A Framework for Analyzing the Ownership, Tenure and Governance Issues for a Proposed International River Crossing

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ABSTRACT

In this paper the authors present a framework for analyzing different Ownership, Tenure and Governance (OTG) strategies for a proposed international river crossing in the Detroit Area that constitutes a major trade corridor between the US with Canada. The framework is designed to identify an economic analysis procedure that can be used to test the fiscal consequences of different OTG strategies, including public ownership, private ownership and joint ownership. The authors also demonstrate the application of the procedure with limited data and conclude that the framework is viable and can be used to test the economic consequences of various OTG strategies. Recommendations for future research include procedures to incorporate intangibles; risks/uncertainties associated with future economic outcomes; and various joint ownership scenarios.

Keywords: Ownership, Tenure, Governance, Risks, Uncertainties

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1. INTRODUCTION

The trillion dollar transportation infrastructure in the US was built over the last 200 years and has been financed primarily by public dollars through various forms of user taxes (Garber and Hoel, 2002). The Highway Trust Fund created by Congress in the mid-1950s was used to build the interstate highway system (formally the Defense Highway System) that serves as the backbone of the nation’s transportation network today and that has provided much of the stimulus for regional economic growth.

Since the completion of the interstate system in the early 1990s, Congress has taken a number of landmark legislative actions to support the transportation infrastructure in the US. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the 1998 Transportation Equity Act for the 21^{st} Century (TEA-21), and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETY-LU) of 2005 will have provided over $700 billion of support for the transportation infrastructure of the country for the period 1992 through 2010. The intent of these acts is to develop and maintain a multimodal transportation system that is economically efficient and environmentally sound, and that will enable the nation to compete in global economy.

The purpose of the above discussion is the establishment of the framework of this paper focusing on a proposed international crossing across the Detroit River in the Midwest, connecting the cities of Detroit, USA and Windsor, Canada. Historically, the highway infrastructure in the US has been built and maintained by public funds, with a few exceptions. Factors such as improved mobility, reduced congestion, and higher safety, along with economic benefits have been used to justify these investments. Tollways and turnpikes, regardless of tenure, constitute a very small fraction of US highways, and are somewhat of an exception to this rule. Typically, these facilities are financed by long-term bonds, and the revenue generated by the facilities is used to pay for the investment. Very little private funding has been used in the U.S. for roadway infrastructure. Private participation is, however, more common in other modes of transportation, particularly rail, air and transit prior to 1950s. Programs for these modes have been characterized by sharing of costs and revenues by the private and the public enterprise.

1.1 Background Information

The Central Business Districts (CBDs) of the cities of Detroit and Windsor are currently connected by a bridge and a tunnel across the Detroit River, both built during the late 1920s. The Ambassador Bridge is a privately owned four-lane suspension structure, while the Detroit-Windsor tunnel is a two-lane facility with height restriction, jointly owned by the two cities and operated by a private corporation. These two facilities constitute one-half of the vital trade-corridor between the US and Canada in the Midwest.[5] The vehicular crossings between Southwest Ontario and Southeast Michigan are the busiest of all Canada-US border crossings, and the Ambassador Bridge ranks the highest in commercial vehicles among all US border crossings.

A number of recently completed and ongoing studies sponsored by the Michigan Department of Transportation (MDOT) and the Ontario Ministry of Transportation (OMT) consider various issues related to a new Detroit River crossing, two of which have direct relevance to this paper. The Canada–US–Ontario–Michigan Transportation Partnership Study (Partnership Study) attempted to develop long-term strategies to provide for safe and efficient movement of people and goods between Michigan and Ontario (FHWA, 2003). The study

[5] Two other facilities carry freight between Michigan and Ontario. A rail tunnel under the Detroit River at Detroit and the Blue Water Bridge over the St. Clair River (100 km north of Detroit), which connects Port Huron, USA and Sarnia, Canada.

identified and evaluated a total of seven generic alternatives using a set of six factors. Even though the current capacities of the Ambassador Bridge and the Detroit-Windsor tunnel adequately serve the traffic needs during most hours, on specific days during peak periods the systems do run at full capacity. Considering long-term traffic growth and the overall importance of the Detroit River crossings on the regional economy, the need for a third crossing seems immensely justified.

