No. 19

イラン国
テヘラン都市交通計画
予備調査報告書

昭和54年９月

国際協力事業団

開 調
[redacted]
79 － 94

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国際協力事業団

受入月日 '84. 4.21	304
	61.8
登録No. 03720	SDF

はしがき

日本国政府は、イラン国政府の要請に応え、テヘラン都市交通計画に関する調査を、国際協力事業団により実施することを決定した。

事業団は、横浜国立大学井上孝教授を団長とする6名からなる予備調査団を昭和54年6月14日から、同年6月23日まで現地へ派遣した。

今回の予備調査は、調査団は現地においては、イラン側の要請内容を確認のうえ、テヘラン都市交通の現状について調査し、テヘラン都市交通改善のためのとりあえずの勧告を行ない、帰国後は収集資料を分析したうえで改善のための正式な勧告を行うことを目的としたものである。

本調査報告書が、今後の本格調査の立案、実施に際して参考となることを期待するとともに、調査にあたり、多大の御協力をいただいた、イラン国政府、在テヘラン大使館、ならびに関係機関に厚くお礼申し上げる次第である。

昭和54年9月

国際協力事業団
社会開発部長
広田孝夫

（目　　次）

第１章　調査団の派遣に至るまでの径緯

日本政府は海外技術協力事業団及び国際協力事業団を通じ、テヘラン都市交通に関して過去４度の協力を行っている。

(I)　昭和４４年８月～９月

シャレスタニ・テヘラン市長の要請により海外技術協力事業団を通じ「テヘラン市総合交通施設計画」調査団派遣（団長　谷藤正三氏）

昭和４５年４月

上記調査報告書をイ側に提出

(II)　昭和４５年５月～昭和４６年７月

市長の顧問として国際協力事業団より専門家として村上順雄氏（当時建設省計画局海外協力官）を派遣。

（昭和４５年頃テヘラン市長がシャレスタニからニックベイに代わり、フランスに再調査を依頼。昭和５２年夏再びシャレスターニが市長に就任した）

(III)　昭和５２年８月

シャレスターニ市長より上記(I)の調査の up to date 化を含む再調査の要請あり。

昭和５２年１１月～１２月

井上孝東大教授（当時）他３名の調査団を国際協力事業団を通じ派遣。「テヘラン都市交通調査報告書」を提出。

(IV)　昭和５３年２月

上記(III)の調査団の勧告に従い、シャレスタニ市長は環状高架道路の調査を要請。

昭和５３年９月～１０月

高橋力・首都高速道路公団理事（当時）以下４名の事前調査団を国際協力事業団を通じて派遣。

このあと本格調査団を派遣する予定であったが、革命の混乱の中、話は有耶無耶となった。

昭和５４年２月

イラン革命政権が誕生した。

昭和５４年４月

テヘラン市長に就任したタバッソリ氏は、「テヘラン市交通問題は市のみならずイラン国全体の大問題であり、イラン新政府としても重点を置いて解決しなければならない問題であるので、交通体系全体の見直しを早急に行い、方針を決定したいと思っている。前政府

の時代の計画は必しも妥当であると思われないので、これを全面的にレビューする必要があり、ついては公の交通手段の整備の観点から、仏の協力のもと進めようとしていた地下鉄計画を含め、テヘラン都市交通全体をレビューし、対策についての提案をしてもらいたい。」旨述べ、日本政府に改めて本件調査の協力を要請越した。これを受け日本政府は国際協力事業団を通じ新たに専門家グループを派遣することとし本件調査団が派遣されたものである。なお、上記(M)の環状高架道路の件は上記の事情もあり白紙に戻すとのことであった。

第２章　調　査　団　の　目　的

調査団は現地においては、イラン側の要請内容を確認のうえ、テヘラン都市交通の現状について調査し、テヘラン都市交通改善のためのとりあえずの勧告を行ない、帰国後は収集資料を分析したうえで改善のための正式な勧告を行うことを目的とする。

第３章　調　査　団　の　構　成

調査団の構成は以下のとおりである。

(1)井上　孝　（総括、都市計画）　横浜国立大学教授

(2)依田和夫　（都市交通、道路）　建設省都市局都市交通調査室長

(3)岩田貞男　（都市交通、鉄道）　運輸省鉄道監督局民鉄部管理課補佐

(4)武藤秀一　（バス輸送）　運輸省東京陸運局自動車第１部旅客第１課長

(5)瀧島佳一　（地下鉄）　帝都高速度交通営団建設本部計画第２課長

(6)三橋郁雄　（業務調整）　外務省経済協力局開発協力課事務官

第4章　日程及び先方関係者

(1) 日　　程

調査団の現地における日程は以下のとおりである。

6月14日　　午後　成田発

15日　　和田大使、長谷川公使、斎藤一等書記官、杉山JICA事務所長と打合せ、引き続き大使主催夕食会

16日　　午前　テヘラン市長表敬、打合せ。引き続き、地下鉄本部にて地下鉄、都市交通、都市計画関係者と協議

16日　　午後　市内交通視察、とくに北半分（地下鉄工事現場、シャレスタ・パーレビ、王宮周辺等）

17日　　午前　市内交通視察、とくに南半分（バザール、国鉄駅等）

17日　　午後　都市交通関係者（Traffic Organization）と協議

18日　　午前　都市計画関係者（City organization）と協議

18日　　午後　地下鉄関係者（Metro Company）と協議。（夜、テヘラン市長主催の会食に招待される。場所はmunicipality club house）

19日　　団内打合せ及び作業

20日　　午前　テヘラン市長へpreliminary conclusionを提出

20日　　午後　Record of Discussionに関して地下鉄関係者らと打合せ

21日　　午前　大使・公使へ報告

21日　　午後　Record of Discussionの整理作業

22日　　テヘラン郊外の交通状況調査

23日　　資料の収集整理　　帰国

(2) 先方関係者及び会議出席者リスト

Mr. M. Tavassoli (Mayor of Tehran)

Mr. A. Ebrahimi (President of the Board of Directors of Tehran Metro)

Mr. Bouchehri (Managing Divector of United Bus Organization)

Mr. Riazi (Managing Director of Traffic Organization)

Mr. Moinzadeh (General Manager of Urbanism Office)

Mr. B. Ajang (Member of Board of Directors of Tehran Metro)

Mr. H. Azgomi (Head of Electronic and System Dept of Tehran Metro)

Mr. M. Hassanpour (Head of Civil Department of Tehran Metro)

Mr. Kn. Shaghaghi (Head of Electro—mechanics of Tehran Metro)

Mr. Amir Azodi (Deputy Manager of Traffic Organization)

Mr. Moyanian (Expert, Traffic Organisation)

Mr. Zolmajd (Expert, United Bus Organization)

第５章　現地調査及び先方との協議内容

(1) 和田大使との打合せ

和田大使の発言概要次のとおり。

現政権は前政権の大規模プロジェクトを継続するかどうかの見直しを現在行っている。今回の調査団もこの一環で来て頂いた訳である。テヘラン交通問題はテヘラン市の段階に留まる問題でなく、イラン国全体で解決すべき重要な問題となっている。

イ側は仏との契約を続けたらよいのかどうか、地下鉄計画はやはり実現させるべきかどうかで迷っていると思われるので、調査団が仏の作成した計画について、とくにコストの点に関し見直しを行い、忌憚のない意見を述べてあげることにより、イ側として次のステップを考えることになると思われる。私としては素人考えであるが、地下鉄を建設しなくても、路面鉄道の導入、バス交通の拡充、タクシーの大型化（ミニバス化）などを用いる解決策もあるのではないかと思っている。調査団はとりあえずの助言をして頂くこととなっているが、私としては、ラフなものでよいから方向を示すものを期待している。

現在の社会情況については、基本的にはテヘラン市内の治安は確保されており、安全である。しかしまだ若干の混乱は残っているようであり、我々も詳細には、誰がどの程度偉いのかつかみきっていない。今回の革命は基本的には宗教界の国王に対する奪権闘争であるという人がいる。僧呂は約20万人おり、モスクを根城に一般庶民の指導、仲さい等を行っている。僧呂は世襲が大部分であり妻帯も許されている。これら僧呂が現在革命ガードを組織しているとみられる。テヘランには14の教会があり、この教会の下に、各々の統治区域がある。統治区域が異なると一般人に対する指令にもくい違いがみられるという情報もあるが、これは僧呂がコーランを解釈して指示する際、その解釈に違いがあるためと考えられる。現在はこのような状況下にあるため国家の方針から民衆の気持まで何もかも茫然としているといえる。但し、テヘラン交通問題に関しては、政権の性格に拘ず早急に解決を迫られている問題であり、調査団の成果が大いに期待される。

(2) 16日テヘラン市長の発言ぶり

イラン側出席者

(1) Mr. M. Tavassoli (Mayor of Tehran)

(2) Mr. A. Ebrahimi (President of the Board of Directors of Tehran Metro)

(3) Mr. Riazi (Managing Director of Traffic Organization)

調査団が16日テヘラン市長を表敬訪問した際の市長の発言ぶりは、次のとおりである。

今回の調査団は従来のものと異なり、テヘラン市民が招いたものである。従って住民の利益の立場から技術的に検討を行って欲しい。このように、本件は新しい状況下での新しい協力である。

調査団には、現在ある地下鉄プロジェクトの契約及びプロジェクトの内容の検討及び、地下鉄計画を含めどのような交通手段をテヘラン市に導入するのが最も妥当であるかについての提案を要請したい。なお、後者には、自家用車の規制も検討対象にして頂きたい。

(3) Riazi氏と団長とのやりとり

上記(2)を受け、団長がRiazi氏に確認した内容は次のとおりである。

テヘラン市としては調査団に次のことを期待する。

1) 地下鉄計画は現案どおり進めてよいのか
2) 仏との地下鉄契約は妥当なものかどうか
3) 地下鉄計画現案の高架方式部分と地下方式部分のデマケーションは妥当かどうか
4) 地下鉄計画が適切でないのであれば、他の交通改善策として何があるのか

ミッションの勧告をうけたあと、テヘラン市としては今年内にも具体的な改善策に着手したいと考えている。

(4) 16日の協議概要

イラン側出席者

(1) Mr. A. Ebrahimi(President of the Board of Directors of Tehran)
(2) Mr. Bouchehri(Managing Director of United Bus Organization)
(3) Mr. Riazi(Managing Director of Traffic Organization)
(4) Mr. Moinzadech(General Manager of Urbanism Office)
(5) Mr. B. Ajang(Member of Board of Directors of Tehran Metro)
(6) Mr. H. Azgom (Head of Electronic and System Dept. of Tehran Metro)
(7) Mr. M. Hassanpour(Head of Civil Department of Tehran Metro)
(8) Mr. Kn. Shaghaghi(Head of Electro—mechanics of Tehran Metro)

