive overpass, discount rate

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Chapter One: Introduction

The paper that follows takes an in-depth look at benefit-cost analysis and how it is useful in the public sector. The first section of the paper looks at a review of literature about benefit-cost analysis. The second section sets the stage for a benefit-cost analysis on a highway improvement project that is underway in San Marcos, Texas. In chapter four of this paper a discussion about the methodology of how the operationalization of the costs and benefits of the highway improvement project is done. After a benefit-cost analysis has been performed the results are discussed and a conclusion is derived from these results.

Benefit-cost analysis is one of the most widely accepted methods for deciding whether a public investment is a good use of public resources. Here, the benefit-cost analysis technique is being applied to the Wonder World Drive overpass in San Marcos Texas to determine if the project is a good use of funds. By implementing the analysis, city officials and residents can gain a better understanding about worth of the Wonder World Drive overpass. Benefit-cost analysis is a technique used in both the private and public sectors. It has been formally used in the public sector since the 1930's (Fuguitt & Wilcox 1999, 3). In 1936, the Flood Control Act mandated a new criterion for public investment to ensure that measured benefits exceed measured costs (Davisson 1964, 153).

Benefit-cost analysis is particularly useful when considering costly projects like the Wonder World overpass. Financial resources are scarce in the public sector and therefore an organization needs to seek out the best return on their investment. Many organizations in the public sector mandate that a benefit-cost analysis be performed prior to funding any projects. Benefit-cost analysis can be used to set the priorities for an administration and ensure that tax dollars are spent efficiently and in the best interest of the public.

Purpose

The purpose of this paper is two fold. First is to review literature regarding benefit-cost analysis and how it is used. Second is to perform a benefit cost analysis on the Wonder World Drive overpass in San Marcos, Texas.

It is compelling to examine benefit-cost analysis because it is a widely used and acceptable method of decision making. Benefit-cost analysis has been in practice in the public sector for over 60 years (Fuguitt & Wilcox 1999, 3). There are diverse applications of benefit-cost analysis as a decision making tool to assess things such as; transportation, education, health and safety programs and the environmental projects (Fuguitt & Wilcox 1999, 3). This type of analysis evaluates the profitability of a project by subtracting the costs of the project from the revenues or benefits (Galambos & Schreiber 1978, 62). This formula is referred to as net present value (NPV) which is discussed in the literature review chapter.

Cities are continually making improvements to their transportation system in order to keep a metropolis functioning properly. One such improvement is the proposed Wonder World Drive overpass in San Marcos, Texas. Benefit-cost analysis is used to determine whether such an investment is an effective use of resources (Tanadtang 2005, 603). By employing benefit-cost analysis, the City of San Marcos can make better financial investments and thus improve transportation for its residents. (Tanadtang 2005, 604).

The City of San Marcos is facing a crisis situation. The city is geographically divided by frequently used railroads. Majority of the residents live west of the railroads while the only hospital is located on the east side of the city. The population growth and the number of increasing number of trains daily compound the problem. The average wait time for cars at a railroad crossing is now unacceptable. As a result, City officials have approved an overpass at one at grade railroad crossing at Wonder World Drive. The purpose of this paper is to find if this overpass is a viable investment for the City of San Marcos and what can be learned from this endeavor to possibly improve the planning for future overpasses in the area.

The Chapter that follows looks at literature on benefit-cost analysis. This chapter gives a better understanding of what goes into the procedure and all the elements that need to be considered when performing a benefit-cost analysis. This knowledge is then used to perform a benefit-cost analysis on the approved Wonder World Drive overpass.

Chapter Two: Literature Review

Introduction

The purpose of this chapter is to review the available literature on benefit-cost analysis. The literature identifies what costs and benefits are how to measure costs and benefits, the appropriate discount rate for projects, and decision criterion for performing benefit-cost analysis. Ultimately, this literature review seeks to provide insight and validation for an analysis of the Wonder World Drive overpass in San Marcos, Texas.

What is Benefit-Cost Analysis?

Benefit-cost analysis is a decision making aid utilized by economists and finance officers to evaluate a projects worth. The benefit-cost analysis considers the monetary costs and benefits of a project and enables decision makers to invest resources in a more efficient manner. But how are costs and benefits identified and measured? What method should be used for evaluating costs and benefits?

The benefit-cost analysis process has a built in conceptual framework. Once an analyst can identify what the framework is, the rest falls into place. In a later chapter the conceptual framework is discussed and spelled out in practice as an operalization table. Both the conceptual framework and operalization table are key elements when performing a benefit-cost analysis. Fuguitt and Wilcox (1999, 35) defines benefit-cost analysis as:

> Cost-benefit analysis is a useful approach to assess whether decisions or choices that affect the use of scarce resources promote efficiency. Considering a specific policy and relevant alternatives, the analysis involves systematic identification of policy consequences, followed by valuation of social benefits and costs and then application of the appropriate decision criterion.

Benefit-cost analysis is a tool designed to evaluate choices while allocating society's scarce resources (Fuguitt & Wilcox 1999, 35).

Eva Galambos and Arthur Schreiber (1978, 62-63) have identified four steps for a successful benefit-cost analysis. The first step is to identify the cost and benefits of the project. Second, the costs and benefits are measured in dollars. Third, the costs and benefits are considered over the life of the project. Finally, a decision must be reached. In the final stage, the decision maker decides whether this is a project that will produce enough social benefit to justify the expenditure of limited funds. These four steps provide a "conceptual framework for assisting decision makers in understanding the decision situation" (McKenna, 1980, 127). Benefit-cost analysis allows for a conceptual framework for methodically investigating certain problems of choice (McKenna 1980, 127). Within the four steps are five elements identified by Christopher McKenna: objectives, alternatives, benefits and cost, a model and a criterion (McKenna 1980, 129). McKenna defines each element as follows:

> The objectives are the desired effects intended to be brought about by the undertaking. Alternatives are the possible uses of resources, or possible approaches to employ. Benefits are results that improve society's welfare. Costs are resources consumed by the undertaking. A model represents the relationship between qualities of an alternative and the consequences. A criterion is the basis for selecting one alternative (McKenna 1980, 129).

Applying McKenna's five elements to the Wonder World Drive overpass we see the objective for the Wonder World Drive overpass is to find if the project is a good investment for the City. The second element is to evaluate alternatives. In all cost-benefit projects there are alternatives to weigh against each other. In projects where there is only one proposal (like the Wonder World Drive project) the alternative would be not to implement the project. Other alternatives are discussed later in the chapter under the subheading *Decision Criterion*. The third element is identifying the costs and benefits that will result from the project. A researcher must be able to identify what costs are invested into the project and what benefits can be expected from them. The costs and benefits of the Wonder World Drive overpass are discussed in the Settings chapter of this paper. Essentially, a cost makes up the negative and benefits the positive. The difference between the net present benefits (NPB) and the net present costs (NPC) yields the Net Present Value (NPV) of the project.

There is a difference between the value of current and future dollars. In order to equate future benefits and costs across time the net present value of benefits and costs is calculated. This concept is discussed later in the chapter under the subheading *Discount Rate*. The fourth element is the model used for the analysis. In the Wonder World Drive case the model is specified in an operalization table where each cost and benefit is measured in dollars. The final step is selecting a criterion for evaluating the project. Such as using net present value or benefit cost ratio.

Benefit-cost analysis is a powerful tool for influencing public decisions. Kornhauser (2000, 1039) states in his article, *On Justifying Cost-Benefit Analysis,* that “cost-benefit analysis is both a theory and a practice”. Kornhauser goes on to break down the practice of cost-benefit analysis into three parts:

> (i) A formal theory that derives relations between an individual's fundamental preferences and a ranking, in terms of money, of policies
> (ii) A theory of measurement that identifies real world correlates of the theoretical entities manipulated in the formal theory
> (iii) Applications of the formal theory and theory measurement to specific policy decisions (Kornhauser 2000, 1039).

The formal theory proposed by Kornhauser assumes that individuals will have a well-defined policy preference that will best serve their needs. Individual needs can be found through survey techniques (Kornhauser 2000, 1039). The needs of the individual can be satisfied through the benefits that a project or policy will provide. In the case of the Wonder World Drive overpass the need is determined by measuring how many people are using the road. This is discussed in the methodology chapter of this paper.

Once the costs and benefits are known, they can be measured in market values. These market values are then applied to a decision criterion to establish the worth of a policy or project.

Identifying Costs and Benefits

Project Costs

Project costs are the value of goods and services that are required for a project. This includes initial and recurring costs of the project (Davisson 1964, 153). Some of the initial costs include: research and development, planning, testing and evaluation, training, land acquisition, building facilities, vehicles and equipment (McKenna 1980, 134). Recurring costs are those costs that are necessary to keep a project or program running. Recurring cost can include: personnel, materials, rental of building and equipment, maintenance, administrative overhead, education, and security and insurance. Maintenance costs are those cost that will occur throughout the life of the project. They include roadside maintenance, drainage, and structure up keep. These maintenance types are categorized as routine, preventive and major maintenance (McKenna 1980, 134).

In addition to traditional costs, analysts should consider social costs. Social costs are "what a community gives up in undertaking a project" (Galambos & Schreiber 1978, 64). These social costs are sometimes labeled as non-tangibles because they are difficult to measure in dollars. "Environmental effects such as increased air or noise pollution and flooding from increased storm water runoff" are common social costs included in benefit-cost analysis (Galambos & Schreiber 1978, 64). Other social costs are the inconveniences people experience during the initial construction of physical improvements. A cost-benefit analysis should include any social costs and benefits, however, these "may be divided into local and non local components for presentation to local decision makers" (Galambos & Schreiber 1978, 72).

Project Benefits

Benefits are what a community or stakeholders can expect to gain from a project or policy. In the case of Wonder World drive, the benefits are outlined in the conceptual framework (table 3.2). These benefits are intended to make at least some of the population better off then they were before. For example, time travel saving is considered a project benefit. However, the benefits may not be distributed equally among the residents. Motorists who don't use Wonder World Drive on a regular basis will not experience the same degree of benefits as those residents who frequent Wonder World Drive. Yet all residents are treated the same in regards to the burden of cost.

Project benefits are weighted against project costs in the Net Present Value formula. "Benefits in the comprehensive sense include all outputs of the process or consequences of an alternative" (McKenna 1980, 142). According to Kornhauser (2000, 1039) "benefits are usually defined solely in terms of the change in individual well-being that the policy induces … individual well-being is understood as the satisfaction of subjective preferences". These subjective preferences can be measured in the market choices that individuals make. In a benefit-cost analysis, it is necessary to measure subjective benefits in monetary terms to ensure that apples are not being compared to oranges (Kornhauser 2000, 1039).

Measuring Costs and Benefits

Once the benefits and costs have been identified, the second step is to measure or assign a dollar amount to each benefit and cost. Many scholars argue that flaws of benefit-cost analysis occur during the measurement of costs and benefits. Too often analysts will leave out or incorrectly measure costs and benefits. Often there will be benefit and cost variables that are difficult to measure in market value. These are referred to as intangibles. Fuguitt and Wilcox have three principles for measuring intangible variables:

> When a policy has hard-to-measure effects, the analyst should (1) value as many benefits and costs as possible using monetary units; (2) if unable to assign a monetary value to a particular policy consequence, try to quantify it in physical units; and (3) in the especially difficult situation where the consequence eludes quantification of any kind, identify and describe it qualitatively (Fuguitt & Wilcox 1999, 173).

When performing a cost-benefit analysis using unmeasured variables, a decision maker can estimate a threshold. "Intuitively, the decision maker can weigh the unmeasured benefits and consider whether or not these exceed the threshold" (Fuguitt & Wilcox 1999, 173). It is important to "measure all variables in terms of dollars so you are not comparing apples to oranges" (Galambos & Schreiber 1978, 62). There are a number of ways to measure intangibles. It is important to note that the analyst cannot "include increased profits from a business as a social benefit because there is a decrease in profit sales elsewhere" (Galambos & Schreiber 1978, 71).

Opponents of cost-benefit analysis argue "that in practice cost-benefit analysts tend to undervalue decision consequences that are difficult to monetize or, worse yet, use this technique to mask the real value choices that underlie judicial, administrative, or legislative decisions" (Markovits 1984, 1169).

The operalization of the variables is discussed and measured in the methodology chapter of this paper. The operalization of the costs and benefits is considered over time. To do this future costs and benefits must be measured using the appropriate discount rates.

