MIT STUDENT RESEARCH ON TREN URBANO

JANUARY - AUGUST 1995

Joint MIT-UPR Educational and Research Program Focused on Tren Urbano

Massachusetts Institute of Technology

August 1995

TREN URBANO:

The Implications of Turnkey on Cost and Distribution of Risk

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May 1995

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Introduction

Risk considerations in the Tren Urbano development process are the key concerns of all parties involved in the turnkey procurement process.

Risk is the uncertainty inherent in any new project, and in the case of transit development, the number and scale of these uncertainties is high. Risk also is a major cost of any infrastructure project.

Because the design-build-operate principles of a turnkey transit system is, in the words of the Federal Transit Administration, "a new approach," the benefit of past experience is not brought to bear. In traditional segmented procurement, different types of risk may or may not be explicitly assigned to the different parties. But at least the process is well defined and the risk has been addressed through standard contract language, accepted practices and the case history of litigation in such issues as design liability. A linear, sequential process spells out each contractor's role in the process through separate contracts.

Table One provides a classification of risk elements involved with the development of fixed guideway transit systems. This list is intended to be exhaustive and non-overlapping. The first section of this paper addresses the impacts of turnkey contracting on these risks (and the costs arising from risk allocation), and the second section treats Tren Urbano as a case study in which the project-specific details are presented in light of the risk analysis framework. Different patterns of risk allocation are the hallmark of the turnkey concept (Table Two), and the net impact on system cost and quality of this new pattern is the ultimate evaluation of any turnkey scheme.

Table One: Fixed-Guideway Transit Project Development Risks (exhaustive and non-overlapping)

	Risk	Description	Phase
1.	Political	collective decision process, agreement among local government agencies, susceptibility to disruptions by opposition groups	System Planning, all others
2.	Funding	commitment by public and private participants to monetary/in-kind support	System Planning, Preliminary engineering
3.	Financing	willingness of financial institutions to lend money based on market for capital and risk, ability to match cash flow with expenditures	System Planning,
4.	Right-of-way	acquisition of right-of-way in timely manner (to avoid delay)	System Planning
5.	Speculative Effort	project planning, preliminary engineering and permitting which precedes full funding agreement and contract initiation	System Planning, Preliminary Engineering
6.	Bids Exceed Estimates	submitted bids are greater than cost estimates, so budget is insufficient to build project	Preliminary Engineering
7.	Geotechnical	difference between what is known about subsurface conditions and what those conditions are	Construction
8.	Hazardous Materials	materials discovered during construction which require expensive disposal	Construction
9.	Underground Utilities	unknown and dislocated underground utilities	Construction
10.	Inflation	growth is general or specific prices which are not correctly forecast, and thus alter the relative magnitude of cost components	Construction
11.	Federal, State, Local Regulations	changes in regulations (or interpretation of regulations) which result in higher costs (i.e. Buy America, ADA, DBE, OSHA, etc.)	Final Design, Construction
12.	Design Integration; Coordination	potential for design element or subsystem to be incompatible and result in malfunctioning system	Construction
13.	Changed Requirements	change in owners requirement discovered/made after critical point in development	Construction
14.	Construction Performance	hidden defects covered up, skill shortage, labor conflicts	Construction
15.	Subsystem Test	possibility that subsystem does not function properly	Construction
16.	System Integration	possibility that subsystem operates, but not compatible with whole system	Construction, Operations
17.	Schedule Slippage	delay which affects subsystem development and/or completion date	Final Design, Construction
18.	Construction Safety	unsafe conditions which threaten workers and property	Construction
19.	Site Security	prevention of theft and sabotage	Construction
20.	Act of God	natural catastrophe occurring during construction which affects completed work, materials, schedule	Construction, Operation
21.	Failure to Complete	contractor fails to deliver contracted work	Construction
22.	Seismic	finished facility is seismically unsafe and/or is damaged by seismic activity	Operation
23.	Operating	possibility that system does not have adequate capacity, other unexpected operating conditions/costs	Operation
24.	Market (Ridership / Revenue)	demand (ridership at given fare) is not high enough to meet revenue projections	Operation

SOURCE: Lee, D.B., et al., *Turnkey Evaluation Guidelines*, U.S.DOT, Volpe NTSC, February 1995.