A second ongoing study–Evaluation of Alternatives from US and Canadian Sides of the Border–explores various alternatives for the proposed new crossing and is expected to recommend the most-desired alternative, based upon a set of comprehensive Environmental Impact Statements (FHWA, 2003). As it now stands, the study identifies a total of 15 alternatives, depicting different bridge structures, plaza locations and connecting routes and narrows these down to three, based upon context-sensitive design considerations, expert opinions, and technical viewpoint. The preliminary report terms these three alternatives

1. X-10 (A), (Dearborn-I75- Shortest route length, least capital intensive)
2. X-10 (B), (Springwells –I75)
3. X-11 (C), (Dragoon-I75- Highest route length , most capital intensive).

1.2 Problem Statement

The United States and Canada share the largest trading relationship in the world. Currently $200 billion of surface trade passes annually between Southwestern Ontario and Southeastern Michigan, a figure expected to reach $300 billion by the year 2030 (FHWA, 2003). More than 50% of this traffic crosses the Detroit River by truck (FHWA, 2003). This large trade volume has a significant positive effect on the local, regional and national economies, through cross-border employment, opportunities. The vehicular crossings between Southwest Ontario and Southeast Michigan are the busiest of all Canada-US border crossings, and the Ambassador Bridge ranks the highest in commercial vehicles among all US border crossings (MDOT and OTM, 2003).

The Ambassador Bridge, on an average day, carries approximately 26,500 passenger-cars and 12,000 commercial vehicles and these figures are projected to increase by more than 40% and 100% respectively by the year 2030 (FHWA, 2003). The corresponding figures for the Detroit-Windsor Tunnel are 25,000 and 700 with projected increases of 100% and 30% respectively by 2030 (FHWA, 2003). The long-range prediction of the trade volume clearly indicates that the two existing Detroit River vehicular crossings (and any additional crossing that may be opened in the future) will have a major part in the overall economic picture of the Southeast Michigan and Southwest Ontario region, not to mention the cities of Detroit and Windsor.

Research presented in this paper is built upon the premise that a new crossing, most likely in the form of a bridge, will be built in the near future, even though its exact location is yet to be determined. The problem investigated in this paper relates to the development of an analytical framework designed to address the issues of Ownership, Tenure and Governance (OTG) of the proposed facility. Research envisioned in the future will explore the OTG issues related to the proposed facility using the framework presented. The proposed framework can be used to conduct exploratory analysis on questions such as, "Should the new crossing be owned, operated and governed by a (yet to be named) public agency, so that the taxpayers can benefit from the revenues likely to be generated over the life of the project?" Or, "Should the ownership and operating rights be left to the private enterprise, thereby protecting the public at large from the risks associated with this investment?" A third alternative would be joint public-private ownership with clearly defined rights and responsibilities in the operation and governance of this proposed crossing.

1.3 Study Objectives

The objectives of the research presented in this paper are to

1. Develop a framework for economic analysis to explore the Ownership, Tenure and Governance (OTG) issues of the proposed river crossing;
2. Identify data requirements associated with using the proposed framework to analyze different forms of OTG issues of the proposed facility; and
3. Demonstrate the application of the proposed framework with limited data.