Time and Discount Rate

The concept of time is important in a benefit cost analysis because the costs and benefits of a project occur throughout its useful life. The "underlying time value of money is the basis for employing interest rates, (also known as discount rates) in assessing the present value of future costs and benefits" (McKenna 1980, 135). The concept of a discount rate is central to an economic analysis because the discount rate "allows effects occurring at different times to be compared by converting each future dollar amount into equivalent present dollars" (Weitzman 2001, 260). Future benefits are worth less than present benefits, which reduce the monetary value of future benefits. In addition, the higher the discount rate the lower the value of future benefits. For example, the benefits of the Wonder World overpass will not be worth the same after 25 years. If a higher discount rate is used for this project, the future benefits are worth even less.

Selecting a suitable time horizon of the benefit and cost stream is important. “Ideally the time horizon should include the entire time period over which policy benefits and costs occur” (Fuguitt & Wilcox 1999, 133). The time horizon is often looked at as the useful life of the capital investment as determined by engineers or manufacturers (Fuguitt & Wilcox 1999, 133). If the time period is capriciously shortened, it is likely to lower the Net Present Value of the project by “reducing the future benefit stream” (Fuguitt & Wilcox 1999, 133). Likewise, a lengthened stream can unreasonably increase the benefits in the future and skew the decision criterion.

Public vs. Private Rates

Selection of an appropriate discount rate has a significant impact on the outcome of a benefit-cost analysis. As shown below, rates can be selected from two general categories: public and private. Furthermore, there is debate about the appropriate discount rate.

The discount rate is used for discounting future costs and benefits. Martin L Weitzman states that “the most critical single problem with discounting future benefits and costs is that no consensus now exists, or for that matter has ever existed, about what actual rate of interest to use” (Weitzman 2001, 260). William Davisson argues that the rate should be the market rate or the market opportunity cost i.e. private rate (Davisson 1964, 155). David Newbery agrees with this theory stating that “the appropriate rate of discount to use in selecting public investment…is the private discount rate” (Newbery 1990, 235). The private discount rate is the rate a private business would use to borrow for a project. On the other hand, Grout (2002, 2) argues the social discount rate is appropriate because “public sector rates should be lower because the public sector can pool risks”. Hence, the social rate of discount (or the rate private citizens receive on savings) is also advocated as the appropriate discount rate. Recent literature supports a private or market value discount rate for public investments to ensure the best return on investment.

Paul Grout, author of *Public and Private Sector Discount Rates in Public-Private Partnerships* states “lower discount rates should be used for the public sector than the private sector. Failure to do so will suggest that private provision is less efficient than public since the present value of private provision will be overestimated relative to public” (2002, 9). The decision of what discount rate is appropriate comes down to the difference between liberals and conservative views about the role of government investments. High discount rates are consistent with a smaller government. The reverse is true for a low discount rate.

Current Discount Rates

There are three government agencies that implement discounting for capital expenditure projects; the Office of Management and Budget (OMB), the Government Accountability Office (GAO), and the Congressional Budget Office (CBO) (Mikesell 2003, 260). The OMB sets the discount rate for most all executive agencies. Currently the discount rate set by the OMB is 7% (Mikesell 2003, 260). The GAO “uses a discount rate based on the average nominal yield of marketable Treasury debt with maturity between one year and the life of the project, with benefits and costs in nominal terms” (Mikesell 2003, 260). Finally, the CBO “Uses the real yield of Treasury debt and estimates that rate to be 2% with a sensitivity analysis of 2% points to test variability. As mentioned the discount rate can affect the outcome significantly. When selecting a rate, an analyst must consider what type of project they are considering.

The current discount rate used by the OMB since 1992 is 7%. Prior to 1992 the discount rate was 10% (Fuguitt & Wilcox 1999, 116). In 1972 the OMB set the discount rate at 10% and required all government agencies to use this rate. This discount rate "was equal to the alternative rate of return on private investment" (Fuguitt & Wilcox 1999, 116). This rate was said by many to be "too high and unfairly penalize desirable government policies" (Fuguitt & Wilcox 1999, 116). As a result the OMB lowered the discount rate to its current value of 7%. One reason for lowing the rate is to obtain a higher return on future benefits (Fuguitt & Wilcox 1999, 112).

Choosing a Discount Rate

When choosing a discount rate the analyst can use a high, moderate, or low rate. It is beneficial to use more than one discount rate in order to compare the influence of changing discount rates on the viability of a project. By using a variety of discount rates, the analysis demonstrates more objectivity. At the Spring 2006 Microeconomics Theory Workshop at Yale University, Jean-Fancois Mertens and Anna Rubinchik-Pessach presented their paper entitled "Intergenerational Equity and the Discount Rate for Cost-Benefit Analysis". In their paper they discussed the discount rates that are being used today.

> Circular A4 of the U.S. Office of Management and Budget (September 2003) mandates that all executive agencies and establishments conduct a regulatory analysis for any new proposal, and more specifically (pp 33-36), a cost-benefit analysis, at the rates of both 3% and 7% (2006, 1).

In a footnote, the authors explain that both of these rates are rational. The 3% interest rate is the rate relative to private savings and the 7% rate is "relative to capital formulation and /or displacement, i.e. as the gross return on capital" (Mertens & Rubinchik-Pessach 2006, 1).

For this paper and the cost-benefit analysis that is to be performed on the Wonder World Drive overpass, the discount rate of 3% and 7% will be used as mandated by the Office of Management and Budget.

Decision Criterion: Performing Cost-Benefit Analysis

Three types of decisions

Once the costs and benefits of the project have been identified and measured, the time horizon determined, and discount rate established, the analysis can be performed to evaluate the project.

There are three kinds of general decision types that have been identified by Fuguitt and Wilcox (1999, 81); (1) one decision, (2) several alternatives that are mutually exclusive and (3) several alternatives that are not mutually exclusive. Benefit-cost analysis is intended to evaluate options or alternatives. In the case where only one program or project is being evaluated (1), the alternatives are to either proceed with the project or not to proceed (Fuguitt & Wilcox 1999, 81). When a policy maker is faced with several alternatives that are mutually exclusive (2) the choice is which one to implement. Mutually exclusive alternatives are those where only one can be executed because of scarce resources. When faced with several polices that are not mutually exclusive (3) the decision maker can choose a subset of alternatives to employ the best use of funds (Fuguitt & Wilcox 1999, 81).

Selection Criterion

There are a variety of methods for selecting the best policy; Pareto criterion, Pay back period, Net present value, Present Value, and benefit-cost ratio. The Pareto criterion is the most conservative approach to deciding capital projects. This section will discuss each and then identify which is the best criterion for the Wonder World Drive overpass.

The Pareto criterion states that a project is economically feasible if “no one is worse off and at least someone is better off” (McKenna 1980, 148). If this standard were used for all public projects, few would ever be implemented. “Cost-benefit analysis is concerned with achieving economic efficiency in the use of resources, regardless of who derives the benefits and who bears the costs” (Galambos & Schreiber 1978, 73). In other words, benefit-cost analysis does not look at fairness of the distribution of cost (e.g., does not use the Pareto criterion).

The pay back period (PBP) is the weakest measure with regard to evaluation of a proposed project. The PBP does not take into account the time and value of money. Payback period can be found by dividing the initial capital outlay (ICO) by the annual net flow (S). Annual capital flow can be found by subtracting annual expenditures from annual benefits.

$$PBP = \frac{ICO}{S}$$

Net Present Value (NPV) simply requires that the benefits exceed the cost of a project. “Alternately expressed, the position states that the total improvement by the gainers outweighs the combined setback of the losers, or the benefit-cost ratio is greater than one" (McKenna 1980, 148). This is a strong measure of the worth of a project.

The project present value is a measure that is often used in conjunction with cost-benefit ratio. These two criterion allow for good decision making because they take into account the time and value of money. Project present value is essentially the present value of a project using the annual capital flow *S* which is the annual benefits minus annual expenditures, the discount rate *r* and, the useful life of the project in number of years *n*. The present value annuity formula requires constant annual net flow for multiple years.

Figure 2.1 Present Value Annuity Formula

$$PV = \frac{S}{r}\left[1 - \left(\frac{1}{1+r}\right)^{n}\right]$$

$S = Annual\ Net\ Flow$
$r = Discount\ rate$
$n = Number\ of\ years$

The Project benefit-cost ratio is found by dividing the present value of the project by the initial capital outlay (McKenna 1980, 148). Ideally, projects with a high benefit-cost ratio are chosen, but the ratio must be greater than one to be considered (Galambos & Schreiber 1978, 70). "This measure is not influenced by the size of the investment, and so it better compares different-sized alternatives" (McKenna 1980, 148).

According to the Kaldor-Hicks criterion, a single policy promotes efficiency if the social benefits outweigh the social costs (Fuguitt & Wilcox 1999, 82). In a single decision scenario, the best evaluation method is to find if the Net Present Value (NPV) is positive. NPV is the present value of incremental net benefits generated throughout the policy time horizon. The NPV is the present value of the benefits (PVB) minus present value of the costs (PVC). The details of the NPV calculations are found in Figure 2.2.

NPV = PVB – PVC

In the year in which the initial expenditure is made, the exponent will be set at zero (this is because the cost is already at present value) and increase to represent each year of the project. All of these will be added together to find the PVB and PVC (Fuguitt & Wilcox 1999, 76-77).

Figure 2.1 Net Present Value Calculations

$$PVC = \frac{C_0}{(1+r)^0} + \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} \cdots\cdots \frac{C_n}{(1+r)^T}$$

$$PVB = \frac{B_0}{(1+r)^0} + \frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} \cdots\cdots \frac{B_n}{(1+r)^T}$$

To find the PVB and PVC an analyst use the following formulas:

$$Where\ PVB = \sum_{i=1}^{T} \frac{B_i}{(1+r)^i} \qquad Where\ PVC = C + \sum_{i=1}^{T} \frac{C_i}{(1+r)^i}$$

$$B_i = Benefits\ in\ year\ i$$
$$C_i = Costs\ in\ year\ i$$
$$T = Final\ year\ of\ project$$
$$r = Discount\ rate$$

The expression *B* represents the incremental benefits, and *C* represents the incremental costs in one year. To find the surplus value generated by the policy an analyst can take the total benefits minus the total costs to find the net benefits for society (Fuguitt & Wilcox 1999, 45). Further, the incremental benefits can be found by taking the benefits with the policy minus the benefits without the policy. The same formula can be used for incremental costs. (Cost with the policy) – (costs without the policy) = Incremental costs (Fuguitt & Wilcox 1999, 58). "Net present value is the present value of incremental net benefits generated throughout the policy time horizon. If the PVB out weighs PVC then the net benefits are positive, (NPV > 0) and from society's perspective, pursuing the policy promotes greater efficiency then not pursuing it" (Fuguitt & Shanton 1999, 82). According to Fuguitt and Shanton, when evaluating one policy or project the best decision criterion is NPV.

Table 2.1 is found in Fuguitt and Wilcox (1999, 91) *Cost Benefit Analysis for Public Sector Decision Makers*. This table expresses the alternatives for policies and what types of criterion should be used for each.

Table 2.1 Appropriate Decision Criterion for Policy Types

Alternatives	Criterion
1. One Policy: Implement?	NPV > 0
2. Mutually exclusive policies: Choose one	Maximum NPV
3. Several Policies: Choose a subset	
a. Dependent policies	
i. No budget constraints	Find possible combinations, maximum NPV
ii. Budget constraints	Find affordable combinations, maximum NPV
b. Independent policies	
i. No budget constraints	All policies with NPV > 0
ii. Budget constraints	Find affordable combinations, maximum NPV; rank by B/C for supplementary information

Chapter Summary

In sum, benefit-cost analysis is a useful tool for policy makers. It allows an analyst to measure the costs and benefits of a project, put them into monetary values and weigh alternatives. Even though public choices are political and no computerized, sterile analysis can substitute for political discourse, a thorough benefit-cost analysis can supply policy makers with information to allocate scarce resources and make tough policy decisions. Flexibility in application of the analysis is an attractive feature since it offers a variety of criterion to evaluate a project and allows for a range of discount rates to be used. While not infallible, these elements of benefit-cost analysis tend to insulate the method considerably from much scrutiny when policy choices are made.