Even when aspects of the risk factors are not explicitly addressed, the cost of these risks are in play in the project. As one commentator has written, risk is like energy, it can not be created or destroyed, only reallocated. Under traditional, sequential procurement, the public authority assumes these uncertainties by default, and one of the results is the extended timeframe required for procurement. Other costs of uncertainty traditionally borne by the public authority include speculative "system planning" investment, contingency and reserve funds, and general obligation bonds issues.

Table Two: Risk Allocation Implications of Turnkey

	Risk	Traditional Allocation	Effect of Turnkey
1.	Political	owner	
2.	Funding	owner	shared (potentially)
3.	Financing	owner	shared (potentially)
4.	Right-of-way	owner	
5.	Speculative Effort	owner	preparation of bids
6.	Bids Exceed Estimates	owner	
7.	Geotechnical	owner	negotiable
8.	Hazardous Materials	owner	negotiable
9.	Underground Utilities	owner	negotiable
10.	Inflation	owner prior to award, between stages	to contractor, after signing
11.	Federal, State, Local Regulations	regulatory changes only	full compliance
12.	Design Integration; Coordination	owner	full transfer
13.	Changed Requirements	owner	
14.	Construction Performance	share	
15.	Subsystem Test	contractor	
16.	System Integration	owner	full transfer
17.	Schedule Slippage	negotiated	transferred
18.	Construction Safety	contractor	
19.	Site Security	contractor	
20.	Act of God	contractor	
21.	Failure to Complete	contractor	full (capped)
22.	Seismic	based on standards	meet standards
23.	Operating	owner	negotiable (Design-Build-Operate)
24.	Market (Ridership /Revenue)	owner	negotiable (Design-Build-Operate)

NOTE: "Owner" includes transit agency, local, state and federal agencies and ultimately taxpayer.

The Cost of Risk

In any public project in which specific outcome is uncertain, there is a cost element of risk. Because government action is justified often on the basis of welfare maximization, the risks may be higher in the public sector than in the private sector. Uncertainty about project outcome is coupled with the uncertainty of the estimate of non-market benefits. As related to improvements in metropolitan transportation, a major issue is the "value of time" that travelers use in making decisions; any project, like Tren Urbano, which uses these types of welfare improvements to justify public expenditure will necessarily introduce more risk into the equation.

The process of designing and building a rail transit system encounters numerous risks even before encountering the operations phase and its inherent risks relating to market forces and public safety. When a major piece of infrastructure is built through a sequential design-bid-build process, risks are analyzed only to the point that the public owner is concerned about control of these risks. The work is coordinated

by the owner, and the owner assumes risks for every aspect of the project, once the plans are accepted and the closely worded construction contracts are bid.

Cost and Risk Under Turnkey

Under a Turnkey contracting structure, the cost associated with shifting this risk will be higher at the outset, but the net cost implications can be important. In effect, the contractor is the party most capable of controlling certain risks, and this should be the party which is assigned that risk. The cost is made explicit when evaluated as its own expense, but that cost can be lower than embedded cost of the owner carrying that risk.

The Added Cost of Not Specifically Allocating Risk

The fact that a risk is not addressed does not mean that the cost is zero. More specifically, the cost of certain risks may be unnecessarily high if the most appropriate party is not responsible for risk mitigation. The current system has proven to be a case in which neither risk or cost of risk is minimized, and the incentive scheme points toward costly (in money and time) ex post facto assignment of risk. The system in place now results in claims and litigation by construction firms against design firms who in turn bring claims against the owner who initially defined the scope of the project. The most appropriate and cost-effective mechanism for addressing issues which inevitably arise during development and construction would likely be less antagonistic, spending less to determine who is to blame and more on correcting the problem to keep on schedule.