2.0 ANALYTICAL FRAMEWORK

The framework for economic analysis developed for the study is adapted after the concepts of Benefit to Cost Ratio (B/C) and Internal Rate of Return (IRR). The following symbols are used are introduced to explain the methodology

(A/F) = Sinking Fund Factor
(A/P) = Capital Recovery Factor
APOM=Annualized worth of POM
B = Project Benefits in Year 1
(B/C) = Benefit Cost Ratio
C = Unit $ Value of Each Accident Prevented
(C/E) = Cost Effectiveness Index

EUAB = Equivalent Uniform Annual Benefit ($/year)
EUAC = Equivalent Uniform Annual Cost ($/year)
I = Initial Cost ($)
i = Interest rate used (%, annual)
IRR = Internal Rate of Return (%, annual)
K = Annual Operating and Maintenance Cost ($)
MARR = Minimum Attractive Rate (%, annual)
PWOB=Present Worth of Benefit
PWOC= Present Worth of Cost
(P/A) = Present Worth Factor (Uniform Series)
(P/F) = Present Worth Factor (Single Payment)
(PP) = Pay off Period (years)
POM= Periodic Operation and Maintnance(O&M) Cost ($)
PWOB = Present Worth of Benefit ($)
PWOC = Present Worth of Cost ($)
S = Salvage Value ($)
$y_1, y_2, y_3 .... y_n = Years\ when\ Periodic(O\ \&\ M)\ Cost\ is\ Applied$
$g = Annual\ Growth\ Rate$

2.1 Benefit Cost Analysis

Benefit to Cost Ratio is one of the most frequently used methods in economic analysis. B/C Ratio is simply a measure of the number of units of benefits that the project is expected to provide per unit cost. The algorithm typically used is

$$\frac{B}{C} = \frac{Benefit}{Cost} = \frac{EUAB}{EUAC}$$

$$EUAC = I \times \left(\frac{A}{P}\right) + K + POM \times \left[\left(\frac{P}{F}\right)_{n=y_1} + \left(\frac{P}{F}\right)_{n=y_2} + ... + \left(\frac{P}{F}\right)_{n=y_n}\right] \times \left(\frac{A}{P}\right) - S\left(\frac{A}{F}\right)$$

$$EUAB = B \times \left(\frac{P}{A}\right)_{i,n,g} \times \left(\frac{A}{P}\right)_{i,n}$$

where EUAB and EUAC are Equivalent Uniform Annual Benefits and Equivalent Uniform Annual Costs respectively. Furthermore, EUAB and EUAC should include all tangible and intangible benefits associated with the project and should incorporate not only the toll revenues (tangible), but also the benefits associated with increased mobility, possible economic benefits, reduced congestion, and environmental benefit resulting from the project.

EUAC should incorporate all costs associated with the project including agency costs, user costs, and non user cost (Sinha, 2005), where

Agency Cost = Capital Cost + Operating Cost + Maintenance Cost;

Capital Cost = Planning, Engineering, Design, Right of Way and Construction Costs;

User Cost = Cost associated with vehicle operation, travel time, delay and safety; and

Non-User Cost = Costs of Environmental Damage (e.g., air pollution, noise pollution).

Furthermore, savings in user cost and non-user cost can also be treated as a part of benefits when two alternatives are considered, in which case these do not have to be accounted for separately as a part of the cost.

2.2 Internal Rate of Return Technique (IRR)

The IRR technique is also quite frequently used in economic analysis and requires the estimation of the interest rate that the project is expected to return to the investor. IRR is the interest rate at which the Net Present Worth or Net Annual Worth equals to zero. The interest rate at which EUAB equals EUAC or PWOB equals PWOC is the IRR that the project is expected to generate. Projects that generate IRR values exceeding an initially specified Minimum Attractive Rate of Return (MARR) are considered viable. MARR is used to judge the attractiveness of proposed investments, and represents a bench-mark yield below which all investment proposals are considered unattractive. The determination of MARR is normally a policy issue and criteria for setting it vary greatly.