16日の会議には地下鉄公団総裁を初めとし、地下鉄関係者、都市交通関係者、都市計画関係者が参加した。要点を箇条書すると次のとおりである。

1) テヘラン市としては調査団の勧告を受けて地下鉄計画等の進捗を決定したいと考えている。

2) 現在は社会的にも経済的にも見通しがつかないので、過去の計画を現状に合うよう修正しながら進まざるを得ない。新しいマスタープランをつくることには消極的である。

3) テヘラン都市計画、都市交通のもとになっているのは、約10年前に米国ロスアンジェルスのコンサルタントが作成したComprehensive Plan（以下C/P）である。下記にのべるように、すでにかなりの箇所で、現実とC/Pに書かれている構想との間にずれがみられている。

4) 地下鉄計画はこのC/Pのもと仏のSOFRETUに委託して作成した。全部で7路線を予定しているが、構想がより具体化しているのは4路線であり、このうち1号線の1工区2.7kmが現在建設中である。1号線の残りの工区については、革命前までに入札段階にあったが現在はキャンセルすることも含め保留してある。2，3，4号線はまだ構想の段階である。計画によれば1～4号線全体で75.3km、25ケ月前からスタートし完成までには8年間を予定し、うち最初の2年間は準備期間である。なお地下鉄建設費は全額中央政府が負担すると考えて差しつかえない。

5) 1～4号線までの地下鉄の建設にあたって4つの問題点を抱えている。

① 土質の不良に伴う施工方法。

② 現在の予定路線は東南、西南の人口高密度地帯を通過しない。

③ 1号線の南半分では地下水が湧水するのでその処理方法。

④ 地下鉄計画は本当にfeasibleであるのかどうか。

6) 都市計画の点から述べると、現在はC/Pでいう汐2 phaseの段階にある。前政権はテヘランが人口過密になるのを防ぐ見地から人口分散政策を採用したが、目論みは失敗し、近年は年間30万人もの割で人口膨張を続けている。都市計画上の問題点としては、

① 人口の膨張に伴う市街地の拡大をどのように確保するか。

② 古い町と新しい町とを結ぶ輸送手段をどのように配置するか。

③ 大量の自動車交通による社会問題の発生。

が上られる。

7) バス交通に関しては、乗合バスは現在1700台運転されており、1年間に120万人運んでいる。料金は市内バスの場合一律に5リアルである。（なお経営は事業費の75％が補助金に頼っている。市としては、バス輸送量の拡大により交通混雑の改善を図ること考えているが交通混雑時には7km/hという速度しか出せず公共の足として十分機能していないので、現在、自家用車の規制と併せバス専用レーンの設置を検討中であり、近い将来1ケ月間程試行的に実施することを考えている。また、今年中にはバスを600台購入する予

定であり、２ケ年以内に台数を２倍にしたい。

(5) １６日午後の交通状況調査

１６日午後はテヘラン市の北半分について、交通状況等の視察を行った。特記すべき点は以下のとおりである。

1) 2.7㎞の地下鉄１号線１工区の建設現場を視察した。堀削深さが２０ｍに及ぶにも拘ず、土留工は全くみられず、堀削壁がほぼ鉛直であるのには驚かされた。土値（砂と礫）の締りが非常によいためと考えられるが、降雨があると崩れ易すくなると思われる。トンネル断面はカマボコ型である。

2) 視察中、トンネルの配筋状況を見るため、トンネル内に降りようとしたところ、どこからともなく仏人（コンサルタント）が現われ、それ以上の視察は承知していないので立ち去るよう我々に通報してきた。我々は直ちに立ち去った。

3) 市内の交通は東京並みの混雑であり、何十分も身動きできないということはなかった。同行したカウンターパートによれば、これは丁度空いている時刻にあたったからとのことである。しかしそれでも交通渋滞の因子として次の項目を上げうることが判明した。

① 自家用車の数の多さ（これは燃料が１ℓ当り３０円という安さに基くものと思われる）。

② 駐車場が殆んど皆無のため、道路の側端側が左右１車線分、駐車用に占拠されている。（場所によっては２車線に留まらず３～４車線を占拠する道路駐車もみられた）。

③ 通行人が横断歩道以外の場所を実にひん繁に横断するため、そのたびに運転を中止せざるを得ないこと。

④ 新聞売り等の売り子も車線を我が物顔に歩くため交通上の障害となっている。

⑤ 信号機の数が不十分であり、全体システムとして十分機能していないこと。

⑥ 一方通行の標示があるにも拘ず、それを無視した自動車を見かけるなど運転モラルが悪いこと。

⑦ 交通警官の数が少いこと、またその権限の小さいこと。

4) バスは２階建及び通常バスの２種が走っているが、どのバスも定員に足りない客数であった。

(6) １７日午前の交通視察

１７日午前中には、テヘラン市の南半分の交通状況の視察を行ったところ、特記すべき点以下のとおり。

1) 視察した時刻の所為もあるがバザール及びテヘラン駅の周辺の交通混雑は相当ひどい。北半

分よりも明らかに南半分の方が商業活動はにぎやかであり、交通マヒの程度もそれだけひどい。この商業活動領域を通過するのがパーレビアヴェニュー（革命前）であり、従ってこの下に地下鉄を通す場合には、この活気を損うことなく建設を行う必要がある。しかしながら現在の地下鉄計画ではOpen cutで行うこととなっており、問題であると思われた。

2) テヘラン駅はテヘランと国内の他都市とを結ぶ国鉄の駅である。この国鉄は日本と異なり市内輸送の任にはあたっておらず、専ら都市間輸送のみである。駅前には民衆が非常な多数たむろしており、駅内やフォームにも多くの人が列車待ちしていた。たまたま到着したジーゼル機関車けん引の旅客列車には乗客が定員を若干上回る数で乗り込んでいた。このようなことから需要はかなり高いと思われる。列車や線路の保守状態は、線路の傷がかなり目につくことを除けば、道床の砕石も枕木も砂に埋もれることもなく、また列車も比較的清潔であったことなどの点から考えると、維持管理はかなりゆき届いていると思われた。

3) タクシーは日本と異なり、最初に乗車した客が行先を指定でき、途中で行先が同一方向の客をひろいながら目的地に向うという方法をとっているとの由。料金は300m毎に1リアルである。タクシーは市民にとって便利な交通手段となっているとのことであるが、日本のようにひん繁に路上を走っている光景はみられなかった。

(7) 17日の協議概要

イラン側出席者次のとおり

(1) Mr. Riazi(Managing Director of Traffic Organization)

(2) Mr. H. Azgomi(Head of Electronic and System Dept. of Tehran Metro)

(3) Mr. Moyanian(Expert, Traffic Organization)

17日にはTraffic Organizationと協議を行ったところ、要点を箇条書きにすると次のとおりである。

1) 自家用車の市内中心部への乗り入れ規制について説明があった。これによると、試行的に1ケ月間，午前中（6：30～10：30）のみ、自家用車の通行規制を行い、代りにバス及びタクシーのみの専用レーン（6m）を設置するというものである。

2) 今年の4月頃に交通量調査が実施されており、その内容と結果が報告された。市内を8地区に分割し、個々の地区内の交通量の流れを調査したもので、サンプルの数は5000である。これによると、トリップの比率は自家用車は45%、タクシーは22%、バスは25%であった。（ちなみに自動車の数は約100万台、内70%が自家用車である）。またトリップの起終点は家庭と仕事場が41%、家庭と学校が18%であった。また、テヘラン市

内で最も混雑している5.5 kmの地域についての交通の出入量の調査も行なわれた。更に、地方からテヘラン市内に入る交通量の調査も行なわれた。

3) 市内の人口密度分布も詳細に調査された。これをもとに、市内中心部からの距離と人口密度との関係を示す図画をつくり、C／Pにより約10年前予測された混雑状態や、1940年代のロンドンの混雑状態と比べても、現在のテヘラン市内の方がよりひどいことを示した。

4) その他多くの交通現況図を説明してくれた。

5) テヘラン市の人口は1991年には800万人に達すると予測されている。

6) タクシーを増やすことによる市内輸送量の拡大については、タクシーがバスと比較すると輸送人員が少いこと、どこにでも止まって交通の流れを妨げることなどの理由を上げて、消極的である旨のべた。

7) 最後に先方よりPolitical, economical, socialの観点からどんな交通システムがテヘラン市に合うと思うか質問越した。

調査団は参考まで、東京の鉄道、地下鉄の建設の歴史、現在の交通状況等につき詳細に説明した。また、テヘラン市郊外のイラン国鉄沿線に住民を住まわせ（現在は砂漠）、都市を形成するやり方を提案したところ、その地域は低地であり、非常に暑い時期があるので、都市形成上問題があるとの回答に接したが、先方はかなり興味を抱いたように見えた。

(8) 18日午前の協議概要

イラン側の出席者次のとおり

(1) Mr. Moinzadeh(General Manager of Urbanism Office)

(2) Mr. B. Ajang(Member of Board of Directors of Tehran Metro)

(3) Mr. H. Azgomi(Head of Electronic and System Dept. of Tehran Metro)

(4) Mr. M. Hassanpour(Head of Civil Dept. of Tehran Metro)

内　容

1. 急速な人口増加（年増加率約5％）により、テヘラン都市人口は現在約500万人に達している。
2. テヘラン都市区域は将来の人口増加も考慮して最近その境域を約600 kmに拡張した。
3. 現状における人口密度分布は、市中央よりやや南側にバザールを中心とする都心部をピークとする構造をもっているが、低所得層の多い南部に高密地区が散在しいる。最高はヘクタール当り1,000人を超えるところもある。
4. 北部一帯は比較的高所得層の住宅地として市街化が進んでいる。