Many have commented on the contentious nature of the relationship among different contractors and the owner, and even between contractors. The scope of work for each sequentially-contracted piece of work is narrowly defined, and the contractor is concerned with transferring risk away from itself through contract language or litigation. There is no provision for a price premium for a contractor willing to take on and mitigate any risks. Although the designer may be the most appropriate point of risk control, the

confrontational nature of sequential contracting encourages the contractor for each task to reject risk which could be effectively handled internally.

The owner, under this scheme, by nature will be responsible for insuring compatibility of work among the sub-sections as well as quality assurance and job performance. With other risks to confront, the owner is positioned to cover risk generated in a traditionally-contracted scheme. But the cost is high and often unexamined. For instance, the cost of structuring the public owner as a "construction-management" institution means that a whole range of institutional difficulties arise when construction is complete and the period of operations presents the owner with a whole different set of roles to play. A construction-oriented public authority will be mis-aligned in terms of human capacity and experience to deal with this phase. Some have characterized state-level highway authorities as highway construction firms which are now, with the end of the interstate building period, making the difficult transition to being transportation systems operations and maintenance organization. The cost of such transformation can arguably be considered a delayed effect of the earlier risk assumption. When the public owner agreed to bear the construction coordination risks as well as the schedule/cost risks, the agency necessarily became the crucial link for quality control and construction oversight. This focus has cost implications that come from increased maintenance and reconstruction costs, a result of decades of a lack of attention to maintenance.

Financial Risk

Financial risk is one of the most finely analyzed topics in modern business economics. This discussion is a simple overview of the topic with an emphasis on the impact of financial risk on overall cost of government infrastructure projects like fixed-guideway transit systems.

A major part of risk in large projects is the financial risk as allocated to the project owner. One possible financing scheme is a "pay-as-you-go" gradual expansion of a system as utilized by the Interstate Highway System. As revenue is collected (in the form of federal fuel tax), the system has grown. This is not possible in the case of a new transit system like Tren Urbano, since a huge investment in track work and

vehicles must be made before revenue service can commence. By necessity, the owner of a major transit system must finance construction with debt.

Debt adds explicitly to the cost of a project since interest payments must be made on the capital cost over the length of time that the money is held. Twenty year bond issues are perhaps most common, and even at a rate of interest of 5%, the nominal amount repaid on those loans is about double the initial principle. The cost of borrowing (interest paid) will approximately equal the amount borrowed.

Moreover, the market for government debt securities responds to financial risk with higher interest rates. The implicit function by which the market determines interest rates is:

$$i = R + E(\text{inflation}) + \text{Risk Premium}$$

where i is the market interest rate, R is the "risk free" rate of return on other potential investment (conceptually an "opportunity cost" of another investment; generally taken as the rate on a one year U.S. Treasury Note – one of the safest investments around). Over the past few decades, the rate on Treasury Notes has generally exceeded inflation by 1.5 to 3 percentage points, indicating that this is range of the real rate of return. For a longer term security, such as a bond issue, the expected rate of inflation is less, certain, and risk-averse investors will require higher return to guard against future inflation. This consideration is in addition to the "risk premium" added for the specific project.

The risk premium is a much more subjective surcharge relating to the surety of repayment. Bonds issued by a government institution can be secured by the full authority of the government to raise taxes or, more simply, by the revenues to be paid by the users of some new public works project. Revenue-secured bonds have been used historically to raise capital for bridges, water and sewer systems, and public transport projects.

But revenue bonds have a higher risk premium as detailed above. Such calamities as natural disasters can impact the revenue stream from systems which are susceptible to damage. Obviously, in the event that a bridge is washed out by flooding, no tolls (revenue) can be collected from users. A bond backed by the full obligation of the governments taxing authority are less susceptible to such risks, and thus have the lowest risk factor. A unique caveat of this scheme is the presumption that the government is stable and interested in honoring debts (consider the holders of Confederate States of America Bonds who lost all investments made in these debt notes).

However, a governmental entity cannot borrow beyond a reasonable level as defined by the willingness of the population to submit to taxation. Expected tax revenues are relatively stable, and borrowing beyond this level is though to be increasingly risky for investors. A regional or national economic recession will decrease tax revenues, while long-term debt service payments remain constant. Independent financial analysts assign bond ratings to each and every government entity which assesses the ability of the government (and the population base represented) to meet outstanding obligations. This rating allows the bond market to supply capital to the rated authority at a rate which considers the risk of lending to heavily indebted governments.