Furthermore, for projects involving public-private participants, questions are often raised about the inclusion of intangible benefits and costs (discussed earlier), sometimes termed as externalities. Externalities include, among others, environmental damage, pollution, savings in travel time and travel costs that are not reflected in the market (Johnson and Kasarda, 2003). It is customary to ignore these externalities in any analysis dealing with the private sector, as these do not affect the private sector's decisions. The term used for this return is Financial Internal Rate of Return (FIRR), where only the direct expenditures and revenues are included. For the public sector, two sets of returns are generally estimated. The FIRR is used to benchmark public sector performance with that of the private sector. An analysis that includes the externalities (both costs and benefits) is conducted to estimate what is commonly referred to as the Economic Internal Rate of Return (EIRR). The analysis reported below primarily focuses on FIRR, with an effort to estimate EIRR for only one of the few scenarios analyzed (ADB, 2000).

2.3 Data Sources

Most of the data used in testing the analytic framework was obtained from various reports published by MDOT, often supplemented with information obtained through personal interviews (URS Canada, 2005). The accuracy of the data is not of great significance here, as the object of this analysis is simply to test the viability of the framework. The results presented are not intended to be a basis for any action at this time. Future research envisioned will be directed toward testing the framework with more authentic data, taking into account factors such as risks and uncertainties, intangible benefits and various forms of joint ownership scenarios under the Built, Own, Operate and Transfer (BOOT) concept as practiced in many European countries (Merna and Njra, 1995).

2.4 Alternative Scenarios

A total of five independent alternative OTG scenarios were developed, representing various levels of cost-revenue allocation as explained in Tables 1 and 2 . As Table 1 shows, of these five scenarios, the first four are all public ownership models depicting how the capital costs of the bridge, plaza and access infrastructure are considered a part of the investment cost. Since the cost of the plaza and access infrastructure are much higher than that of the bridge itself, the extent to which these costs should be considered a part of the investment is a matter of argument. Scenarios 1 through 4 are designed to address this issue, by allocating these costs in different manners. Scenario 5 is a joint public-private ownership strategy that may be considered an outgrowth of Scenario 1. Furthermore, for each of these five scenarios, two alternatives are tested. These are

- Alternative 1: Least Capital Cost Intensive, as identified by the EIS being developed. (FHWA, 2003 and FHWA, 2005).
- Alternative 2: Most Capital Cost Intensive, as identified by the EIS currently being developed. (FHWA, 2003 and FHWA, 2005).

Thus, the five scenarios presented combined with the two alternatives for each scenario constitute a total of 10 mutually exclusive alternatives. Concerning scenario 5, a review of the documents/reports currently available show some conflicting growth rates for truck traffic ranging from 1.5 percent to 3 percent annually. Since truck toll charges constitute the main source of revenue (tangible benefits) for the proposed project, two cases were analyzed depicting different growth rates for truck traffic, as shown in the last column of Table 2.

3. RESULTS

Results of testing the proposed framework for 1.5% projected truck traffic growth (Case-1) are presented for the five scenarios for alternatives 1 and 2 in Tables 3 and 4. In Table 3, the relevant cost and benefit data are computed based upon the algorithm presented earlier. Two sets of Measures of Effectiveness (MOE) are presented in Table 4, B/C ratio and IRR. Interest rate or cost of borrowing capital was assumed as 6% in computing B/C ratio. Also, the MARR was assumed to be 6%, implying that any project generating an IRR less than 6% should be considered undesirable. Stated differently, projects generating an IRR less than the MARR are expected to result in a B/C ratio less than unity at the annual rate of 6%.

Table 4, which summarizes the economic analysis, shows that of all five scenarios, the B/C ratios for Alternative 1 (A-1) are higher than those of Alternative 2 (A-2). Since A-2 is more capital cost intensive, the above findings are logical. The same trend is generally true for the other MOE, (i.e. IRR). Furthermore, the highest IRR is attained in scenario 4, being equal to 7.3% and 7.1% respectively for A-1 and A-2. As mentioned earlier, the capital cost of the plaza and the access infrastructure is assumed to be much higher than that of the bridge itself. Since these costs are not considered to be part of the investment cost, the higher B/C ratio–the higher IRR for scenario 3 and scenario 4–are logical. Additionally, scenario 4 attempts to capture the externalities by increasing the benefits by 30%. Thus, the combination of these two factors (reduced cost and increased benefit) has the effect of maximizing the B/C ratio or IRR for scenario 4. On the other hand, scenario 1, which requires all capital costs (plaza and access included) to be borne by the public entirely, results in the lowest B/C ratio or lowest IRR.