5. マスタープランは約10年前に策定されたが、現状はプランからかなりくい違いを見せている。主要な点は

(1) 北部一帯は14ケ所のサブ・センターを計画し、東西交通軸に地下鉄を配したが、サブセンターの発達の見通しはない。

(2) ABAS−ABAD地区に新都心の形成を計画したが、革命によって現在は放棄された。

(3) 4本の地下鉄が計画されているが、整備は大幅に遅れている。

(4) 構想としては、更に地下鉄3路線の追加が意図されている。

(5) マスタープランはその都度、修正を施こしながらその命脈が保たれているとされているが、実際は大幅に内容が変っており今や陳腐化している。

6. 現都心の極端な交通混雑に対する緊急対策として自家用車の乗入れ規制が計画されている。

この方は、市交通部の所管であり、都市計画部門とは十分な連絡があるとは思えない。

(9) 18日午後の協議概要

イラン側の出席者次のとおり

(1) Mr. A. Ebrahimi(President of the Board of Directors of Tehran Metro)

(2) Mr. B. Ajang(Member of Board of Directors of Tehran Metro)

(3) Mr. H. Azgomi(Head of Electronic and System Dept. of Tehran Metro)

(4) Mr. M. Hassanpour(Head of Civil−Department of Tehran Metro)

(5) Mr. Kn. Shaghaghi(Head of Electro−mechanics of Tehran Metro)

(6) Mr. Zolmajd(Expert, United Bus Organization)

地下鉄関係者から地下鉄計画の詳細についてヒアリングを行った。とくに建設費、労賃、材料費等を確認すると同時に建設工法の基準、建設にあたって種々留意すべき点につき照会した。詳細はRecord of Discussionを参照のこと。

(10) 20日のテヘラン市長への説明

イラン側の出席者次のとおり

(1) Mr. M. Tavassoli(Mayor of Tehran)

(2) Mr. A. Ebrahimi(President of the Board of Directors of Tehran Metro)

調査団は19日にとり急ぎまとめた暫定的勧告を市長に説明した。暫定的勧告の内容は別章にのせてある。市長はこれに対し、短期間にかようなレポートをまとめて頂き感謝する。こ

れからこのレポートを十分検討したい旨述べた。また地下鉄は若干外交的とは思われるものの、レポートの内容は大変素晴しい旨述べた。

(11) 20日の午後の協議概要

いままでイラン側から多岐にわたりヒアリングしてきたが、これらをベースに調査団は、日本で詳しい分析を行ない、2ケ月後には正式な勧告を出すこととした。(暫定的勧告に明記してある)ついては、ヒアリングの内容を文書で確認しておく必要があるので、Record of Discussionを作成することとし、20日の午後、先方と共同作業を行った。

第6章　協議内容確認文書 (R/A 修正版)

The Record of Discussions between the Japanese Traffic Survey Mission and the Representative of the Municipality of Tehran and other organizations concerned.

No.1 The Japanese Traffic Survey Mission (hereinafter referred to as "the Mission"), which is delegated by the Government of Japan through Japan International Cooperation Agency, visited Tehran between June 15 and 23, 1979, with the request of the Municipality of Tehran (hereinafter referred to as "the Municipality").

During the stay in Tehran, the Mission exchanged views and had a series of discussions with the Representative of the Municipality and other organizations concerned, as well as a meeting with His Exellency Mr. M. Tavassoli, the Mayor of Tehran.

No.2 The members of the Japanese Mission are:

Prof. Takashi INOUYE, Leader of the Mission
Mr. Kazuo YODA (Urban Transportation)
Mr. Sadao IWATA (Urban Transportation)
Mr. Shuichi MUTO (Bus Transportation)
Mr. Yoshiichi TAKISHIMA (Subway)
Mr. Ikuo MITSUHASHI (Coordinator)

Representatives of the Municipality and other organizations concerned are:

Mr. A. Ebrahimi (Counterpart, President of the Board of Directors of Tehran Metro)
Mr. R. Bouchehri (Managing Director of United Bus Organization)
Mr. M. Riazi (Managing Director of Traffic Organization)
Mr. K. Moinzadeh (General Manager of Urbanism Office)
Mr. B. Ajang (Member of Board of Directors of Tehran Metro)
Mr. H. Azgomi (Head of Electronic and System Dept. of Tehran Metro)
Mr. M. Hassanpour (Head of Civil Department of Tehran Metro)
Mr. KN. Shaghaghi (Head of Electro-mechanics of Tehran Metro)

Mr. Amir Axodi (Deputy Manager of Traffic Organization)

Mr. B. Royanian (Expert, Traffic Organization)

Mr. M. A. Zolmajd (Expert, United Bus Organization)

No.3 The following is the summary of discussions and understandings agreed upon by both sides:

1. Number of Passengers by Metro

(1) Estimated Maximum Number of Passengers Interstation (per hour, one direction)

Line No. 1	20.9 km	24,800	passengers (estimated)
Line No. 2	21.0	33,100	
Line No.3	19.7	22,900	
Line No.4	13.7	34,900	
Total	75.3	115,700	

(2) Number of Passengers per day

3 million passengers per day in total by four lines (in 1991) (at beginning of operation 2 millions) 39.8 thousand passengers per km

2. Operation Plan of Metro

(1) Formation of Trains and Number of Coaches

		Formation of trains	Number of Coaches
Line No. 1	29	8 coaches (M)	232
Line No. 2	36	8 coaches (6M+2T)	288
Line No.3	22	8 coaches (8M)	176
Line No. 4	27	8 coaches (6M+2T)	216
Total	114		912

(2) Capacity of Coaches

167 passengers per coach (capacity 5 passengers per m^2)

(3) Frequency of Service

First Stage per 3.1 minutes

Final Stage per 2 minutes

(4) Signal System

PCC (centralized Control Room System, Remote Control)

3. Operation Body and Personnel

(1) Operation Body

Tehran Urban and Suburban Railway Company (SCFUTO)
(100% shares owned by the Government) established in 1976

(2) Capital of the Company

100 million rials
(until now 7 billion rials spent)

source of fund { capital / subsidies

(3) Number of Personnel

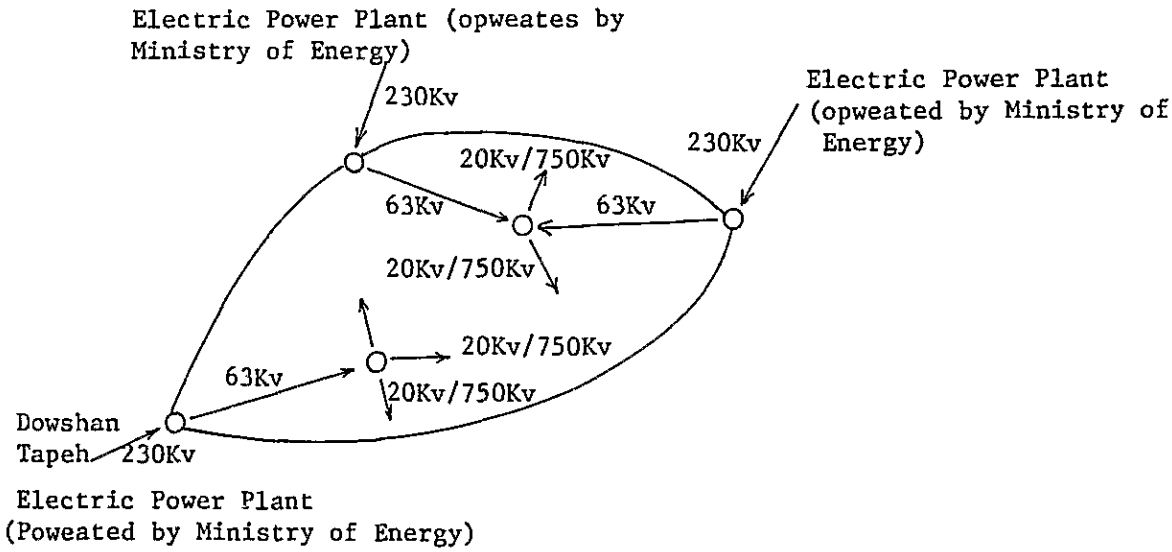
at present	70
at operation time	around 3,000
(Chart of Structure	Attached paper 1)

(4) Training of Personnel

* Some trainees be sent to France
* Specialized Technical School be set up
* Few French specialists be dispatched here at the time of operation

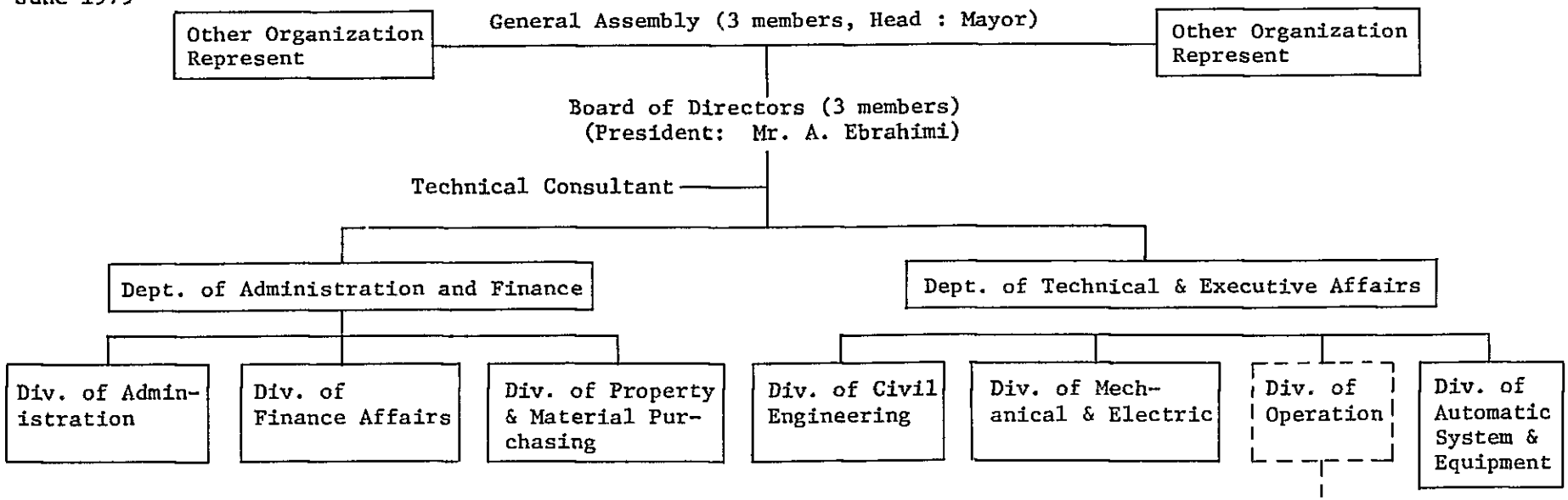
4. Energy Supply

Electric Power Plant (operated by Ministry of Energy)



ATTACHED PAPER 1

June 1979



at operation

(1)	Head of Dept.	Deputy for Chairman
(2)	Each Division	Department
(3)	Div. of Operation	to be established by the time of operation

5. Profit and Loss Account

(1) Passenger Fare

10 rials / trip (Unit System) *1
(Bus Fare: Express 10 rials Ordinary 5 rials)

(2) Fund Plan

* Construction Cost — be expected to be subsidized by the Government (300 million dollars each year for ten years)

* Operational Cost (revenue per day: 30 million rials) — be compensated by passenger fares *2 (10 rials x 3 million passengers)

(detail is not clear at present)

*1 This fare will be subject to be changed in accordance with social conditions etc. at the time of operation

*2 Operational cost is calculated at 1978 price index.