This discussion is to make clear the point that debt financing can add significantly to the cost of a big capital project. As the size of the project increases relative to a region's economic base, the risk premium increases. In the case of debt secured by the revenue potential of the project, many additional risks factors, including the market risk of demand for the project, are added to the rate of return demanded by investors.

Construction Risks

Construction risks include a wide range of uncertainties regarding the process of construction itself. Is the site preparation going to uncover any unknown conditions which require costly mitigation? Potential pitfalls include unstable geotechnical conditions like expanding clays which swell and shrink with moisture

(which are unsuitable for supporting foundations and structures); buried utility lines which were unaccounted for in the cost-of-relocation estimate; archaeological sites which can require careful excavation; contaminated sites which were unanticipated and require treatment of soils and groundwater. Most contractors will consider the probability of encountering these sorts of conditions when calculating a bid. A certain unspecified premium will be added to the bid which reflects the uncertainty of such occurrences. Often, standard contract language and accepted practice allocate this risk to the owner, who will reimburse the contractor for unanticipated complications. No matter who bears this risk, the cost is still real.

In the cases where the risk of construction complications is borne by the public authority owner, the cost of this risk is manifested in contingency funds. The amount of money raised through the sale of bonds is increased by some number of percentage points above the contracted cost. This sum of money is held in reserve for just such occurrences as detailed above, and represents an added cost to the finished project. The interest income on the contingency fund defrays the cost of debt service; but this standard practice, brought about by the default assumption of construction risks by the public owner, certainly adds to the project cost.

In many cases where the owner is responsible for construction risks, the cost of construction risks take the form of budget over-runs. When the owner is forced to come up with more funds to finish a nearly-completed project which, through construction complications, is over budget, the cost of this risk is painfully clear. Construction risk becomes financial and political risk, and the delays resulting from all of these factors add to the cost as a snowball rolling down hill gains size.

In a turnkey scheme where the contractor agrees to deliver a working system for a fixed price (subject to a range of design and performance standards), the contractor will most certainly exact a higher minimum contract price as compensation for assuming these risks. But the net effect of these risks on the cost is expected to be a reduction. The party actually in the field doing the construction is the agent most suitable

for handling these risks. The incentive to minimize cost (mitigate negative outcomes) is internalized since there is no outside party, traditionally the owner, to pick up the added expenses. Time saved in cost disputes and litigation is one non-trivial secondary benefit.

Risk Issues Beyond Construction

In Table Two, the effect of turnkey on other risk allocations is addressed. All of the potential effects of turnkey are not likely to be addressed in this first round of demonstration projects, but a examination of the potential of this scheme is important in the longer-term prospects for turnkey. Federal interest in these issues is keen and is a justification for pushing forward with this set of demonstration projects. Risks inherent in the operations phase are critical to the broader notion of privatization of government services.

Safety

One aspect of the operations risk is the question of safety for passengers. One major assumption of turnkey is that design standards as developed by safety regulations would be applied to these systems. In fact, federal funding is often tied to compliance with these standards. But one of the risks to be dealt with is the liability related to safe operation of the system.

In principle, safety is an important consideration for the design stage. This is the level at which the risk is best handled. A safely designed system will be much more easy to operate, and while safety is not to be ignored in the operations of a system (quite the opposite), most would argue that the designer should be responsible for safety aspects. The question remains as to whether the design-build contractor should be held liable for the safety risk. As discussed in the latter section about the specifics of Tren Urbano, certain allowances are made for this first wave of ground-breaking demonstration projects. The ultimate potential of turnkey is hampered by the lack of familiarity of the parties with the risks involved. The allocation of safety risk to the contractor would likely result in rather large risk premiums, and so it is most likely that these safety concerns will remain with the owner. The owner, of course, can call on a well-specified set

of design criteria based on past experience with transit safety, and thus any turnkey contract will likely include detailed design parameters aimed at safety.