Chapter Three: Setting

Introduction

Now that cost-benefit analysis has been discussed, the focus turns to a practical case where it is applied. Funding has been approved for a four lane overpass on Wonder World Drive to bypass the existing railroad tracks. This is a joint project between the City of San Marcos and the Texas Department of Transportation. Since two entities are involved in this project it is important to discuss each. This chapter first looks at the history and function of the Department of Transportation. Second, a needs assessment for the City of San Marcos is developed to justify why an overpass is needed. The costs and benefits of the project are identified in the needs assessment.

A Brief History of the Department of Transportation

President Lyndon B. Johnson made the Department of Transportation (DOT) a cabinet level department in 1966 (Barnsness 1970, 500). Once it became a more powerful agency it allowed for more concise implementation of highway projects throughout the United States. The purpose of the DOT is to develop “a coordinated transportation system that permits travelers and goods to move conveniently and efficiently from one means of transportation to another, using the best characteristics of each” (Barnsness 1970, 500). From the cabinet level DOT sprang new agencies to assist in the efforts of efficient transportation. The Federal Highway Administration incorporates the Bureau of Public Roads and the Highway and Traffic Safety Bureau. These agencies handle the federal highway planning and construction, and the supervision of extensive programs of federal aid to highways (Barnsness 1970, 503). A significant percentage of the DOT budget goes to the funding of Federal highways. The Wonder World Drive overpass is not a federal highway, but the overpass is being funded with some State money. It is necessary to have a better understanding of the DOT so the City can comply with good policy practices when using the State of Texas' money. Because of this, it is worth looking at the costs and benefits that arise in a highway improvement project.

The City of San Marcos

In 2000 San Marcos had a population of 34,733 (U.S. Census Bureau 2000). In 2004 the population grew to an estimated 44,769. It is anticipated the population will exceed 70,000 by 2020 (U.S. Census Bureau 2000). The increase of population means the City is charged with accommodating and sustaining this growth. President Johnson once said that "The life of a city depends on an adequate transportation system" (Dodson 1969, 373). To have an adequate transportation system a city must have enough infrastructures to transport its citizens efficiently.

Figure 3.1 Map of San Marcos, Texas

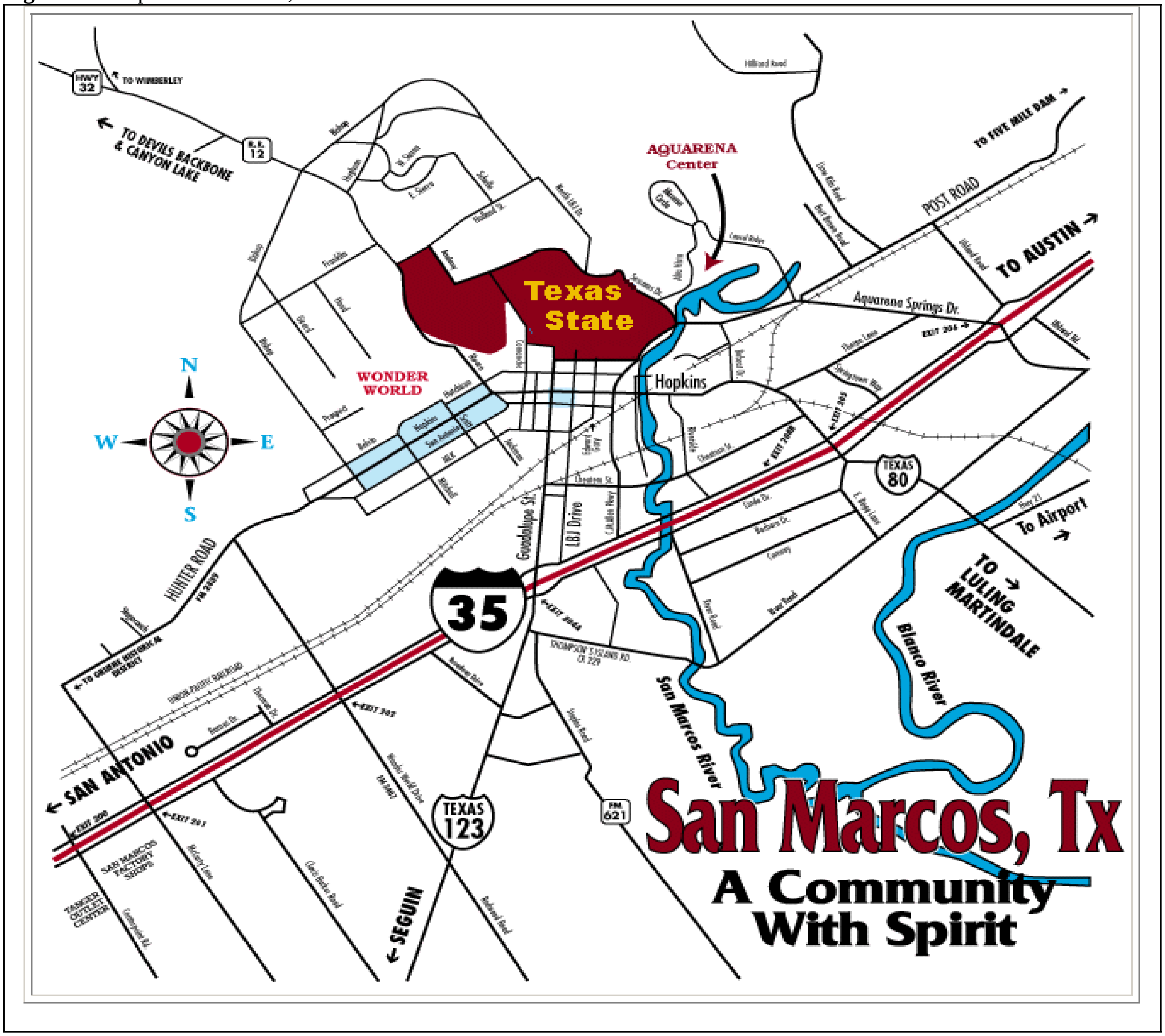

Image obtained from the City of San Marcos Web Site

The Problem San Marcos is Facing

San Marcos has a few unique characteristics that make growth and transportation planning more challenging. San Marcos houses Texas State University which has a student body of 26,000. This represents almost 29% of the San Marcos population (San Marcos Trends 3-10). A significant percentage of students housing is on the other side of the railroad track from Texas State University. Many students and faculty commute from Austin and San Antonio and must cross the railroad tracks to get to the university.

The first unique feature of San Marcos is the high volume of trains that pass through daily. The City Manager of San Marcos, Dan O'Leary estimates that 30 trains pass through the city daily, and the number of carrier cars is increasing the length of the trains. The increased length of trains results in longer wait times at railroad crossings.

The City of San Marcos is geographically divided by a heavily used railroad system. There are 68 at-grade railroad crossings in the city (San Marcos Press Release October 25, 2001). Currently, there are no bridges to overpass the railways. The only hospital in the city is located on the east side of the train tracks while many of the citizens reside west of the train tracks. The City of San Marcos web page states that, three-fourths of the City's population lives west of IH-35 and one-fourth live east of the Interstate.

The only Hospital is located less than a mile east of IH-35. With the high volume of trains and no overpass, the likelihood of being stopped by a train when trying to get to the hospital is increased. At peak traffic hours the delay time is increased by train impediment. The train delay has immeasurable negative affects on citizens' health and safety. With no existing train overpass, both citizens and emergency officials run the risk of being stopped by a train in an urgent situation.

The city has experienced train derailments, train vehicle collisions, and pedestrian injuries caused by trains. All of these instances caused roadways to be impassable for extended periods of time. Having uninterrupted access to the hospital would be a great benefit for the residents of San Marcos.

The trains are not only an inconvenience for residents, but a safety issue for emergency officials. The San Marcos Police Department reports the average number of emergency vehicles (fire, police, and EMS) that were stopped by trains was 488 between 2003 to 2005. The average wait time for these emergency response vehicles was 2 minutes and 45 seconds. Table 3.1 shows emergency vehicles that were stopped by trains when responding to a call.

Table 3.1 Wait time for Emergency Vehicles in San Marcos

Year	**Emergency Vehicles stopped at train crossing**	**Average wait time**
2003	415	1:28 min
2004	516	4:03 min
2005	534	2:46 min
Average (2003 to 2005)	488	2:45 min

These figures represent the wait time that emergency vehicles experience. This is a safety concern for the citizens of San Marcos. Table 3.1 is difficult to operationalize. Because of the varying calls that officials were responding to there it is hard to know how much could have been saved in dollars by avoiding waiting for a train. These numbers do however give an accurate picture how the trains affect citizens and officials in emergency situations.

Wonder World Drive: The Big Picture

A part of the overpass project is the extension of Wonder World Drive to Ranch Road 12. The overpass and extension are independent projects financially, but are dependent on each other to increase traffic flow in the City. The description and purpose of the Wonder World Drive extension project is found in the San Marcos Capital Improvement Program project input form. This description includes the overpass as a central part of the project. The description reads as follows:

> The Wonder World Dr. Extension Project is a 3 mile roadway construction project which will extend Wonder World Dr. from the proposed railroad overpass to Hunter Road (FM 2439) to RM 12, west of the San Marcos City Limit. The project will improve local and region transportation mobility and safety in and around San Marcos by providing an east/west alternative to RM 12, reducing g existing and future traffic volumes and delays through San Marco's downtown and historic neighborhoods, reducing truck traffic through San Marcos and substandard intersections/roadways, connecting emergency management facilities to the east with west San Marcos via unrestricted railroad crossing route utilizing the city's only planned railroad overpass. As part of the Minute Order approved by TxDOT, the City will acquire ROW, conduct the environmental assessment, fund mitigation measures and complete construction plans. [1]

The purpose statement has identified many of the costs and benefits that are expected from this project. The remainder of this chapter identifies the expected costs and benefits of the project.

---

[1] Wonder World Drive is a two part improvement project. First is the railroad overpass and second is to extend Wonder World Drive to RM 12. For this benefit-cost analysis the overpass is the only focus, but it is important to see how the overpass will facilitate the extension of the road.

San Marcos Financial Status

The City of San Marcos residents are not wealthy. The San Marcos Horizons report in 2004 found that the median family income is $37,113. The U.S. Department of Housing and Urban Development reported that almost 71% of residents were classified as low to moderate income (San Marcos Horizons 2004, 22). The financial status is improving for residents. Between 1990 and 2000 the average income of San Marcos residents increased 30% (adjusted for inflation). This averages to 3% annually (San Marcos Horizons 2004, 23). This annual income and annual growth is used in the methodology chapter to operationalize the benefits of time savings and accident reduction.

Identifying Costs and Benefits for Wonder World Drive

Transportation Costs

The Wonder World Drive overpass is a joint project between the City of San Marcos and the Texas Department of Transportation. As stated in the San Marcos Capital Improvement document, the City has acquire the Right of Way (ROW), conducted the environmental assessment, funded mitigation measures, completed construction plans and additional amenities for the overpass[2]. The Texas Department of Transportation will be responsible for funding the remaining costs such as construction costs which take into account the materials needed, wages for workers, insurance, and machinery.

[2] The City has chosen to add a bike lane to the overpass. This cost will be the responsibility of the City of San Marcos.

The initial cost of the project is determined by engineers and the cost is final once a bid for construction is accepted. The project costs are estimated for the useful life of the project. The useful life of the project is the time period where no major repairs or improvements are expected. Engineers have determined the useful life of the Wonder World Drive project to be twenty-five years. No significant improvements, expansions or major repairs are expected during this time.

Right-of-Way Costs

The right of way (ROW) acquisition can be very costly (in both time and money) for transportation projects. In 1999 the federal government spent 4% of the federal highway funding on ROW acquisitions (Hakimi & Kockelman 2005, 2). In some cases eminent domain must be used to acquire the needed land for a highway improvement project. Eminent domain falls under both a monetary cost and a non tangible cost to society. "A useful indicator of time, cost and customer satisfaction in ROW acquisition is the agency's rate of property condemnation. The condemnation rate is the fraction of parcels acquired through the power of eminent domain. If the acquiring agency and the property owner cannot reach an agreement, the agency is legally permitted to acquire the property through its power of eminent domain by filing its case with the appropriate state or federal agency" (Hakimi & Kockelman 2005, 3). The process of eminent domain can increase the cost of ROW acquisition. It is best for a city to avoid this type of condemnation by looking at the city's master plan early and evaluating what kind of projects are to come. It is best to acquire the needed land early to avoid inflated cost once the project is in the latter stages of planning (Williams 2004, 23). In addition to the land itself, other costs involved in ROW include appraisals, damages, attorney fees, administrative settlements, court costs, relocation costs, demolition, abatement, and clean up for contaminated sites (Williams 2004, 10). Measuring the cost of ROW acquisition can be complicated by the use of eminent domain as well as other unforeseen costs mentioned above. The cost of Right-of-Way is necessary for all road improvements. Planning can help to limit or reduce these kinds of costs.