6. Concerning bus transportation

(1) Buses are operated by United Bus Company in Tehran.

(2) United Bus Company has 2,250 buses including 1,000 buses of 2-storeys. Of them, 1,800 buses are in use.

(3) United Bus Company is going to buy about 600 buses this year. And it has a plan that the number of buses will increase to 5,000 within 5-6 years period. But this is very difficult to realize because of nonavailability of engineers and terminals.

(4) United Bus Company has 4,000 drivers, 1,200 conductors and 5,000 other workers.

(5) The fare of bus is 5 Rials and 10 Rials. The fare of long-distance express bus is 10 Rials, and that of intra-city bus is 5 Rials.

(6) The cost of United Bus Company is covered by the fare from users (25%) and the subsidy from the Government.

(7) Tehran Municipality is going to restrict private cars in certain city center areas and to give priority to buses of United Bus

Company and taxi by setting up exclusive bus-taxi lanes in other areas.

(8) Exclusive bus lanes is planned to extend to 40 kilometers by Tehran Municipality.

(9) Average speed of city bus is 7 km/h and that of taxi is 10 km/h.

(10) Frequency of bus service with each route is from every 2 minutes to every 15 minutes.

(11) Frequency of bus service with each line is from every 7-8 minutes to every 20 minutes.

7. On the city planning

(1) List of materials and data and related matters

(a) Transportation Plan: Final Report: Summary and Conclusions: 1974.

(b) A profile of Tehran's transit: City Traffic Dep.: 1979

(c) Cordon Count Result (Table)

(d) Estimated Daily Person Trips in Tehran (1979)

(e) Estimated Daily Vehicular Flows to the C.B.D. (Chart)

(2) Comprehensive Plan was approved about ten years ago, but urbanization has not progressed in accordance to plan owing to the various changes of social circumstances.

(3) Urban area was about 625 km^2 originally, but 272 km^2 of new urban area were added recently. The new urban areas have been situated mainly at the north-western and north-eastern parts of the city boundary.

(4) Linear pattern is still kept after the expansion of the urban area.

(5) The estimation of population was 5.5 million in 1981, now it is being amended to about 8 million.

(6) The municipality had inaugurated the development of Abbas-Abad district for the second city centre, but this project is now being suspended.

(7) Three metro lines are being added, in addition to 4 planned lines, in view of the new urban development.

(8) The utilization of National Railway for the rapid transit system is not considered for the time being.

8. Metro as a whole.

(1) Shield method and open cut method have been considered as the underground construction method of Metro as a whole.

(2) The number of Metro lines is 7

Line No. 1 is divided into 4 sections. 1st section (2.7 km) of line No. 1 is under construction. The location of other sections (2-4) are not fixed yet. Other lines (2-7) are expected to be introduced.

(3) The outline of plan of Metro is as follows:

(A)	(B)	(C)	(D)	(E)	(F)
1	20.9	18	2.6	41	44
2	21.0	18	5.8	34	46
3	19.7	15	8	37	44
4	13.7	11	11.6	45	49

(A): Line No.
(B): Length (km)
(C): No. of stations
(D): Underground length (km)
(E): Construction period including preparations (month)
(F): Total period (month)

(4) The total construction period of 1,2,3,4 lines is 8 years and the first 2 years are for designing. The line No. 1 started 25 months ago.

(5) The figure of cross-section of tunnel charges depending upon its depth.

(A) 3m < depth above the top of tunnel < 6m; Box
(B) 14m > depth above the top of tunnel > 3m; upper wall is arch
(C) Depth above the top of tunnel < 10m; round

(6) The type of all the stations are considered to be side-platform.

(7) Cost of civil works

(A) The total approximate cost of line No. 1

45.8 billion rials/21 km

(B) 1st section (2.7 km) of line No. 1

Total civil works - approximately 1.8 billion Rials unit cost of excavation works - approximately

1.800 Rials/m^3

Total volume of excavation works - approximately

1.0 million m^3

(8) Labour ost

(A) Carpenter 3,000 - 3,500 Rials/day

(B) Labourer about 600 Rials/day

(C) Arrangement of iron-bar 8 Rials/kg

(D) Driver 35,000 Rials/month

(E) Driver for bulldozer 60,000 Rials/month

(9) Material cost

(A) Gravel about 350 Rials/m^2

(B) Sand about 430 Rials/m^2

(C) Cement about 2,900 Rials/m^2

(D) Iron-bar about 35 Rials/kg

(10) Seismic coefficient is about 0.1

(11) There is no workshop along line No. 1

(12) In construction of the intersection with other lines which are not constructed yet, the related part of other lines is to be constructed in advance.

(13) Three shield-machines (diameter 9m) have already been imported.

第7章　調 査 団 の 暫 定 勧 告

Preliminary Conclusion

1. Forewords

Japanese Traffic Survey Mission (hereinafter referred to as "the Mission") which is delegated by the Government of Japan submits the following comments to the Municipality of Tehran (hereinafter referred to as "the Municipality"), based on available information, discussions with agencies concerned and also, on the results of the studies made by the Mission in the field.

The Municipality would be expected to make the prompt response concerning this comments to the Mission, if necessary, through the Japanese Embassy in Tehran (hereinafter referred to as "the Embassy"). Considering the above-mentioned reponse of the Municipality, if any, the Mission will elaborate this Preliminary Conclusion in Japan, and submit the final report under the title of "the Report of the study on Traffic Survey" (hereinafter referred to as "the Report") to the Minicipality through the Embassy within two months after departure of the Mission from Tehran. The Mission expect the prompt reponse of the Municipality, the Mission will recommend the Government of Japan through JICA (Japanese International Cooperation Agency, the official agency responsible for implementation of technical cooperation) to send a small group of experts to Tehran to discuss with those who are concerned about the scope of work on the specific subjects for the cooperation this autumn.

According to this agreed scope of work the Mission expects the Government of Japan to send a new survey team within this fiscal year of Japan which ends at the end of next March.

2. The Points to be Studied

The Municipality requested the Mission to study whether the construction of the Metro Line No. 1 must be continued as proposed in the past and if the answer is "no", then what modification must be considered and if the answer is "yes", then whether it must be underground, surface ground or elevated structure, and also the Municipality requested to study on the Metro network in conjunction with the transportation system as a whole. The Mission focussed these studies into the following two points:

2-1 On the Metro network with other transportation modes.

First of all, whether big city like Tehran must have a metro system as a part of urban transportation system.

Secondly, what pattern and contents of urban transportation systems are suitable for the City in Consideration with some new types of transportation mode adding to the ordinary means of transportation such as metro, bus, etc.

Thirdly, whether the concept which the Municipality is now going to introduce in the near future to improve the present traffic congestion in Tehran is suitable.

2-2 On the Metro Line No. 1

To review the project of the Metro Line No. 1 which is now under construction from the view points of chice of design, easiness and safety of execution, econimization, stage construction for partial operation and consideration to other related projects.

3. On the Metro Network with Other Transportation Modes

The Metro network plan in Tehran, consisted of 4 lines at present, was already authorized. The Mission, however, recommends that the sufficient study for the extensive Metro network including the 3 additional lines or branch lines should be proceeded, which is now under examination by the Departments concerned. As it is considered that the number of population in Tehran will be more than 8 million in the future, the following comparison should be referred. In Tokyo, there are around 8 million population within a radius of 15 km from the center (600 km^2), which is nearly equal to the future population in Tehran. In the metropolitan region of Tokyo including above-mentioned areas, there is more than 30 million population which is also nearly equal to one in Iran. In Tokyo Metropolitan region, there are at least 6 big sub-centers and there are centers which give the opportunity for employment other than 6 big sub-centers. On the other hand, Tehran is a mono-center type city which has one existing central part of the city as a center of city. Accordingly the centripetal force by traffic and information is remarkably high on the center of the city.

In Tehran, the outsides of the areas with 8 million population are deserts and mountains. Even though it is considered that the different conditions between Tehran and Tokyo, around 75 km (4 Lines) of Tehran rapid transit is not sufficient, compared with around 500 km (including 175 km metro network)

of Tokyo rapid transit within a radius of 15 km. In this sense, the future drastic plan for mass transit network might be needed in Tehran. Though Tehran at present at the stage of 1.2 million cars, it will get the same level of Tokyo which has almost the same rate of car wonership. The ratio of road areas to total areas in center of cities is much different, that is, in comparion with 25% in case of Tokyo, the ratio is only 10% in Tehran. This fact tells clearly the necessity of persistent construction of roads and rapid transport system. As the fundamental basis on the above mentioned facts, special attention should be paid on the following points.

3-1 As clear as in the recent investigation on the density of population, the zones with more than 600 persons per hectare (certain zones with more than 1,000 persons per hectare) are located in the southern part of the city. These southeast and southwest parts of the city with many and high density population should be serviced by the Metro network which should be considered drastically in conjunction with the urban redevelopment planning.

3-2 Even after the Comprehensive Plan was approved, the development of inhabited areas in the northern part of the city has been sporadic. According to this situation, the routes and the location of stations on the Metro network ought to be reviewed in detail and furthermore the systematic formulation of the new residential areas should be realized.

3-3 While the transportation within the northern part of the city may be mainly by motor-vehicles, the transportation by private cars in the existing central part of the city should be restricted as much as possible. The two parts of the city should be combined by the strong transportation routes, otherwise each other can not survive. In this sense several points such as routes of Metro lines No. 2 and No. 3 and the junction of the lines should be reconsidered and, if necessary, construction of new lines should be added.