A concern related to safety which has been expresses is the potential for erosion of the professional certification process for engineers. Designs must be currently be stamped by a professional engineer as an assurance that public safety is accounted for. And this is one of the most strident rationales for the present sequential design-bid-build system. The issue of competency of the design team must be assured through the RFQ/RFP process in a turnkey project.

Funding

In an era where federal and state government involvement in transportation infrastructure is predicted to decline, private capital is probably going to be required to undertake transit projects of the next century. The funding risk must be examined and clearly defined for private sources to be expected to tapped at reasonable cost. Currently, bond issues in conjunction with transit construction are secured primarily with revenue from sources other than fares or with the general obligation of the public authority's taxing power. This is certainly the case with Tren Urbano.

A lesson to be learned from the recent examples of private development of highways is the need for local government commitment of the project. California has offered the toll road developers risk reduction measures such as a promise not to build infrastructure projects which could potentially reduce the demand for the service offered by the toll roads. Such a guarantee reduces the risk of a decline in demand as demonstrated in the project planning phase.

Tren Urbano: Turnkey Case Study

The above discussion serves as an abstract treatment of risk issues which recur in any complex construction project. The dynamics of the sequentially-phased development process is generic to any project undertaken by any owner, private or public sector. Each and every project, due to the size and

complexity of fixed guideway transit systems, will handle these issues in a unique way. The peculiarities of each project make this the desirable approach.

A "turnkey contract" includes such a wide range of possible arrangements that generalizations are hard to support. Within the risk allocation framework as discussed above, the impacts of different arrangements can be highlighted and examined. It is in this light that the federal Transit Administration has outlined the Turnkey Demonstration project as a series of dissimilar projects all related to fixed guideway transit systems with some aspect of the application of design-build format (see Table Three). In as much as the four selected demonstration projects vary, the project will serve as a series of case studies to illuminate pitfalls and potentials of the concept. Tren Urbano is, like each of the other projects, unique with lessons to guide future projects. No future project will be able to use the Tren Urbano development process as a step-by-step recipe to follow in other areas, but this does not diminish the value of demonstration program.

Table Three: FTA Turnkey Demonstration Projects

Maryland Mass Transit Administration; Baltimore system 3 extensions of light rail $106 million	Bay Area Rapid Transit District BART extension to SFO International Airport 6.4 miles, 3 stations $900 million – $1,300 million
Los Angeles Metropolitan Transportation Authority Green Line Union Station Gateway Transit Center	New Jersey Transit Hudson-Bergen light rail system $1,300 million for initial 10 miles design-build-operate-maintain turnkey

Stated Goals of Tren Urbano

One way to apply the risk analysis framework to different turnkey projects is to examine the interaction of the proposed risk allocation as it affects the goals of the system. Is the turnkey scheme helping or hindering the attainment of the goals? Are the goals of the project attainable under turnkey and not attainable under a traditional sequential procurement. The sequential process is not used for no reason; this process confers some distinct advantages, but the movement to turnkey involves a trade-off of control (on

the part of the owner) for potential cost and time savings. Will the trade-offs being made add value to the final outcome? What can be determined about the implicit goals of the project from contract details?

The Stated Goals are outlined in the Tren Urbano Draft Environmental Impact Statement (see Table Four). This document was prepared as part of the environmental and community review process of the overall project. Much of the first section is dedicated to explaining the motivation for action. And ultimately, Tren Urbano is envisioned to mitigate these problems, thus achieving these goals. As discussed above, the value of a turnkey contracting scheme, as a means to these ends, can be evaluated with an eye toward the final allocation of risk.

Table Four: Stated Goals of Tren Urbano

1. Improve mobility in San Juan Region - Maximize PT ridership - Reduce travel time - Connect key institutions and job centers with residential population - Improve service for transit-dependent - reduce car ownership requirement for low-income - provide alternative to highway congestion
2. Provide for Expansion of PT service - meet existing demand - meet future demand (2010) - flexibility for expansion
3. Improve PT service - frequency - speeds, schedule reliability - modal integration
4. Minimize Impacts on Natural environment - Maintain air quality -- reduce VMT - Minimize highway construction
5. Support Economic growth in San Juan - construction and operation
6. Design , Construct and operate in the most efficient and effective manner - Accelerate construction and opening - lower costs - Maximize opportunities for local AEC firms - Transit expertise implanted in Puerto Rico

SOURCE: Puerto Rico Dept of Transportation and Public Works, *Draft Environmental Impact Statement*, March 1995.