The City of San Marcos is funding the ROW acquisition. The City has issued General Obligation Bonds to fund part of the ROW. The remaining cost will be taken from the City's cash assets. This will be discussed further in the next chapter.

Maintenance and other Costs

Another cost that should be considered in the benefit-cost analysis is the price of maintaining the project after it has been completed. These maintenance costs are referred to as recurring costs. Recurring costs can include the utilities, personnel, general maintenance, repairs, training and the like. These are costs that continue throughout the life of the project. It can be difficult to speculate exactly how much the maintenance will be. In the Methodology chapter, a formula has been developed to estimate future maintenance costs.

The Wonder World overpass cost maintenance will be handled by TxDOT. As stated, no significant maintenance is expected for the first twenty-five years of the project as determined by its engineers. Texas Department of Transportation categorizes maintenance into three areas: Routine, preventive and major (TxDOT Paving the Way 2001). For structures like the Wonder World Drive overpass these three areas are classified as follows:

> *Routine Maintenance*: Repair of substructures, superstructures, decks, joints, approach slabs, and railing and spot painting, repair and operate movable bridges, install temporary bridges, repair and install fender systems
>
> *Preventive Maintenance*: Steel structure cleaning and repainting or install bridge deck protection, joint cleaning and sealing or replacement
>
> *Major Maintenance*: Bridge rehabilitation, reconstruction, or replacement, replacement of structures only as a result of major disaster when no other funds or programs are available. (TxDOT Paving the Way 2001)

Some of annual routine maintenance includes trash pick-up and de-icing in winter weather. Other maintenance that is performed less often is the re-painting of road markings and repaving. The Texas Department of Transportation estimates that re-painting is needed every 3 years and the cost is about $1 a foot.

The overpass has an expected useful life of 25 years. The Texas Department of Transportation does not anticipate any major maintenance during this time. The routine and preventive maintenance are recurring costs that will be factored into the cost stream.

Other costs such as traffic lights and signs also need to be considered. Often the analyst needs to determine if the road improvement will generate enough traffic to warrant the need for more police officials to patrol and regulate the area. If so, then additional personnel are a potential external cost of the project. Since it is an external cost it is not factored into the analysis, however it is important for local budgets to plan for unexpected expenditures.

The social costs that are involved in a highway improvement are difficult to measure, but need to be considered to obtain a true benefit-cost analysis.   An estimate of negative environmental effects should be considered in the analysis. A copy of the environmental impact statement (EIS) can be found from city or state offices. An EIS must be performed on all physical improvements and is a matter of public record that can be easily obtained. Sabas Avila, the Project manager for the Wonder World Drive overpass and extension, stated that there were no significant environmental concerns for the overpass. The Wonder World overpass was labeled as having a FONSI, or Finding of no Significant Impact on the environment. Because of the FONSI determination, this analysis does not consider environmental impacts of the project.

The costs that have been discussed are all included in the conceptual framework for the Wonder World Drive overpass. In the methodology chapter, the costs are operationalized into dollar values to use in the NPV formula.

Transportation Benefits

Benefits of a highway improvement project are almost always non-tangible; nevertheless they are important qualitative reasons for including them in the analysis. With the exception of a toll road that is designed to pay for itself, there are few monetary benefits. For example one of the most commonly stated reasons for pursuing a highway improvement project is to relieve traffic congestion and save drivers travel time during peak hours. The time that motorists save by not waiting is time and money for the citizens of San Marcos.

If improvements are made to enhance traffic flow, accident reduction can also be seen as a benefit. The accidents reported for Wonder World drive have been obtained from the San Marcos Police Department. The type, frequency and time it took to clear the accidents are considered. There are two ways to look at accident reduction benefit. The first is to find the most frequent kinds of accidents and estimate the repair costs.

Another way to operationalize accident reduction is to look at the time police and other officials spend at an accident. The time that police are present at the scene is an indicator of the seriousness of the accident and takes into account the time that other motorists were delayed because of this incident at the railroad crossing. A more detailed discussion is found in the accident reduction section of the Methodology chapter.

A unique benefit for the citizens of San Marcos is to have unimpeded emergency access. Table 3.1 (see above) illustrates the problem that emergency officials are experiencing with the train delay. This delay is also experienced by citizens trying to access the hospital. In the Methodology Chapter of this paper the Willingness to pay model is discussed and utilized to find the monetary benefit for citizens to have emergency access.

Conceptual Framework

Eva Galambos and Author Schreiber's (1978, 62-63) first step in a benefit-cost analysis is to identify the costs and benefits. The conceptual framework for this research outlines the costs and benefits that will be involved in the analysis. These costs and benefits where identified through scholarly research. The variables within the framework are designed to address costs and benefits of the Wonder World Drive overpass project. A discount rate that takes into account the present value of future benefits will be utilized in this benefit-cost analysis. The conceptual framework that is used for this research is a Net Present Value.

Below, table 3.2 outlines the conceptual framework of costs and benefits for the Wonder World Drive overpass. This is the framework for the benefit-cost analysis that is to be performed.

Table 3.2 Conceptual Framework – Listing of Costs and Benefits

Conceptual Framework Table	
Research Purpose: To perform Benefit-Cost analysis on the Wonder World Dr. over pass in San Marcos, TX.	
Costs:	**Scholarly Support:**
(IC) Initial Project Costs (M) Maintenance	David (1997), Galambos & Schreiber (1978), Hakimi (2005), Heiner (2005), Litman (1997), Williams (2004)
Benefits:	**Scholarly Support:**
(TS) Time travel savings (AR) Accident Reduction (EA) Emergency Access	Barnsness (1970), Davisson (1964), Galambos & Schreiber (1978), Williams (2004)
Discount Rate	**Scholarly Support**
Social 3% Private 7%	Miskesell (2003), Mertens & Rubinchik-Pessach (2006)

The Net Present Value (NPV) for this table is illustrated below in figure 3.1

Figure 3.1 Present Value Formula for Conceptual Framework

$$PVC = IC + \sum \frac{M}{(1+r)^i}$$

$$PVB = \sum \frac{B_i}{(1+r)^i}$$

$$Where\,B_i = TS_i + AR_i + EA_i \; (see\,Table\;3.2)$$
$$r\;is\;calculated\;at\;3\%\;and\;7\%\;discount\;rate$$

$$NPV = PVB - PVC$$
$$PVB = \Pr esent\;Value Benefits$$
$$PVC = \Pr esent\;Value\;Costs$$

Construction is the largest cost in the initial project costs for the overpass project. The construction will provide for a 4 lane bridge and 1 lane frontage roads at railroad tracks. The construction costs include: Paving, Drainage, Railroad Crossing and Intersections Signalization. The ROW will pay for land acquisition. Maintenance is a recurring cost and is estimated for the life of the project. Maintenance includes any and all upkeep and preservation of the bridge. The social cost of the environmental impact has already been found to be of no significant impact. Therefore environmental costs are not be used in the NPV formula.

The benefits expected from the project are time travel saving, accident reduction, and access to hospital. Because this project is paid for and maintained with tax payer dollars the benefits are intended for the citizens of San Marcos.

Chapter Summary

This chapter discussed the two governmental bodies (Texas Department of Transportation and the City of San Marcos) responsible for construction and paying for the Wonder World Drive overpass. The benefits and costs of the project were then identified. Construction for the overpass began in Summer 2005 and is estimated to be completed in 2007. The method used to measure the costs and benefits for this project are discussed in the next chapter.

Chapter Four: Methodology

Introduction

This chapter describes the methodology used to operationalize the costs and benefits identified to calculate the Net Present Value for the Wonder World Drive overpass. A separate section is devoted to each cost and benefit to discuss how they are measured as dollar amounts. The last part of this chapter discusses the discount rate and criterion that is used in the benefit-cost analysis of the Wonder World Drive overpass.

The benefits and costs are operalization in table 4.1 on the following page. This table illustrates how each cost and benefit is measured in dollars and is a map that can be used for this chapter.

Costs

Initial Project Costs

Funding for the Wonder World Drive overpass comes jointly from the Texas Department of Transportation (TxDOT) and the City of San Marcos. The main source of funding for TxDOT projects is the tax taken from gasoline sales. The City of San Marcos has funded the right of way costs for the overpass by issuing General Obligation Bonds and using cash funding. In 1998 San Marcos voters approved the $1.5 million for the purchase the ROW costs (San Marcos Press Release October 25, 2001). The General Obligation bonds are voter approved and backed by the property tax. The City issued $245,000 in General Obligation bonds. This debt is financed at 4.51% interest for 20 years

Table 4.1 Operalization Table: Measuring Costs and Benefits

Operalization of Conceptual Framework Table	
Costs:	**Measurement:**
Initial Project Costs: -Construction of 4 lane bridge and 1 lane frontage roads at railroad tracks -Construction costs include: 1. Paving 2. Drainage 3. Bicycle/Pedestrian Lanes 4. Bridges and Major Culverts 5. Railroad Crossing 6. Intersections Signalization	-Estimates project cost in dollars
Maintenance	Based on estimates and data provided from TxDOT. A percentage of the initial cost is used for $year_i$.
Benefits:	**Measurement:**
Time travel Savings	One-half the median family income in year *i* divided by two. This quotient is then divided by the total minutes of work annually or 120,000. To find the total benefit annually the one-half median family income per minute is multiplied by the train time savings times the number of work days in a year, 250. (Galambos & Schreiber 1978, 65)
Accident Reduction	To find the benefit of accident reduction the same formula for time savings is used but train time savings is replaced with the average time police spend at accident. The product is added to the estimated cost of repairs for either major or minor accident.
Emergency Access	Willingness to pay model to demonstrate citizens' willingness to pay for emergency access. Residents are asked what they would be willing to pay for emergency access. This average is used for all households in San Marcos.

The cash funding for the ROW was $985,000[3]. In addition to ROW cost, the City is installing bike lanes for the overpass. This cost is estimated for the bike lane is $100,000[4].

Texas DOT is paying for majority of the cost for the overpass. TxDOT estimates their cost for the project to be $7,182,934 million plus $629,300 for Planning, surveying and estimates (PSE)[5]. The PSE costs were incurred prior to the funding of the overpass. To find the initial cost of the project the two entities outlays are added together. The City of San Marcos financed $245,000. The money that has been financed by the City is financed at a rate of 4.51%; this is the median of the interest rates of 3% and 7%. Finding the present value of the $245,000 at three and seven percent would cancel each other out. This makes the present value of the bonds issued $245,000.

Maintenance Costs

The expected maintenance for the Wonder World overpass is routine and preventative as discussed in the Setting Chapter. Lowell Choate, Director of Maintenance for the Texas Department of Transportation states that it is difficult to estimate what the maintenance of a project will be. Choate says that TxDOT estimates maintenance as a percentage of the initial project cost. The initial project cost for maintenance does not include the land acquisition ROW or the Planning Surveying and Estimates, PSE. These are a one time expense and have no recurring cost in the project

[3] The ROW cost estimation was obtained from a phone interview with Rondney Gonzales from the City of San Marcos Finance Department.
[4] This cost is an estimation from 2002. The final cost of installing bike lanes may change in the final stages of the project.
[5] The cost estimate for TxDOT funding was obtained from a phone interview with Danny Stabeno from Texas Department of Transportation

that need to be maintained. In the early years of the project, the maintenance is less. The cost of maintenance increases as the structure ages.

For the first five years of the project, 1% of the initial cost is used to estimate maintenance (2007 through 2011). Years 2012 through 2016 maintenance cost is expected to increase to 1.5% of the initial cost. This trend is expected to continue throughout the life of the project increasing one-half a percent ever 5 years. Table 4.2 illustrates the year and expected maintenance percentage increase.