3-4 If transportation should not be able to depend on motor-vehicles by the lack of roads on the stage that the number of population becomes more than 8 million, the capacity of the planned 4 Metro lines would be not enough to cover these vast area. It might be necessary to construct above-mentioned branch lines and new Metro lines and moreover in order to meet the transportation demand from the north, it would be

necessary to construct new lines which pass through the center of the city, or to increase the capacity of the planned North-South line, for example, by dual double track or additional lines.

3-5 Strict traffic regulation including owner car driving in the central part of the city should be done as soon as possible.

At the sametime it is necessary to increase the capacity of bus service.

Moreover, possibility to introduce new transport system, as mentioned later, should be considered.

3-6 An appropriate feeder system is essential in order to realize the full function of metro system. Almost of the cases, bus service has a role of feeder to the Metro.

Mono-rail and/or other new transport system besides bus must also be studied in case of the city of Tehran. Infrastructures such as roads and plazas which are essential to the realization of feeder function are to be planned parallel to the metro planning.

3-7 Infrastructures must be provided based upon the traffic demand which resulted from the citizens needs of modal split, and trip chain of trip purposes.

Thus, future urban transportation system should be formulated on this concept.

Therefore, the planning and the priority of the infrastructure should be fixed as soon as possible, then existing stock of infrastructures must be utilized fully, even on the way of every stage of construction.

4. On the Metro Line No. 1

Regarding Line No. 1 of which 2.7 kms. is currently under construction. It is considered that its necessity and methods of construction are fundamentally not needed to be reviewed. However, there are a few points which should be taken into consideration.

4-1 There is no sideline depot. It must to be set up between tracks to keep disable cars as well as cars not in use.

4-2 It is desirable for a workshop to be set up near starting point.

4-3 Regarding southern part of the line where open-cut method of excavation to be undertaken, a consideration should be given so that the construction will not interfere with traffic flow even at some higher cost of expenses. There are similar cases in Japan.

4-4 Some room for future design of grade separation intersections of roads should be taken into consideration.

4-5 The impression is that the cross-section is designed economically. However, the following points need to be taken into consideration.

4-5-1 It is desirable to set up island platforms at stations where numbers of passengers is expected to be high.

4-5-2 For pedestrians, concourse (crossing thoroughfare) is desired to be set up over Metro stations below underground.

4-5-3 In consideration of future needs, in open-cut excavation areas, it is desired that boxculverts which accommodate water pipe, gas pipe, telephone line and electric line will be constructed simultaneously between upper ceiling of sub-way structure and ground surface.

5. Items to be Studied Specifically

After above-mentioned considerations the following items are intensely desirable to be studied.

5-1 Revision of the Comprehensive Plan

The most remarkable changes, which characteristically can be recognized in the present Comprehensive Plan approved about ten years ago, is the sporadic urban development typically shown in the case that fourteen planned district centers cannot likely be realized any more.

Therefore the following items should be studied according to the various new circumstances, one of which is mentioned above.

(1) The transportation connection between the new development areas where the private cars have priority and the existing central city area where the usage of the private cars are extremely restricted physically must be studied.

(2) The development of the Abbas-Abad District is desirable to be planned in order to reduce the traffic demand to the existing

central city area through the increase of the employments in the Abbas-Abad District. Therefore the realization of the pattern of Metropolitan Tehran which has the two city centers must be considered.

(3) A strong transport axis is essential as a counter measure against huge traffic demand for the concept of linear town. Then, this axis would stretch over 20 km, so that Metro project is to be considered in such a scale that has a dual double track lines for the possibility of the express train service. This would relate to the problem concerning the increase of the present capacity of the Metro Line No. 1.

(4) The necessary space must be put aside in the existing centered part of the city in order to introduce the expected urban expressway in the future.

5-2 Review of the Metro Lines Besides 2.7 km Part of the Line No. 1.

Though the Mission considers the Metro Line No. 1 must be realized according to the present plan, if, in the case the revision of the Comprehensive Plan is necessary, the review of the present Metro Lines Plan must be done.

5-3 Some Transitional Measures Before the Realization of the Metro Projects.

(1) Drastic improvements of bus services

(2) Execution of the strict traffic regulations

(3) Introduction of the new transportation system

It is recommendable to consider the introduction of the mono-rail systems or the new transport systems in the existing central area of the city and also to plan these systems so suitable that after completion of the Metro projects these systems are still fit to the whole system of the transportation modes.

6. Example of survey works or trainee programs feasible through the Japanese Cooperation.

As the results of the above-mentioned observation, the Mission wants to suggest some of the examples of survey works or trainee programs which are feasible through the Japanese Cooperation. As to the condition of the

payment of the expenses by the Japanese side for the execution of these survey works or trainee programs will be discussed when the small member team of Specialists from the Japan visit Tehran as mentioned in the first chapter of Forewords.

(1) Person trip survey or car origin-destination Comprehensive urban landuse - transport planning based on the person trip or car origin-destination survey is helpful for the comprehensive transportation planning.

(2) Rerouting of the bus routes in the city area.

(3) Study on the check of the possibility of the introducing the new transport system and its planning in the central area of the city.

(4) Review of the technological details of the construction of the Metro Lines including the Metro Line No. 1, if necessary and requested by the Municipality.

(5) Trainees to be invited to Japan
Some examples are shown as follows:

a. Planning process of comprehensive urban landuse-transport planning
b. Subway operation
c. Bus operation
d. Traffic regulation
e. Subway construction especially open cut method without stopping the surface traffic

7. Closing Words

In closing this preliminary conclusion, the Mission wants to say a few words.

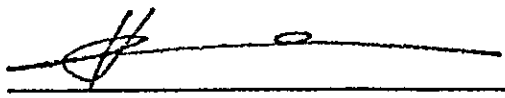
The Mission feels strongly that this 75 km Metro project in Tehran must not be postponed by the various reasons and also that the Municipality must promote this project as the most urgent task for both national and municipal future welfare. So that if there is any necessity of revising the project, it must also be done as quickly as possible.

Furthermore, if the Municipality takes up the task for release of the present serious traffic congestion in Tehran, as the most urgent one, then it must continue the present project of Metro Line No. 1 and at the same time the Municipality must start the study work on the other Metro Lines, No. 2 etc., and new transport system suitable for the future Metropolitan

City of Tehran.

In presenting this preliminary conclusion to the Municipality, the Mission wishes to express our sincere thanks to Your Excellency the Mayor of Tehran and to those who are concerned the work here in Tehran for every warm kindness and inmeasurable cooperation rendered to the Mission.

Tehran,
21st, June, 1979



Professor Takashi Inouye,
Leader of the Mission

第8章　調査団の正式勧告

Report on Traffic Survey

in Tehran

CONTENTS

1. Forewords

In compliance with the request made by the Municipality of Tehran (hereinafter referred to as "the Municipality"), the Japanese Government sent a Mission to make a survey of the situation of Tehran city traffic composed of 6 members, headed by Mr. Takashi Inouye, Professor of Yokohama National University from June 15 to June 22, 1979.

The Mission aimed to study the traffic situation in Tehran and to recommend, after making consultations with officials concerned, the way of settlement of the traffic problems Iranians are confronted. Making a tentative recommendation called the Preliminary Conclusion at the locale, the Mission returned to Japan, where it prepared a complete recommendation paper after analyzing the information again.

As mentioned in the Preliminary Conclusion, the Mission expects the response by the Municipality to this complete recommendation. Depending upon the contents of this response, the Mission is ready to recommend to the Japanese government to start detailed and concrete technical cooperation regarding a certain field of city traffic subsequently. In this report, traffic survey means a comprehensive study of the urban transportation in general.

The composition of the Mission is as follows:

Takashi Inouye	(leader, city planning) Professor, Yokohama National University.
Kazuo Yoda	(urban transport, road) Head, Urban Transport Investigation Division, City Bureau, Ministry of Construction.
Sadao Iwata	(urban transport, railway) Deputy Chief, Administration Division, Private Railways Department, Railways Supervision Bureau, Ministry of Transport.
Shuichi Muto	(bus transport) Chief, First Passenger Transport Division, First Road Transport Department, Tokyo District Land Transport Bureau, Ministry of Transport.
Yoshiichi Takishima	(Metro)) Chief, Second Planning Division, New Line Construction Bureau, Tokyo Rapid Transit Authority.

Ikuo Mitsuhashi	(planning, coordination) Staff, Development Cooperation Division, Economic Cooperation Bureau, Ministry of Foreign Affairs.

The Iranian officials concerned who participated in consultations with the Mission are as follows:

Mr. Mohammad Tavassoli	Mayor of Tehran
Mr. A. Ebrahimi	President of the Board of Directors of Tehran Metro
Mr. R. Bouchehri	Managing Director of United Bus Organization
Mr. M. Riazi	Managing Director of Traffic Organization
Mr. K. Moinzadeh	General Manager of Urbanism Office
Mr. B. Ajang	Member of Board of Directors of Tehran Metro
Mr. H. Azgomi	Head of Electronic and System Department of Tehran Metro
Mr. M. Hassanpour	Head of Civil Department of Tehran Metro
Mr. Kn. Shaghaghi	Head of Electro-mechanics of Tehran Metro
Mr. Amir Azodi	Deputy Manager of Traffic Organization
Mr. B. Royanian	Expert, Traffic Organization
Mr. M. A. Zolmajd	Expert, United Bus Organization

2. Contents of Request and the Object of Study

The Municipality requested the Mission to study whether the construction of the Metro Line No. 1 should be continued as proposed in the past and if the answer was to be "no", then what modification could be considered and if the answer was to be "yes", then which level should be selected, underground, surface level or elevated structure, and also the Municipality requested the Mission to study the Metro network in conjunction with the transportation system as a whole.

The Mission focused these considerations on the following two points:

(1) The Metro network and other transportation modes

First, whether or no a big city like Tehran should have a Metro system as part of the urban transportation system.

Secondly, what pattern and contents of urban transportation systems are suitable for Tehran, taking into account some new transportation modes as well as ordinary modes such as Metro, bus, etc.

Thirdly, whether or no the concept which the Municipality is to introduce in the near future to alleviate the present traffic congestion in Tehran is effective.

(2) The Metro Line No. 1

To review the project of the Metro Line No. 1, now under construction, from viewpoints of choice of design, easiness and safety of execution, economization, stage construction for partial operation and consideration on other related projects.