In examining these goals as outlined, most of the main goals could be met through any sort of procurement process. Specifically, the goals of improving mobility as well as expanding and improving public transportation service could be met by a rail transit system built in a traditional sequential process. One point arguing strongly for the turnkey scheme is the potential for earlier completion. The earlier such a

system can commence operation, the greater the benefits. This a function of interest rates and debt service requirements as discussed in the earlier section.

But fundamentally, these primary goals could be met without the turnkey contracting scheme. In fact, it is conceivable that such goals as flexibility for expansion and improved service parameters such as frequency, detailed as sub-points of the main goals, are contrary to the incentives provided by a fixed price turnkey contract. The same dynamic by which the private contractor will minimize costs to maximize profits will lead this firm to deliver a "no-frills" system which meets the stipulations of the contract, but no more. Careful crafting of the initial contract is crucial, as is continual monitoring, by the owner, of contractor performance with respect to design specifications. Potentially, the close coordination required by a turnkey contract could revert to the confrontational atmosphere of current party interactions. A closely-specified contract, however, reduces the potential design-build synergy of cost savings and could counteract the benefits of adopting a turnkey approach.

Another entire class of goals is tied to the market risks of the project (see Table One). Such goals as maintenance of air quality and alleviation of the growth of congestion will not be met is no one rides the system.

This risk is not independent of the procurement scheme. One theory of private enterprise in the framework of a turnkey operations contract is that the profit motive of a private operator will make market success more likely. This hypothesis requires scrutiny, but it makes intuitive sense. A system design-build-operate contractor would have some sort of internal incentive to produce a user-friendly service which would be attractive to potential users.

The market risk of Tren Urbano also feeds back into the political risk. The use of public funds to build an unsuccessful project with low ridership would be a distinct liability to the responsible decision-makers.

Goal 6, the goal which states that Tren Urbano will be built in the most efficient and cost effective manner, seems to be aimed directly at enabling the PRHTA† to pursue a turnkey strategy. The acceleration of opening and lower costs are the promise of turnkey, and thus fits with this goal. In the final analysis of Tren Urbano and the turnkey scheme, analysts will likely need to estimate a cost and timeframe of the project under traditional contracting. This is likely difficult to estimate given that any sort of generalization from other earlier projects is limited in usefulness (for the same reasons that generalizations about the results of turnkey are difficult to make -- each project is fundamentally different from any other superficially similar project). There is no fine-grained formula for determining the cost of a project under different contracting schemes.

The establishment of an aggressive procurement schedule is achieved through transfer of risk to the contracting party. The types of construction and system integration risks discussed above could be allocated to the contractor for an explicit price premium, but the unstated assumption which accompanies this trade (risk for higher fees) is that the contractor assumes the authority to mitigate those risks. It would be impractical to arrange the situation any other way. And it is from this authority that the time and cost savings benefits come. For example, the risk of discovering unstable geological conditions in the subsurface must be coupled with the authority to change the design of the foundation work to adequately address these concerns. Furthermore, such a mitigation must be made in "real-time" as the problem is discovered. A typical process for such events under current practices would be a reiteration of the design process (performed by the design contractors or some other outside party) with plans approved by the owner and then forwarded to the construction contractor. The delay is extended by the process. The contractor is given no choice but to wait for design changes. It would be unacceptable to a turnkey contractor to be solely responsible for such delays and cost increases outside of its control. The authority must be internalized.

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† "Puerto Rican Highway and Transportation Authority;" the public authority which will be the owner of Tren Urbano.

More likely, a close working relationship between the owner and contractor would have to be established with clear channels of communications. The owner will, by necessity, retain some oversight of the development process, but such relationships will vary from project to project, with the Tren Urbano-like model of a private consultant consortium representing the owner in technical oversight likely to become the model.