Table 4.2 Maintenance percentages by year

Year	Estimated % for Maintenance
2007	1%
2008	1%
2009	1%
2010	1%
2011	1%
2012	1.5%
2013	1.5%
2014	1.5%
2015	1.5%
2016	1.5%
2017	2%
2018	2%
2019	2%
2020	2%
2021	2%
2022	2.5%
2023	2.5%
2024	2.5%
2025	2.5%
2026	2.5%
2027	3%
2028	3%
2029	3%
2030	3%
2031	3%

Benefits

Time Savings

Time savings is one of the most important benefits for the citizens of San Marcos. The time savings that is expected from this overpass is the time that motorists will not be stopped waiting for a train. To operationalize this benefit the total daily vehicle delay is used. This benefit is measured by finding the average number of trains that pass daily and the average time it takes for them to pass. The roadway is considered blocked when the safety bars start the descent, blocking motorists, and passable when the safety bars return to full upright position.

To find the estimated train delay, the City's engineering department conducted a study to record the number of trains that came through daily and time delays that vehicles experience. This data can be found in Table 4.3. This table shows data collected in 2004. The number of trains that pass each roadway daily, the average speed and length of the trains, the type of traffic control that is in place at the railroad crossing, the number of vehicles that pass the railway daily, the time delay when a train passes, the number of vehicles that are stopped by the train, the queue dissipation time, the train delay movement and the total delay vehicles experience daily are shown in table 4.3.

Table 4.3 Train and Vehicle time data

Source: Table obtained from City of San Marcos, City Manager's Office

Impact of Railroad Crossings on Vehicular Traffic
San Marcos Transportation Master Plan
San Marcos, Texas

Crossing Location	Trains/Day	Speed (mph)	Length (ft)	Traffic Control	Crossing Traffic Vol AADT	Train Delay (min)	Vehicles Stopped /crossing	Queue Dissipation Time (min)	Train Delay /movement	Total Daily Veh Delay (min/day)
1 FM 1102	25	20	7,000	WFP	3,500	4.14	10	20	41	1,025
2 Posey Road	25	20	7,000	CWGP	3,000	4.14	9	17	35	879
3 Centerpoint Rd	25	20	7,000	WGP	6,900	4.14	20	40	81	2,022
4 McCarty Ln	25	20	7,000	WGP	3,400	4.14	10	20	40	996
5 Wonder World	25	20	7,000	WGP	10,600	4.14	31	61	124	3,106
6 Patton	10	20	7,000	WGFP	3,900	4.14	11	22	46	457
7 Patton Street	15	20	7,000	WGP	3,900	4.14	11	22	46	686
8 Cheatham St.	15	20	7,000	CW	130	4.14	0	1	2	23
9 Guadalupe	10	20	7,000	WGFP	9,400	4.14	27	54	110	1,102
10 Guadalupe	15	20	7,000	CWGFP	9,400	4.14	27	54	110	1,652
11.LBJ	15	20	7,000	WGFP	4,000	4.14	12	23	47	703
12 LBJ	10	10	7,000	CWGFP	11,800	8.12	67	133	403	4,034
13 CM Allen Parkway	10	10	7,000	WGFP	15,700	8.12	89	177	537	5,367
14 Comal Street	10	10	7,000	YARD TRACK	8,000	8.12	45	90	273	2,735
15 Riverside	10	10	7,000	WFP	1,100	8.12	6	12	38	376
16 Hopkins	15	20	7,000		14,700	4.14	42	85	172	2,584
17 Hopkins FM 12	10	20	7,000	WGFP	28,800	4.14	83	166	338	3,375
18 Loop 82	15	20	7,000	CWGFP	27,500	4.14	79	158	322	4,834
19 IH 35 Frontage Road	10	20	7,000	WGP	5,400	4.14	16	31	63	633
20 SH 21	10	20	7,000	WGFP	10,600	4.14	31	61	124	1,242
21 County Line Road	10	20	7,000	WGP	2,200	4.14	6	13	26	258
22 FM 1984	10	20	7,000	WGFP	3,200	4.14	9	18	38	375
23 Uhland St	15	20	7,000	WGFP	2,200	4.14	6	13	26	387
24 Post Road	15	20	7,000	WGP	3,000	4.14	9	17	35	527
Total										39,377

C= Cross Bucks
W = Advanced Warning Signs
L = Flashing Lights
G = Automatic Gates
P = Pavement Markings

The traffic control type refers to safety measures put in place at each of the identified railroad crossings. The Wonder World Drive railway has advanced warning signs, automatic gates and pavement markings. Wonder World Drive experiences 25 trains crossing daily at an average speed of 20mph with an average length of 7,000 feet. On average 10,600 vehicles cross the tracks at Wonder World Drive. Given the train speed and length of the train, these motorists experience an average of 4.14 minute delay when trains pass. On average 31 motorists are stopped at the railroad crossing when a train passes. The queue dissipation time takes into account the total time vehicles were stopped and how long it takes for traffic to return to normal speeds. For Wonder World Drive the queue dissipation time is 61 minutes per day. The total delay for vehicles on

Wonder World drive is 3,106 minutes per day. This takes into account the number of vehicles that are stopped by the train, the wait time they experience and the queue dissipation time. Using the Texas Department of Transportation estimate of the increase in vehicles, the total daily vehicle delay is estimated to increase 3% annually.

According to Galambos and Schreiber (1978, 65) the operalization of this benefit is the total daily vehicle delay in minutes, multiplied by one-half the average gross wage of San Marcos Citizens. Time is often measured in dollars. For this benefit, the time that people are waiting represents time they could have been doing things relating to their daily lives. People measure the worth of their time in the amount they are paid to work. This earned income is the value of the citizen's time. To find one-half the gross wage per year, the median family income in year *i* is divided by two. This quotient is then divided by the average number of minutes people work a year or 120,000. The average number of minutes people work per year is found by multiplying the forty hour work week by the number of weeks in a year 50. This product gives the number of hours people work per year, 2,000. To find the minutes worked in a year the 2,000 hours is multiplied by 60 minutes. To find the total benefit of time savings, the equation is multiplied by the annual time savings (3,106*250). This dollar value is what motorist will save by not stopping at the Wonder World Drive railroad crossing.

Figure 4.1 Time Savings Benefit formula

$$\frac{MFI^{i}/2}{120{,}000} * (VDM * 250) = Time\,Saving\,Benefit_{i}$$

$$120{,}000 = (40hr * 50weeks) * 60Minutes$$
$$50 * 5 = 250\ Days$$
$$VDM = Vehicle\,Delay\,in\,Minutes$$
$$MIFI = Median\,Family\,Income\,in\,year\,i$$

Accident Reduction

Accidents that occur at railroad crossings can be time consuming and dangerous. This is no exception for San Marcos. Between 2003 and 2005 there were 35 accidents that police responded to at or near railroad crossings. Of those 35 accidents, eight were at the Wonder World Drive railroad crossing. Two of the accidents were recorded as major. One of these was a train pedestrian collision and resulted in the death of a 60 year old Hispanic male. Accidents occurring at or near railroad crossings take a significant amount of time to clear and can block traffic for extended periods.

To operationalize the reduction of accidents that occur at railroad crossing accident reports were obtained from the San Marcos Police Department. This data contains the date, location, type of accident, brief description, the time the call was received and the time the accident was cleared (see appendix B). The average time in a year spent at the scene of a railroad crossing accident in San Marcos is 7 hours 21 minutes. The average time spent at Wonder World Dr in a year is 2 hours 3 minutes. This causes a delay to motorists. The more serious the accident, the longer the delay motorists experience. In some cases the accident is serious enough to force the train to stop. This can cause multiple railroad crossings to be blocked for extended periods of time. In the past three years there have been 2 pedestrians hit by trains. Both incidents caused the trains to stop, and multiple road closures. The first person survived but with serious injuries, the second person died at the scene. The injuries and damage experienced during these accidents are difficult to measure. In some cases the details are limited.

An ideal way to operationalize would be to know the extent of damage to each car and person. With this information, estimates from insurance companies could be used to operationalize this variable. Unfortunately, detailed information is limited about the incidents. What is available is the time that officers spend at the scene of an accident. This is time that motorists are delayed. Because there are no overpasses in San Marcos, when an accident occurs it can affect the city's entire traffic flow. Again, the Time Savings formula (see Figure 4.2) is used to calculate a benefit of accident reduction. The formula however is modified to take into account the police officer time and the cost of the accident to the parties involved. This number is multiplied by the time that is spent by police officials at the scene of the accident.

To adjust for annual growth and projected increase of accidents at Wonder World Drive, an annual increase of 1% is used. It is not appropriate to use the annual vehicle growth rate or the population growth rate to estimate the increase in accidents. Accidents are chance occurrences while the population of a city and the number of vehicles on the road do play a significant role in the number of accidents that occur, the increase of accidents is not necessarily equal to the increase of population.

In addition, accidents may be major or minor. Major accidents have more extensive damage to the vehicles than minor accidents. Because there are no details of the extent of damage to the vehicles, a value of $1,000 is assigned to major accidents and $500 to minor accidents. These values capture the cost of repairs to a vehicle and a portion of any resulting future medical expenses. This is a very conservative estimate given the possible costs that occur in accidents. The time savings and damage value are added to operationalize accident reduction. Based on the San Marcos Police Department records, in 2003 and 2004 there were 3 minor accidents and 1 major accident each year. In 2005 there were no accidents reported at the Wonder World Drive train crossing. This three year average shows that 2 minor accidents occur and 1 major accident occur annually[6].

Emergency Access

A major concern for the citizens of San Marcos is that the railroads divide the City. A majority of residents live of the west side of the tracks while the only hospital is on the east side. As stated in the Settings chapter, City officials reported that between 2003 and 2005 on average 488 emergency vehicles (fire, police, EMS) were stopped by trains while on a call. The average wait time was 2 minutes 45 seconds. It is difficult to find how many residents have experienced similar delays when in route to the hospital. It is more difficult to operationalize the medical condition they were experiencing and how a delay affected their condition. Instead a survey was taken to find an estimate of the value citizens placed on not being stopped by a train in the event of a medical emergency. The survey question and format can be found in Appendix C. Forty residents were surveyed in front of HEB and Wal-Mart (the only grocery stores in the city) and asked:

[6] The average of the three years of available data was used. The average for major accidents was rounded to 1.

> How much would you pay a year to ensure that you or emergency officials (police, fire, EMS) would not be stopped by a train in the event of an emergency?

Respondents were given six answer options:

$1 to $5	$15 to $20
$5 to $10	Greater than $20
$10 to $15	Other amount:

The race, age and gender were also recorded.

This method is called *the willingness to pay model*. The mean is used to determine what citizens are willing to pay. It is inherently flawed because it utilizes a hypothetical amount citizens would be willing to pay. Also, respondents have difficultly differentiating emergency from convenience, especially if they do not have any medical problems[7]. The survey results show the residents willingness to pay for the overpass in regards to emergency access to the hospital and access for Fire, Police and EMS. The data obtained from the sample is multiplied by the number of households in San Marcos to find what all residents are willing to pay for the emergency access.

The number of households is used because this would be similar to an annual property tax. It only taxes households instead of each individual. These hypothetical amounts are conceptually similar to an annual tax that residents would pay for the overpass, spread out over the project's 25 year useful years of life. The willingness to pay estimate was not measured over time because there is no reason to assume that residents would be willing to pay more in the future.

[7] Some of the respondents commented that they have no medical issues, or that this has never been a problem for them. In such a case I would explain the hypothetical scenario of having an unexpected medical emergency and what it would be worth to not be stopped by a train. Other respondents questioned how I could put a dollar value on pain and suffering or life itself. I would explain that I was not putting a monetary value on life, but what people would be willing to pay to not be stopped by a train in an emergency.

Discount Rate

The discount rate that is used in the benefit-cost analysis significantly influences the outcome of the present value. In the literature review there was much discussion about whether a private or public rate should be used for public projects. For this benefit-cost analysis both rates are applied as a sensitivity analysis to show the net present value under different conditions. As mentioned the Office of Management and Budget mandates that all executive agencies and establishments conduct a regulatory analysis for any new proposal, and more specifically a cost-benefit analysis, at the rates of both 3% and 7% (Mertens & Rubinchik-Pessach 2006, 1). Thus the present value of the Wonder World Drive overpass is found at a private discount rate of 7% and a social discount rate of 3%.

Criterion

The criterion that is used in the benefit-cost analysis also plays a major role in the results. Fuguitt and Wilcox (1999, 91) states that if only one project is considered the best decision criterion is net present value. Since the Wonder World driver overpass is not being weighted against any other project, the net present value of the project is the best decision criterion.

Chapter Summary

This chapter explains the method used to operationalize the costs and benefits for the Wonder World Drive overpass. The project will use both private and social rates so that a comparison is possible. The criterion that is used for this project is the net present value. This is a single project not weighted against any other project, if the net present value calculation is positive, then the project meets the test and should be built.