3. Basic Principles and Recommendations

(1) Necessity of Metro and Basic Consideration of Metro Planning

The Metro network plan in Tehran, consisting of 4 lines at present, is already authorized. The Mission, however, recommends that a sufficient research on the extensive Metro network including 3 additional lines or branch lines should be carried out, which are now under examination by the authorities concerned. As the population of Tehran is expected to exceed 8 million in the future, the following comparison is noteworthy. In Tokyo, there is around 8 million population within area of 15 Km in radius from the center (600 Km^2), which is nearly equal to the future population in Tehran. In the metropolitan region of Tokyo within area of 50 Km in radius including above-mentioned area, there is more than 30 million population which almost corresponds to that of Iran. In Tokyo Metropolitan region, there are 6 big sub-centers and, in addition, various centers giving the opportunities of employment. On the other hand, Tehran is a mono-center type city with only one central area. Accordingly, the centripetal force of traffic and information is remarkably higher in the center of the city.

In Tehran, the outskirts of the areas with 8 million population are deserts and mountains. Even though different conditions exist between Tehran and Tokyo, it is considered that around 75 Km (4 Lines) of Tehran rapid transit is not sufficient, compared with around 500 Km (including 175 Km Metro network) of Tokyo rapid transit within a radius of 15 Km. In this connection, an innovative plan for mass transit network is needed in Tehran. Though the car ownership in Tehran is at present 1.2 million units, almost the same level as Tokyo, the ratio of road areas to total areas in the city center is quite different in Tokyo and Tehran, that is, 25% in Tokyo, and 10% in Tehran. This clearly indicates the necessity of continuous constructions of roads and rapid transport systems. On the basis of the above mentioned facts, special attention should be given to the following points.

1) According to the recent investigation on the density of population, the zones with more than 600 persons per hectare (certain zones with more than 1,000 persons per hectare) are located in the southern part of the city. These southeast and southwest parts of the city with large population and high

density should be serviced by the Metro network in conjunction with the urban redevelopment planning.

2) Even after the approval of the Comprehensive Plan the development of inhabited areas in the northern part of the city has been sporadic. Against this situation, the routes and locations of the stations on the Metro network should be reviewed in detail and furthermore the new residential areas should be systematically formulated.

3) While the transportation in the northern part of the city can be mainly conducted by motor-vehicles, the transportation by private cars in the existing central part of the city should be restricted as far as possible. The two parts of the city should be connected by the powerful transportation routes, otherwise both cannot survive. In this sense several points such as the routes of Metro lines No. 2 and No. 3 and the junctions of the lines should be reexamined and, if appropriate, construction of new lines should be considered. In this case, the points to be examined are the feasibility and potential merit of forming a new city center at Abbas-Abad. It will create a good employment opportunity and also facilitate the utilization of motorcar traffic in the northern district. Further, attention should be paid to the fact that, since it must connect firmly the city centers in the south and new residential areas in the north, access to the existing south center by motor transportation must be secured.

4) If the means of transportation cannot rely on motor-vehicles due to lack of adequate road system, at the time when the population reaches 8 million, the capacity of the planned 4 Metro lines will not be enough to cover the whole areas of Tehran. It will be necessary to construct above-mentioned branch lines and new Metro lines and, moreover, in order to meet the transportation demand from the north, it will be necessary to construct new lines which pass through the center of the city, or to increase the capacity of the planned North-South line, for example, by dual double track or additional lines.

5) As mentioned above, a new landuse plan should be formulated with due regard to the circumstances since the formulation of the Comprehensive Plan of Tehran and a plan to introduce the Metro lines should be set up.

(2) Revision of the Comprehensive Landuse/Transport Plan

The most remarkable change, in comparison with the present Comprehensive Plan which was approved about ten years ago, is the sporadic urban development. Therefore, the fourteen planned district centers are not considered realizable.

Accordingly, the following items should be studied based on the various new circumstances, one of which is mentioned above.

1) The transportation connection, between the new development areas where the private cars dominate and the existing central city area where the usage of the private cars are extremely restricted by physical means, must be studied.

2) The development of the Abbas-Abad District is desirable in order to reduce the traffic demand toward the existing central city area due to the incrased employment in the Abbas-Abad District. Therefore, the realization of the pattern of Metropolitan Tehran which has two city centers must be considered.

3) A strong transport axis is essential as a countermeasure against huge traffic demand for the concept of linear town. Then, this axis would stretch over 20 Km, so that Metro project is to be considered in such a scale that has dual double track lines including the possibility of the express train service. This would relate to the problem concerning the increase of the present capacity of the Metro Line No. 1.

4) The necessary space must be set aside in the existing central part of the city in order to introduce the expected urban expressway in the future.

Especially it is necessary to introduce the ring roads which aim to detour such traffic that passes through the existing city center and at the same time to equalize the access to the city center from all outside directions.

5) An appropriate feeder system is essential in order to realize the full function of Metro system. In most cases, bus service plays the role of a feeder to the Metro.

Mono-rail and/or other new transport system besides bus must also be studied for the city of Tehran. Since mono-rail and/or other new transport systems are placed above roads, they do not affect the motor-traffic capacity of the roads. Therefore, in planning the introduction of these traffic systems, two kinds of plans may be considered, namely (1) to plan them as a feeder to the Metro, (2) to plan them as a trunk line system which corresponds to the traffic capacity of the existing roads (up to 30,000 passengers/hour, at peak).

Infrastructures such as roads and plazas which are essential to the realization of feeder function are to be planned in correspondence with the Metro planning.

6) Infrastructures must be provided according to the traffic demand which will result from the modal split, due to trip chain of trip purposes.

Thus, future urban transportation system should be formulated along this concept.

Therefore, the priority of the infrastructure in the planning should be fixed as soon as possible, while making the best use of the existing stocks of infrastructure in every stage of construction.

(3) Immediate Program for Easing Traffic Congestion

As transitional measures before the realization of the Metro system the following two points should be studied:

1) Innovation of bus services:

Study should be made on the following:

(a) introduction of the lane exclusive for bus and the traffic signal indicating the priority of bus,
(b) introduction of season and coupon ticket systems,
(c) reorganization of bus service network,
(d) setting up or improvement of bus-guide signboards (including the bus time-table),

(e) installment of bus-terminals.

In anticipation of the future demands, the introduction of the zone-bus system should be studied so as to make the bus services on schedule. In this case, the exclusive bus lane should be provided in the trunk bus roads, and a large number of buses should be operated on the roads to offer frequent services.

(Zone bus system)

The zone bus system means that, by reorganizing the existing bus routes, the bus services is made by operating the trunk bus (large-sized bus to be operated frequently) and the zone bus (small-sized bus to be operated on carefully prepared schedule).

The trunk bus and zone bus are connected at the junction terminals where the trunk and zone buses stop facing each other so that passengers can change easily.

2) Execution of strict traffic control

Study should be made of, for example, establishment of (a) parking control zone and (b) private car entry prohibition zone.

As regards (a), strict measures should be enforced if cars that are parked illegally are to be removed. At the same time, a fixed area for parking is to be made as obligatory requirement for newly constructed buildings.

As regards (b), the establishment of a private car entry prohibition zone is quite effective. If some difficulties are anticipated, as transitional measures, an exclusive lane for bus and taxi is to be provided in the roads with two or more lanes, and the traffic supervisors are to be posted to enforce the regulation strictly.

(4) Metro Line No. 1

For Tehran city at present, there are no adequate means of urban traffic which can transport people safely, securedly, speedily and in a large number (about 60,000 passengers/h or more) other than the Metro. Therefore, the No. 1 line should be constructed as soon as possible.

Moreover, the Metro lines are desirable from the view point of protection of citizens from environmental pollution such as noise, vibration and exhaust gas and of energy conservation.

As regards the routing, it is appropriate because the route is connecting the points which have a large volume of motorcar traffic in the directions north and south. Selection of the structures for Metro (underground or elevated) is also considered appropriate.

Though, due to the differences of the local conditions of geology and underground water in the two countries, there are some differences in ways of design between Iran and Japan, the Tokyo Rapid Transit Authority (hereinafter referred to as "TRTA") generally adopts the shield method because of the economic merit when the line lies ten meters or more earth-covering. The Tehran Metro line is identical in this point. Besides, regarding the section design, it seems that by adopting the arch section, prefabrication construction method, etc., in accordance with the different conditions of geology or underground water, economization and shortening of the period of works are pursuited. Taking the above points into account, no fundamental reconsiderations of the necessity, ways of construction, etc., of the No. 1 line are required.

However, the following points should be duly considered.

1) As the urbanization fringe has reached near TAJRISH, the line should be extended further to the north.

2) The number of tracks to be used to keep the broken-down vehicles or crossover tracks to shunt them promptly is not sufficient. In case of the TRTA, shunting tracks are provided at midway of a line (near a station) which can accommodate one whole train or more and crossover tracks are placed at about every 5 kilometers (near station) so as to shunt broken-down vehicles promptly.

By these means, confusion of the train schedule can be prevented. Further, these facilities can be utilized for parking of vehicles or turning back operation of cars when the line is operated partly.

3) At present, there is no car-repair shop provided for No. 1 line. In order to compensate the construction cost as early as possible, it may have to be operated partly before its full-scale

operation. At that time, a repair shop is indispensable. Therefore, consideration should be given to construct a repair shop at the end of No. 1 line now under construction.

4) It is planned that, at the southern part of the line where an open-cut method is adopted, the motorcar traffic is to be detoured all through the period of construction works. However, since the road is very congested even at present, it will be better to "cover" the road surface for a specified period of time and offer it to general traffic. In Tokyo, the "cut and cover method" is adopted mainly in the Metro construction work and the works which may hinder the motor traffic (pile driving, road covering, pile extraction, road-cover removal, etc.) are conducted from about 11 p.m. to about 6 a.m. next morning when the volume of motor traffic is smallest, leaving the remaining time free to motor traffic. The cost of road covering and road cover removal works is, in the case of TRTA, about 6% of the contract price.

5) When there are plans of grade separate crossings and expressways which cross the Metro line in future, the plan of the Metro line must be made giving due consideration to the space, foundation load, etc., necessary for such other construction works.

6) Though all the stations of the Tehran Metro have the side-platforms with the standardized width of 4 meters, it is considered better to adopt the island-platforms for the central and/or junction stations. The reason is that the side-platform is inefficient since, at rush hours, crowded passengers gather together on only one side. On the contrary, on the island-platform, passengers can utilize the space of platform effectively irrespective of the direction of their destinations, and, in case of a junction, since there is no need to provide separate staircases which connect one platform with another for two directions (up and down), it is convenient for passengers and also for management.

Though there is no standard, on the type of platform to be adopted, in case of TRTA, among 114 underground stations, 71 are the island ones and the remaining 43 are the side ones.