In other design-build projects in the highway sector, specific limits have been placed on the government's opportunity to review plans and revisions. The oversight agency has something like five days to review plans and drawings, after which point they are assumed to be approved, and work continues. This is perhaps an extreme example of the possible arrangements which are brought about by the involvement of private capital equity in the project. Transit turnkey is not so well defined with such high revenue projections to expect to include private capital in the immediate term.

Other sub-points of Goal 6 include the provision of work for Puerto Rican firms as well as an enhancement of transit expertise in Puerto Rico. This goal is pragmatic for the continued success of Tren Urbano through operations and eventual refurbishment. Also, future expansion of the system will benefit from local expertise. The goal is also a summary of a broader plan to develop Puerto Rico as a transit development gateway for the Caribbean Basin and other parts of Latin America. The transfer of technical capacity to Puerto Rican individuals and firms through involvement with Tren Urbano would be one good way to build this potential.

But the fundamental structure of turnkey does not facilitate the achievement of this goal. In the extreme case, a "super turnkey" contract would be bid to the best offer made by a qualified team -- a team which could conceivably be composed of one very large integrated design/engineering/construction management firm. Perhaps such a firm would enter into a joint venture with a large mainland U.S. construction firm which brings over all but the very least-skilled labor force for the construction. The professional capacity of Puerto Rico does not benefit at all under this scenario. In fact, even if the bulk of construction is

subcontracted to Puerto Ricans, the island economy benefits by these jobs, but technology is not transferred. Island construction firms are already familiar with reinforced concrete construction.

This possibility looms large for the designers of the procurement process. Special safeguards must be included in the turnkey Request for Qualifications/Proposals which ensure Puerto Rican involvement with the critical steps of the entire development process.

In some sense, the pursuit of this goal represents a deviation from the pure objective of efficient development. The basis for critical evaluation of bids by potential contractors is proof of ability to complete similar projects of similar scale. But this efficient development directly conflicts the goal of technology transfer. How would a Puerto Rican firm ever be selected without the prior experience of transit system work? It is a dilemma which recurs frequently in the arena of qualification-based contracting.

Stated Goals of Procurement

The Tren Urbano development process has required a good deal of deliberation of what should come from the procurement process. The importance of entering this turnkey process with a clear definition of the owners interests cannot be overstated. The GMAEC† has identified some of the most important goals of the procurement process (as a means to the obvious end of having a completed and functional system delivered). These can be seen in the accompanying Table Five. Some of the goals overlap with the general Tren Urbano goals already discussed, but in the same framework of evaluating the effect of a turnkey contract on these goals, one must consider the goal of retention of owner control.

† "General Management, Architectural and Engineering Consultants;" the consortium of consultants retained by the PRHTA to perform the preliminary engineering for Tren Urbano and complete the Environmental Review Process.

Table Five: Stated Goals of Turnkey Procurement Process

Dec 1994 Procurement Strategy Paper	Mar 1995 TUO Memo
• control interfaces (quality) • maximize technology transfer • owner control • accelerate start of construction • operational design • private funding	• quality • early commencement • owner control • financial feasibility • accountability • competition

SOURCE: GMAEC, Procurement Strategy Paper, December 5, 1995; Tren Urbano Office, Turnkey Contract Procurement Memorandum, March 1, 1995.

The owner control can be largely given up in a turnkey contract. Identification of the importance of owner control is the first step to retaining it. A carefully specified contract will more likely result from this process, given that owner control is defined as a goal.

The other goals are more compatible with a generic turnkey scheme. The acceleration of start of construction is very much enhanced under a turnkey contract. Construction can begin before the complete final design is finished. As rough construction proceeds, site conditions can guide the finalization of plans, and a considerable amount of time is saved. Control of interfaces and overall system compatibility/quality is arguably improved under the turnkey arrangement. The supplier of the car and track systems, including power and communications, will be involved to a great extent as a partner in the turnkey contract, and the integration of close-tolerance interfaces will be overseen by a party which is intimately familiar with the system architecture. The goal of developing an operational design is enhanced when the contractor is responsible for an extended period of operations. In the language of risk allocation, operational risk will have been allocated to the party best capable of controlling it -- the system designer and builder. Increased operational costs will not be an external effect for the design team.