Chapter Five: Results

Introduction

This chapter presents the results of the benefit-cost analysis performed on the Wonder World Drive overpass. The results discuss the outcome of each present value of the benefits and costs. As discussed in the Literature Review Chapter, multiple discount rates were applied. The social rate of 3% and private rate of 7% are used. The City of San Marcos estimates the population growth is 5% annually, but for a more conservative estimate a 3% annual growth rate is used. The Texas Department of Transportation reports that the increase in motor vehicles is 3% annually. This rate is used to show the expected increase of vehicles using Wonder World Drive. The median family income is reported to have a growth rate of 3% annually. Finally, the estimated number of households in San Marcos has a 2% growth rate[8]. These annual growth rates for population, motor vehicles and median family income are used in the Present Value formula for the benefits of the Wonder World Drive overpass (see table 5.1).

[8] This figure is an estimate. No scholarly support was found for rate of increase of households. The rate of increase for population is 3%, so a lower rate should be used for growth of households i.e., 2%.

Table 5.1 San Marcos annual growth for: Population, Vehicles, Median Family Income and Households

Year	Estimated Population	Estimated Vehicles per day on Wonder World Drive	Median Family Income (MFI)	Estimated Total number of Households
	3% Increase	3% Increase	3% Increase	2% Increase
2004	44,769	10,600	$ 37,113.00	12,660
2005	46,112	10,918	$ 38,226.39	13,704
2006	47,495	11,246	$ 39,373.18	13,978
2007	48,920	11,583	$ 40,554.38	14,257
2008	50,388	11,930	$ 41,771.01	14,542
2009	51,900	12,288	$ 43,024.14	14,833
2010	53,457	12,657	$ 44,314.86	15,130
2011	55,060	13,037	$ 45,644.31	15,432
2012	56,712	13,428	$ 47,013.64	15,741
2013	58,413	13,831	$ 48,424.05	16,056
2014	60,166	14,246	$ 49,876.77	16,377
2015	61,971	14,673	$ 51,373.07	16,705
2016	63,830	15,113	$ 52,914.26	17,039
2017	65,745	15,566	$ 54,501.69	17,379
2018	67,717	16,033	$ 56,136.74	17,727
2019	69,749	16,514	$ 57,820.84	18,082
2020	71,841	17,010	$ 59,555.47	18,443
2021	73,996	17,520	$ 61,342.13	18,812
2022	76,216	18,046	$ 63,182.40	19,188
2023	78,503	18,587	$ 65,077.87	19,572
2024	80,858	19,145	$ 67,030.21	19,964
2025	83,284	19719	$ 69,041.11	20363
2026	85,782	20311	$ 71,112.35	20770
2027	88,355	20920	$ 73,245.72	21185
2028	91,006	21548	$ 75,443.09	21609
2029	93,736	22194	$ 77,706.38	22041
2030	96,548	22860	$ 80,037.57	22482
2031	99,445	23546	$ 82,438.70	22932

Source: 2000 U.S. Census and San Marcos Horizon 2004

The year that data became available was in 2004. The Wonder World overpass is not scheduled to open until 2007. Since the project has a useful life of 25 years the present value calculations begin in 2007 and end in 2031. The 2004 data has been used to find the subsequent figures. The formula used to find the total present value is found in Figure 2.1 as discussed in the Literature Review Chapter.

Costs

Initial Cost

The initial cost of the Wonder World Drive overpass is found by adding the City of San Marcos' cost to TxDOT's costs. The City of San Marcos financed $245,000 through General Obligation Bonds. As discussed in the Methodology chapter, this amount is at present value. This is added to their cash funding of $985,000 and the estimated cost of bike lanes $100,000. The total cost for the City of San Marcos is shown in Table 5.2.

Table 5.2 City of San Marcos Cost Estimation

General Obligation Bonds	$245,000
Cash Funding	$985,000
Bike Lanes	$100,000
Total cost estimation for San Marcos	$1,330,000

Source: These estimates where obtained in a phone interview with Rodney Gonzales from the City of San Marcos Finance Department in March 2006

The Texas Department of Transportation does not finance money. All estimated costs are taken at face value. The estimated project cost is $7,182,934. The planning, estimation and surveying was done in advance of finding a contractor to build the structure, but is included in the total cost of the project. Table 5.3 shows the total cost for TxDOT.

Table 5.3 TxDOT Costs Estimation

Estimated Project cost	$7,182,934
Planning Estimation and Surveying	$629,300
Total Cost Estimation for TxDOT	$7,812,234

Source: These cost estimates where obtained in a phone interview with Danny Stabeno form the Texas Department of Transportation in March 2006.

Tables 5.2 and 5.3 show the two entities cost of the Wonder World Drive overpass. The total cost of the project when combining TxDOT costs and City of San Marcos costs is **$9,142,234**.

Table 5.4 Total Project Cost

City of San Marcos Cost	$1,330,000
Texas Department of Transportation Cost	$7,812,234
Total estimated cost of project	**$9,142,234**

Maintenance Present Value

The cost of maintenance is found by using the percentages discussed in Table 4.2. The initial cost of the project is estimated at $9,142,234. The cost is used to find the expected maintenance cost of the project. The ROW and PSE (planning, surveying and estimating) are not used in the project cost to find maintenance. The project cost that is used for maintenance is found in Table 5.5.

Table 5.5 Modified Project Cost

Total cost of Project	$9,142,234
Right of Way Costs	$1,500,000
Planning Surveying and Estimates	$629,300
Modified Project Cost	**$7,012,934**

Source of cost estimates obtained from City of San Marcos and Texas Department of Transportation in 2006

Table 5.6 shows the present values of the cost of maintenance at 3% and 7% using the new modified project cost from Table 5.5.

Table 5.6 Present value of Maintenance

Year	Maintenance Percentage	Initial Project cost	Maintenance cost	PV @ 7%	PV @ 3%
			project cost * percent	$\sum_{i-1}^{T}\frac{C_i}{(1+.07)^i}$	$\sum_{i-1}^{T}\frac{C_i}{(1+.03)^i}$
2007	1.0%	$7,012,934.00	$70,129.34	$65,541.44	$68,086.74
2008	1.0%	$7,012,934.00	$70,129.34	$61,253.68	$66,103.63
2009	1.0%	$7,012,934.00	$70,129.34	$57,246.43	$64,178.28
2010	1.0%	$7,012,934.00	$70,129.34	$53,501.34	$62,309.01
2011	1.0%	$7,012,934.00	$70,129.34	$50,001.25	$60,494.18
2012	1.5%	$7,012,934.00	$105,194.01	$70,095.21	$88,098.33
2013	1.5%	$7,012,934.00	$105,194.01	$65,509.54	$85,532.36
2014	1.5%	$7,012,934.00	$105,194.01	$61,223.87	$83,041.12
2015	1.5%	$7,012,934.00	$105,194.01	$57,218.57	$80,622.45
2016	1.5%	$7,012,934.00	$105,194.01	$53,475.30	$78,274.22
2017	2.0%	$7,012,934.00	$140,258.68	$66,635.89	$101,325.85
2018	2.0%	$7,012,934.00	$140,258.68	$62,276.53	$98,374.62
2019	2.0%	$7,012,934.00	$140,258.68	$58,202.37	$95,509.34
2020	2.0%	$7,012,934.00	$140,258.68	$54,394.73	$92,727.51
2021	2.0%	$7,012,934.00	$140,258.68	$50,836.20	$90,026.71
2022	2.5%	$7,012,934.00	$175,323.35	$59,388.08	$109,255.72
2023	2.5%	$7,012,934.00	$175,323.35	$55,502.88	$106,073.51
2024	2.5%	$7,012,934.00	$175,323.35	$51,871.85	$102,983.99
2025	2.5%	$7,012,934.00	$175,323.35	$48,478.37	$99,984.46
2026	2.5%	$7,012,934.00	$175,323.35	$45,306.89	$97,072.29
2027	3.0%	$7,012,934.00	$210,388.02	$50,811.46	$113,093.93
2028	3.0%	$7,012,934.00	$210,388.02	$47,487.35	$109,799.93
2029	3.0%	$7,012,934.00	$210,388.02	$44,380.70	$106,601.87
2030	3.0%	$7,012,934.00	$210,388.02	$41,477.29	$103,496.96
2031	3.0%	$7,012,934.00	$210,388.02	$38,763.82	$100,482.49
			Total	**$1,370,881.04**	**$2,263,549.50**

The estimated maintenance cost for the Wonder World Drive overpass is $1,370,881.04 at 7% and $2,263,549.50 at 3%.

Present value of Costs

To find the total cost, the maintenance and initial costs are added to together.

$$PVC = C + \sum_{1\_i}^{T} \frac{C_i}{(1+i)^n}$$

The value *C* is the initial cost plus the maintenance costs. The cost of the project at the two discount rates is shown in Table 5.7

Table 5.7 Present Value of Costs

Total Cost with 7% Discount Rate		**Total Cost with 3% Discount Rate**	
Initial cost	$9,142,234.00	Initial cost	$9,142,234.00
Maintenance	$1,370,881.04	Maintenance	$2,263,549.50
Total cost at 7%	**10,513,115.04**	**Total cost at 3%**	**11,405,783.5**

Source: City of San Marcos Finance Department and Texas Department of Transportation

Benefits

Time Savings Present Value

The time savings for the overpass has been found by taking one-half the median family income divided by the average number of minutes worked annually. This quotient is then multiplied by the number of minutes saved daily multiplied by 250, to represent the annual minutes saved by motorists. Table 5.8 shows the present value for time savings at 7% and 3%.

Table 5.8 Present Values: Time Savings at Railroad Crossing

Year	1/2 MFI	1/2 Wage per min	Vehicle delay at RR in min per day	Annual Vehicle Delay at RR in minutes	Time saving benefit	PV @ 7%	PV @ 3%
		1/2 MFI/120,000 minutes worked annually	3% Increase	Daily Vehicle delay * 250 work days annually	wage per min * Annual Vehicle delay	$\sum_{i-1}^{T} \frac{B_i}{(1+.07)^i}$	$\sum_{i-1}^{T} \frac{B_i}{(1+.03)^i}$
2007	$21,481.47	$0.18	3,394	848,503	$151,892.33	$141,955.45	$147,468.28
2008	$22,555.54	$0.19	3,496	873,958	$164,271.56	$143,481.14	$154,841.70
2009	$23,683.32	$0.20	3,601	900,176	$177,659.69	$145,023.23	$162,583.78
2010	$24,867.48	$0.21	3,709	927,182	$192,138.95	$146,581.89	$170,712.97
2011	$26,110.86	$0.22	3,820	954,997	$207,798.28	$148,157.30	$179,248.62
2012	$27,416.40	$0.23	3,935	983,647	$224,733.84	$149,749.65	$188,211.05
2013	$28,787.22	$0.24	4,053	1,013,156	$243,049.65	$151,359.10	$197,621.60
2014	$30,226.58	$0.25	4,174	1,043,551	$262,858.19	$152,985.86	$207,502.68
2015	$31,737.91	$0.26	4,299	1,074,858	$284,281.14	$154,630.10	$217,877.82
2016	$33,324.81	$0.28	4,428	1,107,103	$307,450.05	$156,292.01	$228,771.71
2017	$34,991.05	$0.29	4,561	1,140,316	$332,507.23	$157,971.79	$240,210.30
2018	$36,740.60	$0.31	4,698	1,174,526	$359,606.57	$159,669.62	$252,220.81
2019	$38,577.63	$0.32	4,839	1,209,762	$388,914.50	$161,385.69	$264,831.85
2020	$40,506.51	$0.34	4,984	1,246,055	$420,611.03	$163,120.21	$278,073.44
2021	$42,531.84	$0.35	5,134	1,283,436	$454,890.83	$164,873.37	$291,977.12
2022	$44,658.43	$0.37	5,288	1,321,939	$491,964.43	$166,645.38	$306,575.97
2023	$46,891.35	$0.39	5,446	1,361,597	$532,059.54	$168,436.42	$321,904.77
2024	$49,235.92	$0.41	5,610	1,402,445	$575,422.39	$170,246.72	$338,000.01
2025	$51,697.71	$0.43	5,778	1,444,519	$622,319.31	$172,076.48	$354,900.01
2026	$54,282.60	$0.45	5,951	1,487,854	$673,038.34	$173,925.90	$372,645.01
2027	$56,996.73	$0.47	6,130	1,532,490	$727,890.96	$175,795.19	$391,277.26
2028	$59,846.57	$0.50	6,314	1,578,465	$787,214.08	$177,684.58	$410,841.12
2029	$62,838.90	$0.52	6,503	1,625,819	$851,372.02	$179,594.27	$431,383.18
2030	$65,980.84	$0.55	6,698	1,674,593	$920,758.84	$181,524.49	$452,952.34
2031	$69,279.88	$0.58	6,899	1,724,831	$995,800.69	$183,475.46	$475,599.95
					Total 2007 to 2031	**$4,046,641.30**	**$7,038,233.36**

The present value for time savings with a 7% discount rate is $4,046,641.30 and $7,038,233.36 with a 3% discount rate. This is the estimated benefit that citizens will gain by not waiting for trains.