7) It is desirable for the benefit of pedestrians walking on the street above the Metro, to utilize the free concourse installed underground for pedestrians crossing traffic under the street.

8) In case the open-cut method is adopted, if there is a space between the upper floor of the tunnel and the road surface, it is advantageous to execute, at the same time with the construction works of the Metro, the utility box culvert to accomodate burried pipes and calbes of water, gas, telephone, power, etc., en bloc. This box culvert is quite beneficial for future expansion, maintenance, and repair, and moreover the cost of construction is lower in the long run than that required when the work is done separately.
(see Chapter 6, Fig. 1)

4. Examples of Technical Cooperation Expected in the Subsequent Stage

As mentioned in the Chapter 1 "Forewords", the Mission is expecting the response of Iran to this complete recommendation and, depending on the contents of such response, the Mission is prepared to recommend to the Japanese Government to start detailed and concrete technical cooperation subsequently. This is because, the improvement of urban transport in Tehran in future requires the formulation of plans for short and long range countermeasures for which the steady and long term study and the introduction of high quality technology are indispensable, and because the precious experiences accumulated in many cities of Japan are considered to be highly helpful for these efforts.

The Mission considers that, as the examples of technical cooperations to be undertaken by Japan, following can be cited. As regards the concrete ways to put forward this cooperation (items of cooperation, sharing in expenses, period of cooperation, number of experts, number of trainees to be accepted, scope of work, etc.), consultation between the two governments is important from now afterwards. If necessary for such cooperation, we should like to recommend to the Japanese Government to send a small member team of specialist to Tehran, say, in this fall.

1) Investigation to obtain detailed fundamental data concerning actual status of landuse and transport which are necessary to map out the plan of urban transport.

2) Development of the short-term measures concerning the Tehran city transport plan and the long-term conception which fits the landuse.

3) Cooperation in the technological aspect of the Metro construction plans other than No. 1 line now under construction partially.

4) Plans to strengthen the bus service which is deemed urgently necessary and plans to control traffic in general.

5) Study of the feasibility of introduction of new transport systems including the mono-rail.

5. Acknowledgements

In order to improve the urban transport of a large city, a huge sum of money, a long period of time, consensus among citizens and a powerful administrative organization are necessary. To satisfy such requirements, it is prerequisite to establish a precise and accurate plan based on thorough investigation made in the initial stage, and at the same time, after the plan is put into practice, to modify and renew the plan at the interval of every few years, giving due consideration to the changes of socio-economic situations so as to ensure that the plan always corresponds to the actual state of affairs.

We members of the Mission, were aware of the severe congestion of motor traffic in Tehran. We thought the situation could be compared to that of Japan 15 years ago. In coping with that situation, Japan conducted large-scale improvement of the railway networks including the Metro lines and the road systems including the expressways, and at the same time, executed the city re-development projects to improve the inefficient areas in cities drastically. These efforts succeeded in establishing the transport system in which 12 million people (central area in metropolitan region) can move to any destination in the area without any inconveniency. There are major differences between Tehran and Tokyo with regard to the social and cultural situations, and though the experiences in Tokyo may not apply to Tehran directly, we expect this report will serve as the useful reference to settle the problems confronting Tehran.

Furthermore, it is the sincere hope of the Mission that the present cooperation project will promote closer collaboration between Japan and Iran in the field of urban transport and contribute to strengthening the friendly relations between the two nations.

In conclusion, the Mission expresses its deep gratitude for the warm hospitality and thoughtful considerations extended by the people of Tehran and, wish to convey its heartfelt appreciations to The Honourable Mayor of Tehran, President of Board of Directors of Tehran Metro and those Iranian officials concerned who participated in consultations with the Mission.

6. Reference Materials

Regarding the construction works of the Metro line No. 1 (2.7 Km) now under construction in cooperation with France (contract price: 1,800 million Rials; contracted at early 1977; including escalation of 10% for material prices and wages), rough estimation was made assuming that the construction works were to be done in Tokyo (see the separate tables for details) and following results were obtained;

1) Based on the unit prices in Tokyo as of July 1979 (details of work method and volume of reinforce bars, etc., are merely suppositions the estimation was approximately 5,140 million yen. (see Table 1)

2) On the other hand, when the unit prices which the Mission confirmed in Tehran during their stay there (exchange rate 1 Rial = 3 yen; for those unknown, the unit prices in Tokyo July 1979 were applied) were adopted, the estimation was about 4,410 million yen. (see Table 2).

3) In order to compare this amount with that of 1977, careful calculations must be made taking into account the rate of rise of commodity prices and wages related to the construction works in both countries, changes of exchange rates, ways of estimations, etc.

Table 1 2.7 Km Section Construction Cost (Unit Price at Tokyo)

Work	Unit	Volume	Unit Price (Yen)	Cost (yen)
Excavation	m^3	1,000,000	740	740,000,000
Base concrete	m^3	2,940	18,000	52,920,000
Reinforced-concrete A	m^3	47,160	30,440	1,435,550,400
Reinforced-concrete B	m^3	13,570	56,240	763,176,800
Reinforced-concrete C	m^3	5,890	67,000	394,630,000
Prefab reinforced-concrete	m^3	7,930	132,800	1,053,104,000
Top waterproofing	m^2	33,560	3,900	130,884,000
Filling up	m^3	767,500	540	414,450,000
Earth transport	m^3	232,500	660	153,450,000
Total (Construction Cost)				5,138,165,200

For details see the Table 3,4 and 5.

Table 2 2.7 Km Section Construction Cost (Unit Price at Tehran)

Work	Unit	Volume	Unit Price (Yen)	Cost (Yen)
Excavation	m^3	1,000,000	640	640,000,000
Base concrete	m^3	2,940	8,700	25,578,000
Reinforced-concrete A	m^3	47,160	22,580	1,064,872,800
Reinforced-concrete B	m^3	13,570	48,950	664,251,500
Reinforced-concrete C	m^3	5,890	65,040	383,085,600
Prefab reinforced-concrete	m^3	7,930	132,800	1,053,104,000
Top waterproofing	m^2	33,560	3,900	130,884,000
Filling up	m^3	767,500	470	360,725,000
Earth transport	m^3	232,500	370	86,025,000
Total (Construction Cost)				4,408,525,900

For details see the Table 3, 4 and 5.

Table 3 Concrete Work Unit Price

Name	Remarks	Unit	Unit Price (Yen)	
			Tokyo	Tehran
Material cost				
Steel form	re-use 25 times	m^2	298	298
Outer form, Support	re-use 25 times	m^2	200	200
Concrete	Ready mixed concrete	m^3	11,600	* 6,200
Reinforcing bar	SD-30 Reinforcing bar ratio Concrete A: 50kg/m^3 Concrete B:150kg/m^3 Concrete C:250kg/m^3 Prefab :250kg/m^3	t	60,000	* 105,000
Labor cost				
Carpenter	Erection, removal	day	11,580	* 9,000 ∿ 10,500
Steel worker	Cutting & Bending	t	Cutting 18,396 Bending 42,924	* 24,000
Concrete worker	Concrete placing	day	10,070	* 9,000 ∿ 10,500
Common worker		day	7,980	* 1,800
Machine rent				
Vibrator	ϕ-43 mm	m^3	52	52
Transport cost				
Rainforcing bar	Distance 20 Km	t	4,695	4,695
Form, Supporter	Distance 10 Km × 2	t	4,916	4,916

Note: * Data at Tehran

Exchange rate 1 Rial = 3 Yen

Table 4 Excavation, Filling up Work Unit Price

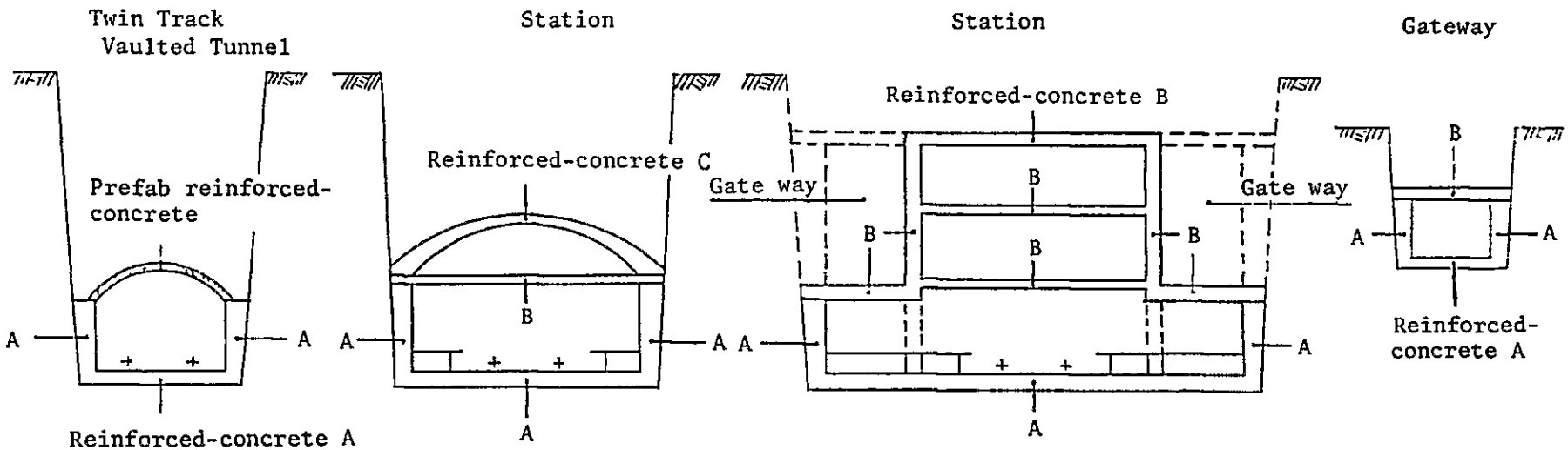
Name	Remarks	Unit	Unit Price (Yen)	
			Tokyo	Tehran
Machine rent				
Rippdozer	32t-class	hour	11,900	11,900
Bulldozer	21t-class	hour	6,010	6,010
Clamshell	0.6 m^3-class (weight 18t)	hour	4,800	4,800
Labor cost				
Operator		day	11,260	* 7,200
Helper		day	7,980	* 1,800
Dump-driver		day	9,800	* 4,200
Power cost				
Rippdozer	30ℓ/h × 52 yen/ℓ	hour	1,560	1,560
Bulldozer	17ℓ/h × 52 yen/ℓ	hour	884	884
Clamshell	8.6ℓ/h × 52 yen/ℓ	hour	447	447
Transport cost				
Rippdozer	50t trailer Distance 20 Km × 2	one vehicle	466,000	466,000
Bulldozer	50t trailer Distance 20 Km × 2	one vehicle	122,000	122,000
Clamshell	50t trailer Distance 20 Km × 2	one vehicle	88,000	88,000