Tables 5 and 6 are counterparts of Tables 3 and 4 respectively for the higher truck growth rate (3%). Increased truck traffic would result in increased revenue, resulting in higher B/C ratios and IRR values for Case 2 as compared to Case 1.[6] Overall, the results indicate that the proposed framework is viable and can be used to test various allocations of costs and benefits to the participating entities, which might include the public and/or private sector.

4. CONCLUSIONS AND RECOMMENDATIONS

The purpose of the research presented in this paper is to develop a framework for economic analysis to explore various OTG scenarios for a proposed Detroit River crossing connecting the US with Canada. This research is based on the premise that a need for the third crossing in the general vicinity of two existing crossings in the Detroit-Windsor area will be built in the near future. A number of recent and ongoing studies will support the validity of the assumption.

The proposed framework for economic analysis was tested with limited data available for the study. While the results by themselves are of minor significance, the trends observed are important for assessing the validity of the framework. The trends appear to be logical, thereby attesting to the overall viability of the proposed framework. Even though only one joint public-private ownership scenario was tested, it is possible to test various scenarios under this concept using the framework developed. A Build, Own, Operate and Transfer (BOOT) scenario that seeks to raise capital funds from private resources, in exchange of future revenues is being used extensively in Europe and Asia for large scale infrastructure and can be used to develop different versions of the joint ownership scenario and tested using the proposed framework (Merna and Njra, 1995).

The proposed framework also should be refined to incorporate the concept of externalities (i.e., intangible costs and benefits) as well as the concept of uncertainty/risks

[6] Since this is simply a demonstration exercise to test the viability of framework, as opposed to an actual case study, the possible increased operating cost resulting from increased truck traffic was not considered in the analysis.

associated with the estimation of future costs and revenues. For the public entity in particular, intangible outcomes comprise a major source of benefits and thus need to be accounted for in any economic analysis. Finally, the economic analysis presented is based upon expected project returns and costs during the life of the project (75 years), which have been considered fully deterministic. In effect, these future outcomes have significant amounts of uncertainty/risk associated with their estimate. Additional research is needed to incorporate the concept of Investment Decisions Under Uncertainty with a more realistic assessment of future costs and revenues.

LIST OF TABLES

Table 1: Proposed Scenarios, Cost and Benefit Elements

Scenario	Explanation	Cost Components (%)						Benefits(%)
		Planning and Design Cost	Capital Cost	Access and Plaza Cost	Toll Collection Cost (Annual)	Operation and Maintenance Cost (Annual)	Periodic Operation and Maintenance Cost	
1	1. Fully Publicly Owned	100	100	100	100	100	100	100
2	2. Fully Publicly Owned (50% of Plaza Cost)	100	100	50	100	100	100	100
3	3. Public Owned ("0" Plaza Cost)	100	100	0	100	100	100	100
4	4. Public Owned ("0" Plaza Cost) and 30% Increase in Benefits (Intangibles)	100	100	0	100	100	100	130 (30% factor include intangibles)
5	Public Private Partnership							
5a	Public Owned	100	50	50	100	50	50	75
5b	Private Owned	0	50	0	0	50	50	25