Accident Reduction Present Value

The present value for accident reduction was found by using data from the San Marcos Police Department. The average number of hours an accident costs a resident at the Wonder World railroad crossing is multiplied the same one-half median family income divided by the average minutes worked in a year, 120,000. The type of accident also plays a role in the present value. As stated in the Methodology chapter $500 is assigned to minor accidents and $1,000 for major accidents. A more detailed table showing the Total Damage results can be found in appendix D. Table 5.9 shows the present value for accident reduction.

Table 5.9 Present Value for Accident Reduction

Year	Accident time in minutes annually	1/2 MFI	1/2 Wage per min	Accident benefit	Total damage	Total Benefit	PV @ 7%	PV @ 3%
			1/2 MFI/120,000	**Accident minutes * 1/2 MFI per min**	**minor accident + major accident**	**accident benefit + Total damage**	$\sum_{i-1}^{T}\frac{B_i}{(1+.07)^i}$	$\sum_{i-1}^{T}\frac{B_i}{(1+.03)^i}$
2007	125.49	$20,277.19	$0.17	$21.20	$2,575.75	$2,596.96	$2,427.06	$2,521.32
2008	126.75	$20,885.50	$0.17	$22.06	$2,601.51	$2,623.57	$2,291.53	$2,472.97
2009	128.01	$21,512.07	$0.18	$22.95	$2,627.53	$2,650.47	$2,163.58	$2,425.56
2010	129.29	$22,157.43	$0.18	$23.87	$2,653.80	$2,677.67	$2,042.78	$2,379.08
2011	130.59	$22,822.15	$0.19	$24.84	$2,680.34	$2,705.17	$1,928.75	$2,333.51
2012	131.89	$23,506.82	$0.20	$25.84	$2,707.14	$2,732.98	$1,821.10	$2,288.83
2013	133.21	$24,212.02	$0.20	$26.88	$2,734.21	$2,761.09	$1,719.47	$2,245.02
2014	134.54	$24,938.38	$0.21	$27.96	$2,761.56	$2,789.52	$1,623.52	$2,202.07
2015	135.89	$25,686.54	$0.21	$29.09	$2,789.17	$2,818.26	$1,532.95	$2,159.96
2016	137.25	$26,457.13	$0.22	$30.26	$2,817.06	$2,847.32	$1,447.43	$2,118.68
2017	138.62	$27,250.85	$0.23	$31.48	$2,845.23	$2,876.71	$1,366.71	$2,078.20
2018	140.01	$28,068.37	$0.23	$32.75	$2,873.69	$2,906.43	$1,290.49	$2,038.51
2019	141.41	$28,910.42	$0.24	$34.07	$2,902.42	$2,936.49	$1,218.54	$1,999.61
2020	142.82	$29,777.74	$0.25	$35.44	$2,931.45	$2,966.89	$1,150.61	$1,961.46
2021	144.25	$30,671.07	$0.26	$36.87	$2,960.76	$2,997.63	$1,086.48	$1,924.06
2022	145.69	$31,591.20	$0.26	$38.35	$2,990.37	$3,028.72	$1,025.93	$1,887.40
2023	147.15	$32,538.94	$0.27	$39.90	$3,020.27	$3,060.17	$968.77	$1,851.45
2024	148.62	$33,515.10	$0.28	$41.51	$3,050.48	$3,091.98	$914.81	$1,816.21
2025	150.11	$34,520.56	$0.29	$43.18	$3,080.98	$3,124.16	$863.86	$1,781.67
2026	151.61	$35,556.17	$0.30	$44.92	$3,111.79	$3,156.71	$815.75	$1,747.79
2027	153.12	$36,622.86	$0.31	$46.73	$3,142.91	$3,189.64	$770.34	$1,714.59
2028	154.65	$37,721.54	$0.31	$48.61	$3,174.34	$3,222.95	$727.46	$1,682.03
2029	156.20	$38,853.19	$0.32	$50.57	$3,206.08	$3,256.65	$686.98	$1,650.12
2030	157.76	$40,018.79	$0.33	$52.61	$3,238.14	$3,290.75	$648.76	$1,618.83
2031	159.34	$41,219.35	$0.34	$54.73	$3,270.52	$3,325.25	$612.68	$1,588.16
						Total 2007 to 2032	**$33,146.34**	**$50,487.09**

The present value for accident reduction at 7% is $33,146.34 and $50,487.09 at 3%. This present value benefit shows what motorists will save by not waiting for accidents to clear at the Wonder World Drive railroad crossing and the money that can be saved by not having a collision at the railroad tracks.

Emergency Access

The benefit of emergency access was found by using the willingness to pay model that was discussed in the methodology chapter. In the willingness to pay survey, 54% of respondents said they would be willing to pay between $5 and $20. This gives a median of $12.5 per household annually. This number is held constant over the 25 year period because it is not safe to assume that residents would be willing to pay more than the initial amount. Table 5.10 shows the present values for Emergency Access.

Table 5.10 Present Values: Willingness to Pay

Year	Willingness to pay	Number of Households	Total benefit	PV @ 7%	PV @ 3%
		2% Increase	willingness * number of households	$\sum_{i-1}^{T}\frac{B_i}{(1+.07)^i}$	$\sum_{i-1}^{T}\frac{B_i}{(1+.03)^i}$
2007	$12.50	14,542.36	$181,779.51	$169,887.39	$176,484.96
2008	$12.50	14,833.21	$185,415.10	$161,948.73	$174,771.51
2009	$12.50	15,129.87	$189,123.40	$154,381.03	$173,074.70
2010	$12.50	15,432.47	$192,905.87	$147,166.96	$171,394.36
2011	$12.50	15,741.12	$196,763.98	$140,290.00	$169,730.34
2012	$12.50	16,055.94	$200,699.26	$133,734.39	$168,082.47
2013	$12.50	16,377.06	$204,713.25	$127,485.12	$166,450.61
2014	$12.50	16,704.60	$208,807.51	$121,527.87	$164,834.58
2015	$12.50	17,038.69	$212,983.66	$115,849.00	$163,234.24
2016	$12.50	17,379.47	$217,243.34	$110,435.50	$161,649.45
2017	$12.50	17,727.06	$221,588.20	$105,274.96	$160,080.03
2018	$12.50	18,081.60	$226,019.97	$100,355.57	$158,525.86
2019	$12.50	18,443.23	$230,540.37	$95,666.06	$156,986.77
2020	$12.50	18,812.09	$235,151.18	$91,195.68	$155,462.63
2021	$12.50	19,188.34	$239,854.20	$86,934.20	$153,953.28
2022	$12.50	19,572.10	$244,651.28	$82,871.85	$152,458.59
2023	$12.50	19,963.54	$249,544.31	$78,999.34	$150,978.41
2024	$12.50	20,362.82	$254,535.19	$75,307.78	$149,512.60
2025	$12.50	20,770.07	$259,625.90	$71,788.72	$148,061.02
2026	$12.50	21,185.47	$264,818.42	$68,434.11	$146,623.54
2027	$12.50	21,609.18	$270,114.78	$65,236.26	$145,200.01
2028	$12.50	22,041.37	$275,517.08	$62,187.83	$143,790.30
2029	$12.50	22,482.19	$281,027.42	$59,281.86	$142,394.28
2030	$12.50	22,931.84	$286,647.97	$56,511.68	$141,011.81
2031	$12.50	23,390.47	$292,380.93	$53,870.95	$139,642.76
			Total 2007 to 2031	**$2,536,622.84**	**$3,934,389.11**

The present value at 7% is $2,536,622.84 and $3,934,389 at 3%. These present value benefits represent what citizens are willing to pay for emergency access unimpeded by the trains.

Present Value of Benefits

To find the total benefit for the Wonder World Drive overpass all benefits are added together. Table 5.9 shows the total benefit for this project.

Table 5.11 Present Value Benefits

Total Benefit with Private 7% Discount Rate		**Total Benefit with Social 3% Discount Rate**	
Time savings	$4,046,641.30	Time savings	$7,038,233.36
Accident reduction	$33,146.34	Accident reduction	$50,487.09
Willingness to pay	$2,536,622.84	Willingness to pay	$3,934,389.11
Total Benefit at 7%	**$6,616,410.49**	**Total Benefit at 3%**	**$11,023,109.56**

Net Present Value of Wonder World Drive Overpass

The present value has been found for the costs and benefits of the Wonder World Drive overpass. Finding the net present values is most appropriate for this project. The total benefits in Table 5.11 are subtracted from the total costs found in Table 5.7. Table 5.12 shows the net present value of the Wonder World Drive overpass at each discount rate.

$$\mathbf{NPV = PVB - PVC}$$

Table 5.12 Net Present Value of Wonder World Drive Overpass

	Private Rate 7%	**Social Rate 3%**
Present Value Benefits	**$6,616,410.49**	**$11,023,109.65**
Present Value Cost	**$10,513,115.04**	**$11,405,783.50**
Net Present Value	($3,896,704.55)	($382,673.93)

The NPV is negative at both the private rate and the social rate of discount. This Net Present Value shows that the stream of benefits do not out weigh the stream of costs in the project. According to the NPV, this is not a viable project.

Many scholars argue that analyst will falsely inflate benefits. To avoid this conservative estimates have been used. This may be a contributing factor to why the NPV is negative. When the Social discount rate of 3% is used the NPV comes to less than $400,000. If less conservative estimates were to be used, the NPV at the social rate could be positive making the Wonder World Drive overpass a viable project.

Chapter Summary

This chapter shows the results of the of the present value calculations for the costs and benefits for the Wonder World Drive overpass. A public and private discount rate has been used to show what the difference in value. As stated in the literature review, the higher the discount rate the lower the present value. The net present value has shown to be significantly less than zero at both the private and social discount rate. By all economic standards, the project is inferior.

However there are five good reasons for proceeding with the Wonder World Drive Overpass. First, the voters in San Marcos approved issuing bonds for this project. This indicates that residents wanted this project. Second, the Wonder World Drive overpass is part of the planned Wonder World Extension project. This highway would not be effective if motorist had to stop at railroad crossings. Third, the benefit of having access to the hospital is invaluable. The operalization only took into account what people are willing to pay. In the event of an emergency life and property can be saved. This was not taken into account in the NPV. Fourth, the City of San Marcos is growing. Overpasses are a necessity to keep traffic moving. Finally, when using the Social discount rate the NPV is not a significant quantity compared to the overall cost of the project. It could be argued if the stream of benefits and costs were extended beyond the useful life of the project the difference would not be greater than $400,000. This could then be considered a viable project using the Social discount rate.

The City of San Marcos needs to have an adequate transportation system and a significant move in that direction is to eliminate the extended wait time at railroad crossings. As President Johnson said, “The life of a city depends on an adequate transportation system” (Dodson 1969, 373).

Chapter Six: Conclusion

Introduction

This final chapter provides a summary of the analysis that has been performed. Recommendations for future benefit-cost analysis for the City of San Marcos are provided in this chapter. These recommendations are related to this study of overpasses and improving transportation for the growing population.

Summary

In the Chapter One, the Literature review, the process of benefit-cost analysis was discussed. This process is a decision making tool that is used by public officials to ensure the best use of funds. It can be used to compare projects and pick the most efficient (finding the highest NPV) or to establish if a single project is worth doing (NPV > 0). The steps of performing a cost-benefit analysis were followed to ensure an accurate outcome. The first step of identifying the costs and benefits was done by performing a needs assessment for the overpass. A need was established the costs and benefits were derived from that need. The second step of measuring the costs and benefits was accomplished in the methodology chapter where a detailed description of the operalization of each variable was provided. Third, the costs and benefits were considered over time. For this project the expected useful life is 25 years. Each cost and benefit was discount over that 25 year period. Finally a decision criterion was used and the NPV was found for the Wonder World Drive overpass. The purpose of this paper was to perform a benefit-cost analysis and find if the Wonder World Drive overpass is a viable project. The Net Present Values at both the social and private discount rates illustrate that this is not a good economic investment.