Preliminary Turnkey Arrangements: Responses to Risk and Cost Considerations

The consensus emerging from a conference sponsored by the FTA on turnkey procurement was less a set of hard-and-fast guidelines to be followed and more an exhaustive list of questions to be addressed in any particular implementation of turnkey procurement. The issues to be resolved range from broad concerns

about the legislative restraints placed on contract structure to the detailed issues of uncertainty regarding specific contract language. Many of these issues are being addressed for the first time in the course of developing this first wave of turnkey demonstration projects.

As the first projects of their kind, the demonstration projects are not likely to represent the full potential of turnkey to cut costs and time. If we assume that contractor is only willing to accept a greater amount of the project risk in return for a higher contingency fee, we can easily extend this assumption to imply that a risk-averse firm will necessarily require a more lucrative arrangement in light of the undefined aspects of this novel risk allocations. Since less is known about the risks involved, the prudent firm will estimate increased costs conservatively, which is to say this contractor will demand more compensation. Specifically, the construction firm which has no experience with the risk aspects of construction will bid defensively.

The premise behind a demonstration program like this one sponsored by the FTA is that experience and information about the risks will lead to better estimates of the cost. The full benefits of turnkey will accrue to the follow-on projects which benefit from the work and experience of these early projects. In this light, some of the arrangements made in the case of Tren Urbano are aimed at confronting this dilemma of scant experience.

Primarily, the scope of the turnkey contract has been scaled back from the point of conceptualization. The current plan for a Systems and Test Track Turnkey is a significant reduction of latitude for the bidding parties, which is probably not unwelcome in the vendor community. Under this turnkey contract, the bidder would be responsible for all the technical systems relating to the car system, track, power, communications, and operations. The construction management aspect would consist of construction of an operable section of track and two stations in the set-aside right-of-way in the 65th Infantry Corridor. This is envisioned as a relatively straight-forward section of construction. Of course, the technical specifications of the track and power system would guide the design of other sections such as the tunnel

alignment, and this contractor would be involved in the integration of section design as well as the final testing and verification.

This reduction of scale still captures many of the major benefits of a private contracting scheme, and simultaneously addresses some of the concerns from above which could add unnecessarily to the costs. Also, the reduction in scope of the turnkey contractor could be interpreted as a response to the desire to retain owner control of the project.

Another response to risk unfamiliarity is the decision to have the GMAEC complete the preliminary engineering (~30 % design) on the project as a way of reducing the uncertainties involved with construction risk. With a more completely designed system, the risks are much more well defined and understandable. The risk premium demanded by a theoretically risk-averse contractor would be more in line with the true risk. Some other turnkey project could be formulated with respect to performance-based criteria, and the design-build contractor could take it from there. The path chosen for Tren Urbano is nearer the other extreme where the system alignment is well-defined by the owner, the stations are likely to be well defined by the owner, and the final design of sensitive portions (like the aerial piece of track work in the median of Avenida Muños Rivera) is likely to be undertaken by the owner. The work involved in developing the final design could be limited to detail concerns such as concrete dimensions and hardware placement. And, of course, the final design will by necessity be subject to compliance with the full range of federal design guidelines for seismic security, handicap access, and the like.

As the final details of the turnkey contract take shape, the impact on risk allocation will be firmly settled. The impact on cost will develop during the extended construction, start-up, and operations phase. Risk is after all, an uncertainty, and any "worst-case scenario" is defined by a low probability of occurrence. The final impact on cost will be randomly determined, but the more difficult evaluation of turnkey success will have to be the change in cost and disruption that such uncertainties cause for the entire project. If, for

example, a hurricane were to strike during construction, the true success of turnkey would be a comparison of how quickly the pieces are picked up and work is moved ahead (in comparison to the potential for the traditional contracting scheme to end up in court, with multiple parties arguing about liability, while traffic congestion gets worse daily).

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