Table 2 Alternatives and Cases for Proposed Scenarios

Cost and Benefit Items	Alternative-1 (Least Capital Intensive) in Millions	Alternative-2 (High Capital Intensive) in Millions	Case-1	Case-2
Planning and Design Cost	100	100	1.5% Growth of both Passenger Cars and Commercial Vehicles	1.5% Growth of Passenger Cars and 3% Growth of Commercial Vehicles
Construction Cost	250	500		
Access and Plaza Cost	850	1500		
Annual Operation and Maintenance (O&M) Cost	5 % of Construction Cost	3% of Construction Cost		
Periodic O&M Cost	(i)(N,20) =$25 (ii)(N,40)=$50 (iii) (N,60)=$75	(i)(N,20) =$30 (ii)(N,40)=$60 (iii) (N,60)=$90		
Toll Collection Cost (Annual)	10	10		
Benefits (First Year)	Total Revenue (B)	130% of B		

Table 3 Cost and Benefit Items -Case-1- (Commercial Vehicle Growth 1.5% and Passenger Car Growth 1.5%)

Possible Scenario	Costs (In Millions)										Annual Benefits (In Millions)			
	Planning and Design Cost	Capital Cost		Access and Plaza Cost		Toll Collection Cost (Anuual)	Operation and Maintenance Cost (Anuual)		Periodic Operation and Maintenance Cost		Passenger Cars	Trucks	Passenger Cars	Trucks
	A-1 &2	A-1	A-2	A-1	A-2	A-1 &2	A-1	A-2	A-1	A-2	A-1	A-1	A-2	A-2
1	\$100	\$250	\$500	\$850	\$1,500	\$10	\$12.5	\$15.0	(i)(N,20) = \$25 (ii)(N,40)= \$50 (iii) (N,60)= \$75	(i)(N,20) =\$30 (ii)(N,40)=\$60 (iii) (N,60)= \$90	\$7.44	\$23.76	\$8.56	\$27.32
2	\$100	\$250	\$500	\$425	\$750	\$10	\$12.5	\$15.0	(i)(N,20) = \$25 (ii)(N,40)= \$50 (iii) (N,60)= \$75	(i)(N,20) =\$30 (ii)(N,40)=\$60 (iii) (N,60)= \$90	\$7.44	\$23.76	\$8.56	\$27.32
3	\$100	\$250	\$500	\$0	\$0	\$10	\$12.5	\$15.0	(i)(N,20) = \$25 (ii)(N,40)= \$50 (iii) (N,60)= \$75	(i)(N,20) =\$30 (ii)(N,40)=\$60 (iii) (N,60)= \$90	\$7.44	\$23.76	\$8.56	\$27.32
4	\$100	\$250	\$500	\$0	\$0	\$10	\$12.5	\$15.0	(i)(N,20) = \$25 (ii)(N,40)= \$50 (iii) (N,60)= \$75	(i)(N,20) =\$30 (ii)(N,40)=\$60 (iii) (N,60)= \$90	\$9.68	\$30.88	\$11.13	\$35.52
5(a)	\$100	\$125	\$250	\$425	\$750	\$10	\$6.3	\$7.5	(i)(N,20) =\$12.5 (ii)(N,40)=\$25 (iii) (N,60)= \$37.5	(i)(N,20) =\$15 (ii)(N,40)= \$30 (iii) (N,60)= \$45	\$5.58	\$17.82	\$6.42	\$20.49
5(b)	\$0	\$125	\$250	\$0	\$0	\$0	\$6.3	\$7.5	(i)(N,20) =\$12.5 (ii)(N,40)=\$25 (iii) (N,60)= \$37.5	(i)(N,20) =\$15 (ii)(N,40)= \$30 (iii) (N,60)= \$45	\$1.86	\$5.94	\$2.14	\$6.83

Table 4 B/C Ratio and IRR for Case-1

Possible Scenario	EUAB (i = 6%)		EUAC (i = 6%)		B/C (i = 6%)		IRR	
	A-1	A-2	A-1	A-2	A-1	A-2	A-1	A-2
1	$44.75	$51.47	$100.71	$161.36	0.444	0.319	3.6%	2.7%
2	$44.75	$51.47	$73.33	$113.05	0.610	0.455	4.7%	3.6%
3	$44.75	$51.47	$45.95	$64.74	0.974	0.795	5.7%	5.1%
4	$58.18	$66.90	$45.95	$64.74	1.266	1.033	7.3%	7.1%
5(a)	$33.56	$38.60	$58.57	$88.90	0.573	0.434	4.5%	3.6%
5(b)	$11.19	$12.87	$14.76	$24.15	0.758	0.533	4.9%	4.4%