There are many factors that influence the outcome of the benefit-cost analysis. The discount rate plays a notable role in the outcome of the benefit-cost analysis. It is suggested that the present value be found at both a private and social discount rates. By doing this, decision makers will know the worth of the project at different levels. The costs and benefits that are selected also play a role. By disregarding costs or benefits that are involved in the project will give an inaccurate result. In addition the operalization of the costs and benefits will determine the outcome. By incorrectly measuring costs and or benefits the projects worth can become erroneous. In this analysis, the benefits were intentionally reduced to prevent a flawed outcome.

The benefit-cost analysis that was performed on the Wonder World overpass has been done in hindsight. The research for this paper began after the Wonder World project had been approved and construction started. The analysis of this project still holds merit even in retrospect. This is the first overpass to be approved and funded in San Marcos. It is important to know what the worth of this project is. This analysis provides data for future overpasses and transportation improvement projects for the City.

In the Settings chapter a needs assessment was performed. It outlined the current conditions of the City. Because of these conditions, it was necessary to build an overpass. The purpose of this research was to find if the overpass is viable. As shown in the results chapter, the NPV shows the project to be a great benefit for the City of San Marcos.

This is only the beginning the transportation improvements in the City of San Marcos. In the City's Master Plan there are 3 other proposed bridges and many road improvements planned. The data that has been collected in this research and the benefit-cost analysis can assist in the decision making for these future projects.

Recommendations for Future Research

The results of this benefit-cost analysis are significant. This analysis can be duplicated on other proposed overpasses in the City. Multiple benefit-cost analyses can be done to select which overpass should be constructed first to provide the highest benefit for citizens. For the Wonder World Drive over pass the Willingness to pay model was used to find what citizens would be willing to pay for emergency access. In other analysis, a benefit unique to that area can be used. For example, Aquarena Springs Drive is a heavily used road especially for Texas State University students. This road runs right next to the Bobcat Football stadium. Benefits could be identified for having an overpass on this road. In addition, significant costs could result from the existing football stadium. This would be a worthy benefit-cost analysis.

Another suggestion for research is to perform a benefit-cost analysis on the Wonder World Drive extension. Much of the same data that has been used in this analysis can be used to find the estimated worth of the extension to Ranch Road 12. If the extension project was to be joined with the overpass project the total Net Present Value may be positive.

Hays County is the fastest growing county in the State of Texas. San Marcos is the county seat and has a booming population. Because of its location between San Antonio and Austin it is locating in the middle of a growing corridor. It is important for the city officials to plan for increased traffic and population in the future. In order for San Marcos to possess an adequate transportation system the costs and benefits of new proposals need to be established. Having knowledge of the costs and benefits of a project will allow decision makers to build new infrastructure where it is needed most. Performing benefit-cost analyses is a good way to find what, where and when projects should be built. Benefit-cost analysis may be criticized by some, but the qualitative and quantitative data that it can provide is invaluable.

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Appendix A
Definition of Terms

Annual Net Flow (S):
Used to find Pay Back Period and used in PV formula. Annual Benefits – Annual Expenditures. Found on pages 10 & 11.

Benefit-cost analysis:
Method of assessing whether decisions or choices that affect the use of scarce resources promote efficiency. The analysis involves a systematic identification of policy consequences, followed by valuation of social benefits and costs and then application of the appropriate decision criterion

Benefits:
Involve the tangible and the intangible negative unintended consequences; positive consequence, intended or unintended; direct services provided and their effects on human life

Benefit-Cost Ratio:
Ratio found by dividing Present Value by Initial Capital Outlay. Ratio must be greater than one to be considered a good project.

Costs:
Are the value of goods and services that are required for a project.

Decision Criterion:
Is the basis for selecting one alternative.

Discount rate:
Used for discounting future costs and benefits. OMB has set the discount rate at 7%.

Incremental Costs & Benefits:
Baseline scenario of what would happen with or without the policy by identifying costs and benefits by comparing consequences with the policy to those without the policy. Formula found on page 12.

Initial Capital Outlay:
The total original costs of the project or policy

Net Present Value:
The present value of incremental net benefits generated throughout the policy time horizon.

Net Welfare:
Criterion that requires net benefits to exceed net costs

Non-tangibles or Intangibles:
Variables that are not quantified in market value. Formula found on page 7.

Operationalize:
The process of measuring variables into quantifiable data for use in an analysis

Pareto Criterion:
Way of evaluating a project. A project is considered acceptable if, on one is worse off and at least one person is better off. This criterion is not often used for public projects.

Pay Back Period:
Considered the weakest criterion for a project because it does not take into account the value of time and money. Formula found on page 21.

Present Value:
Benefits and costs will be discounted to present values. Formula found on page 11

Recurring costs:
Those costs that are necessary to keep a project or program running

Social Costs:
What the community gives up in the undertaking of a project

Time Horizon:
The useful life of a capital investment as determined by engineers or manufacturers.

Appendix B

San Marcos Police Department Accident Data 2003-2005

Date	Location	Type of Accident	Details	Start time	End time	Total Time in Hours
2003						
3/28/2003	WW Drive	Hit & Run	HEB truck ran through RR arms	15:27	16:03	0:36
4/23/2003	McCarty	Minor accident	Truck in Ditch	6:56	7:36	0:40
5/2/2003	WW Drive	Major accident				0:00
5/4/2003	River Rd	Major accident	Pedestrian hit by train. Amputation of L leg and head injury. Air lift to hospital	2:22	5:05	2:43
7/9/2003	Hwy 21	Minor accident	one vehicle struck other	11:20	11:44	0:24
8/13/2003	Aquarena Springs	Major accident	Accident w/ injury, blocking traffic	17:32	18:04	0:32
9/5/2003	WW Drive	Minor accident	2 car collision	14:43	15:27	0:44
11/15/2003	Hwy 21	Minor accident	2 car collision, blocking traffic	0:18	0:50	0:32
11/25/2003	WW Drive	Minor accident	RR arm struck Veh	12:21	12:33	0:12
12/8/2003	S LBJ	Hit & Run	City bus did not yield to rr arm	13:07	13:45	0:38
Summary 2003					**Total**	**7:01**
4 out of 10 accidents were at WW Dr					**WW total**	**1:32**
Date	**Location**	**Type of Accident**	**Details**	**Start time**	**End time**	**Total Time in Hours**
2004						
3/9/2004	Aquarena Springs	Major Accident	SWT tram and sm car	17:28	18:17	0:49
3/25/2004	WW Drive	minor	2 car collision	20:35	21:48	1:13
4/6/2004	S LBJ	Minor accident	2 car collision, blocking traffic	13:20	13:32	0:12
5/8/2004	WW Drive	Minor accident	3 veh collision	17:15	17:57	0:42
5/20/2004	WW Drive	Minor accident	no details	17:11	17:33	0:22
6/14/2004	S LBJ	Minor accident	2 vehicle collision, blocking traffic	7:30	8:05	0:35
6/30/2004	HWY 21	accident unknown	2 vehicle collision, blocking traffic	9:57	10:44	0:47
8/9/2004	Centerpoint	Major Accident	2 car collision with injurys	13:06	13:52	0:46
8/15/2004	Patton st	Minor accident	car in ditch	0:41	1:27	0:46
8/22/2004	HWY 21	Minor accident	2 car collision	19:30	19:54	0:24
9/11/2004	Aquarena Springs	Minor accident	no details	0:08	0:27	0:19
10/10/2004	WW Drive	Major Accident	train hit pedestrian, deceased	17:42	20:04	2:22
11/2/2004	Aquarena Springs	Minor accident	2 vehicle collision, blocking traffic	15:03	15:52	0:49
11/3/2004	Aquarena Springs	Minor accident	2 vehicle collision	16:20	16:35	0:15
12/10/2004	E Hopkins	Hit & Run	blocking traffic	7:45	8:06	0:21
Summary 2004					**Total**	**10:42**
4 out of 15 at WW Dr					**WW total**	**4:39**

Appendix B Continued						
Date	**Location**	**Type of Accident**	**Details**	**Start time**	**end time**	**time total**
2005						
1/8/2005	HWY 21	Major accident	accident with injuries	17:03	17:44	0:41
2/4/2005	HWY 21	Minor accident	3 vehicles	12:44	13:21	0:37
3/26/2005	Aquarena Springs	Minor accident	no details	17:31	18:04	0:33
6/22/2005	Patton	Minor accident	no details	1:33	1:35	0:02
8/24/2005	S LBJ	Minor accident	2 car collision	12:06	12:50	0:44
9/10/2005	Patton	Major accident	investigation	20:32	20:52	0:20
9/23/2005	HWY 21	Minor accident	2 car collision	22:26	22:30	0:04
10/14/2005	E Access rd	Minor accident	bus car collision	6:40	7:28	0:48
10/21/2005	S Guadalupe st	Minor accident	Deer ran into side of vehicle	8:59	9:11	0:12
12/2/2005	MC Allen	Minor accident	no details	19:13	19:32	0:19
Summary 2005					**Total**	**4:20**
No accidents at WW Dr					**WW total**	**0**
			3 year average hours in San Marcos	**7:21**		
			3 yr Average hours at WW DR	**2:03**		

Appendix C
Willingness to Pay Survey
Worth of the Wonder World Drive Overpass to Citizens of San Marcos

Question:
How much would you pay a year to ensure that you or emergency officials (police, fire, EMS) would not be stopped by a train in the event of an emergency?

$1 to $5

$5 to $10

$10 to $15

$15 to $20

Greater than $20

Other amount

Race		**Age**			
Minority	White	<25	25-40	40-60	>60

Gender Male Female

SPSS Survey Results

Worth of overpass to citizens of San Marcos

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	$1 to $5	4	10.0	10.0	10.0
	$5 to $10	9	22.5	22.5	32.5
	$10 to $15	5	12.5	12.5	45.0
	$15 to $20	8	20.0	20.0	65.0
	$20 to $30	7	17.5	17.5	82.5
	> $50	7	17.5	17.5	100.0
	Total	40	100.0	100.0	

Appendix D
Total Accident Damage Calculation

Year	Accident time in hours	Cost of Minor Accident	Cost of Major Accident	Total Damage
	1% Increase	1% Increase	1% Increase	Minor + Major
2004	2.03	$1,500.00	$1,000.00	$2,500.00
2005	2.05	$1,515.00	$1,010.00	$2,525.00
2006	2.07	$1,530.15	$1,020.10	$2,550.25
2007	2.09	$1,545.45	$1,030.30	$2,575.75
2008	2.11	$1,560.91	$1,040.60	$2,601.51
2009	2.13	$1,576.52	$1,051.01	$2,627.53
2010	2.15	$1,592.28	$1,061.52	$2,653.80
2011	2.18	$1,608.20	$1,072.14	$2,680.34
2012	2.20	$1,624.29	$1,082.86	$2,707.14
2013	2.22	$1,640.53	$1,093.69	$2,734.21
2014	2.24	$1,656.93	$1,104.62	$2,761.56
2015	2.26	$1,673.50	$1,115.67	$2,789.17
2016	2.29	$1,690.24	$1,126.83	$2,817.06
2017	2.31	$1,707.14	$1,138.09	$2,845.23
2018	2.33	$1,724.21	$1,149.47	$2,873.69
2019	2.36	$1,741.45	$1,160.97	$2,902.42
2020	2.38	$1,758.87	$1,172.58	$2,931.45
2021	2.40	$1,776.46	$1,184.30	$2,960.76
2022	2.43	$1,794.22	$1,196.15	$2,990.37
2023	2.45	$1,812.16	$1,208.11	$3,020.27
2024	2.48	$1,830.29	$1,220.19	$3,050.48
2025	2.50	$1,848.59	$1,232.39	$3,080.98
2026	2.53	$1,867.07	$1,244.72	$3,111.79
2027	2.55	$1,885.74	$1,257.16	$3,142.91
2028	2.58	$1,904.60	$1,269.73	$3,174.34
2029	2.60	$1,923.65	$1,282.43	$3,206.08
2030	2.63	$1,942.88	$1,295.26	$3,238.14
2031	2.66	$1,962.31	$1,308.21	$3,270.52