Table 5: Cost and Benefit Items -Case-2- (Commercial Vehicle Growth 3% and Passenger Car Growth 1.5%)

Possible Scenario	Costs (In Millions)										Annual Benefits (In Millions)			
	Planning and Design Cost	Capital Cost		Access and Plaza Cost		Toll Collection Cost (Anuual)	Operation and Maintenance Cost (Anuual)		Periodic Operation and Maintenance Cost		Passenger Cars	Trucks	Passenger Cars	Trucks
	A-1 &2	A-1	A-2	A-1	A-2	A-1 &2	A-1	A-2	A-1	A-2	A-1	A-1	A-2	A-2
1	$100	$250	$500	$850	$1,500	$10	$12.5	$15.0	(i)(N,20) = $25 (ii)(N,40)= $50 (iii) (N,60)= $75	(i)(N,20) = $30 (ii)(N,40)= $60 (iii) (N,60)= $90	$7.44	$25.94	$8.56	$29.83
2	$100	$250	$500	$425	$750	$10	$12.5	$15.0	(i)(N,20) = $25 (ii)(N,40)= $50 (iii) (N,60)= $75	(i)(N,20) = $30 (ii)(N,40)= $60 (iii) (N,60)= $90	$7.44	$25.94	$8.56	$29.83
3	$100	$250	$500	$0	$0	$10	$12.5	$15.0	(i)(N,20) = $25 (ii)(N,40)= $50 (iii) (N,60)= $75	(i)(N,20) = $30 (ii)(N,40)= $60 (iii) (N,60)= $90	$7.44	$25.94	$8.56	$29.83
4	$100	$250	$500	$0	$0	$10	$12.5	$15.0	(i)(N,20) = $25 (ii)(N,40)= $50 (iii) (N,60)= $75	(i)(N,20) = $30 (ii)(N,40)= $60 (iii) (N,60)= $90	$9.68	$33.73	$11.13	$38.78
5(a)	$100	$125	$250	$425	$750	$10	$6.3	$7.5	(i)(N,20) = $12.5 (ii)(N,40)= $25 (iii) (N,60)= $37.5	(i)(N,20) = $15 (ii)(N,40)= $30 (iii) (N,60)= $45	$5.58	$19.46	$6.42	$22.38
5(b)	$0	$125	$250	$0	$0	$0	$6.3	$7.5	(i)(N,20) = $12.5 (ii)(N,40)= $25 (iii) (N,60)= $37.5	(i)(N,20) = $15 (ii)(N,40)= $30 (iii) (N,60)= $45	$1.86	$6.49	$2.14	$7.46

Table 6: B/C Ratio and IRR for Case-2

Possible Scenario	EUAB (i = 6%)		EUAC (i = 6%)		B/C (i = 6%)		IRR	
	A-1	A-2	A-1	A-2	A-1	A-2	A-1	A-2
1	$59.05	$55.07	$100.71	$161.36	0.59	0.34	3.8%	2.9%
2	$59.05	$55.07	$73.33	$113.05	0.81	0.49	4.9%	4.0%
3	$59.05	$55.07	$45.95	$64.74	1.29	0.85	7.7%	5.6%
4	$76.77	$71.59	$45.95	$64.74	1.67	1.11	10.2%	7.2%
5(a)	$44.29	$41.30	$58.57	$88.90	0.76	0.46	4.6%	3.4%
5(b)	$14.76	$13.77	$14.76	$24.15	1.00	0.57	6.2%	4.4%

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