Note: * Data at Tehran

Exchange rate 1 Rial = 3 Yen

Table 5

Reinforced - Concrete Note:

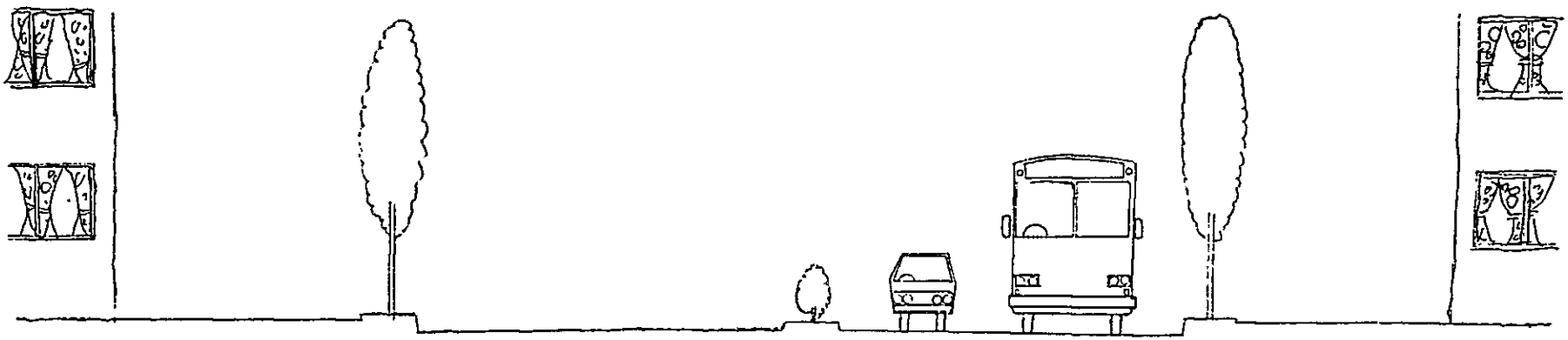


Construction Cost Note :

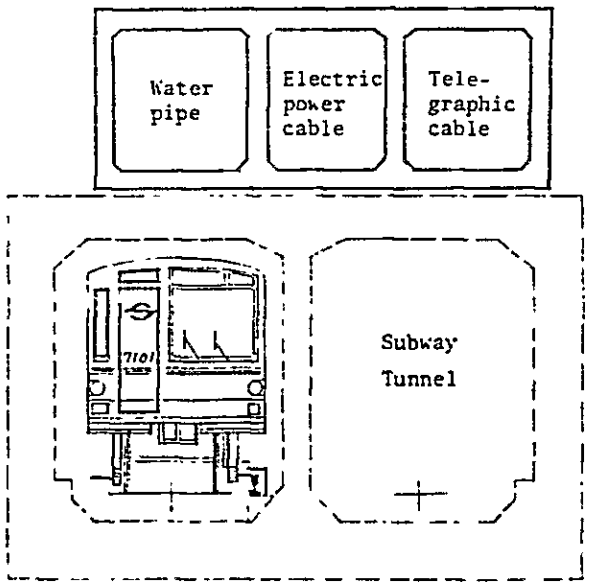
Cost		Formula
1	Direct cost	
2	Indirect cost	① × 2%
3	Net construction cost	① + ②
4	Overhead cost	③ × 9%
5	Job office overhead cost	③ × 10%
6	Construction cost	③ + ④ + ⑤

Others: Earth transport distance, 1 Km

Earth transport distance for excavation, 0 Km



UTILITY BOX CULVERT



第９章　　付　　録

（１）　調査に先立ち在イラン日本大使館より「イ」側に提出された文書

EMBASSY OF JAPAN
P.O. Box 348
TEHRAN

June 10, 1979

H.E. Mr. M. Tavassoli
Mayor of Tehran.

Excellency,

I have the honour to inform Your Excellency that in compliance with the request of the Municipality of Tehran, the Government of Japan has decided to send a six-member traffic survey mission to Iran. The members are listed in Annex (1).

The Mission will arrive in Tehran on June 15, 1979, and stay for a period of a week. The draft itinerary of the mission is attached as Annex (2).

I should be most grateful if Your Excellency would be so good as to inform the authorities concerned of the visit of the mission and to make necessary arrangements and facilities for meeting with officials concerned and providing necessary information as requested in Annex (3).

Accept, Excellency, the renewed assurances of my highest consideration.

Tsutomu Wada
Ambassador of Japan

Annex (1) Members of the Mission.

Dr. Takashi INOUE

Professor for City Planning and Traffic Engineering,
Yokohama National University

Mr. Kazuo YODA

Director-General
Urban Traffic Investigation Section
Ministry of Construction

Mr. Sadao IWATA

Deputy Director-General
Private Railways Department, Ministry of Transportation

Mr. Shuichi MUTO

Director-General
Road Transport Department, Ministry of Transportation

Mr. Yoshiichi TAKASHIMA

Assistant to the Director-General
Teito Rapid Transit Authority

Mr. Ikuo MITSUHASHI

Transportation Engineer,
Development Cooperation Division,
Ministry of Foreign Affairs.

Annex (2) Draft Itinerary*

Khordad 25 (Fri.)	2.25	Arrival in Tehran
	13.00	Visit to the Embassy of Japan
26 (Sat.)	9.00	Visit to the City Hall Courtesy call on the Mayor Confirmation of itinerary
	14.00	Visit of the city
27 (Sun.) - 29 (Tues.)	9.00	Meeting and discussions with Iranian counterparts
	14.00	Visit of the city

Khordad 30 (Wed.)	9.00	Final meeting and discussions
Tir 1 (Fri.)	11.00	Departure from Tehran

* Subject to change pending the consultation with Tehran Municipality

Annex (3) Facilities Requested

1. Two vehicles for the mission between Khordad 26 and 30.

2. Necessary Counterparts etc.

   (1) Three counterparts in the following fields
   Urban Planning
   Highway Engineering
   Transportation Engineering

   (2) Appointment with Iranian officials concerned

3. Necessary Information (in English)

   (1) Policy of the Municipality to control the present congestion of road traffic (especially control of private cars)

   (2) Any specific plan of the Municipality to improve the bus service system in order to control the traffic congestion

   (3) The basic policy of the Municipality in the review of the Tehran Metro Plan and the present relations with France on the Plan

   (4) The priority of the construction of driveways in the traffic policy

   (5) Any comments of the Municipality to the Record of Discussions on the Tehran Inner Ring Road Project which the Japanese traffic mission asked for last October.

（２） 調 査 団 収 集 資 料 一 覧

(a) A PROFILF ON TEHRAN'S TRANSPORT

(b) Cordon における交通量調査

(c) THE COMPREHENSIVE BUS LANE PLAN FOR TEHRAN A PRELIMINARY ECONOMIC STUDY

(d) 地下鉄関係資料

(e) 都市交通関係資料

(a) A PROFILE OF TEHRAN'S TRANSPORT

resented at a meeting
with the Japanese Traffic Team.

(June 16, 1979)

Prepared in
City Traffic Department,
Tehran.

A PROFILE OF TEHRAN'S TRANSPORT

Abstract:

This report gives an outline of the growth of population, income and traffic in the city of Tehran since 1966 and includes the measures being adopted to improve the traffic condition in the city.

The State of the Affair:

The city of Tehran, the capital of Iran, is one of the 'exploding cities' presenting the tendency of a bursting increase in the urban population accompanied by high growth in the number of motorised vehicles and the spreading of metropolitan area.

The present city area of Tehran extends 20 kilometer from north to south and 15 kilometer from east to west, the total area approximately being 250 square kilometer.

Of all the cities of Iran Tehran has experienced the highest population growth since 1956. The city had a small population of only 1.5 million in 1956 which reached 2.7 million in 1966 and in 1976 the figure reached 4.5 million (Table 1). The net annual growth between 1956 and 1966 was 8% and between 1966 and 1976 was 6.5%. The slower growth during 1966-76 could be attributed to the Government's plan of decentralisation adopted in early 1970s. However, it is observed in a study that of the total population growth during 1966-76 only 2.5% was due to the natural growth while the rest was due to the influx of people from other localities(4).

To keep pace with the population growth the total land under housing development has increased to a significant extent during 1966-76. Total land under housing development was 9,160 hectare in 1966 which reached 16,800 hectare in 1977. The estimated land under housing development program will reach 18,710 hectare in 1981(5).

With the increase in population and housing the level of employment and per capita income have also increased to a significant extent during the period

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* The author is a Transport Economist in the City Traffic Department of Tehran. Any views expressed in this report are the author's own and not necessarily those of the City Traffic Department.

between 1966-76. The rate of gainful employment was 24.4% in 1966 and in 1976 the figure arrived at 30.2%[2,3]. The per capita income of the people of the city was 56,139 Rials[i] in 1966 which reached 292,160 Rials in 1976 (Table 2), a 42% increase during the period. The present per capita income in the city is estimated at 328,528 Rials, a more than four times increase within a period of twelve years.

The increase in level of employment and per capita income have resulted in a sharp increase in motor vehicle ownership and usage in the city. The total number of vehicles registered in the city was 141,257 in 1966 which arrived at 979,218 in 1976 (Table 3). The number of private cars increased at an annual rate of 71% during the above period. In 1966 there was one private car per every 35 persons while in 1976 every seven persons owned a car. But the number of buses with the United Bus Company, the sole public bus transport authority of the city showed only a 10.4% increase during the same time. However, the over all annual growth in the number of vehicles registered in Tehran was 59.3% during the period between 1966 and 1976. This increase in the number of motor vehicles has led the 11.5 million Auto Kilometer[ii] of available roadways to run at 22% more than the carrying capacity[6] giving rise to heavy traffic jam.

According to an estimation there were 5.5 million trips undertaken everyday by Tehran's population of 3.6 million in 1971 and a total of 17.7 million trips will be undertaken by a projected population of 8 million in 1991[7]. This estimation seems to be highly over ambitious. However, a conservative estimation shows that approximately 7.5 to 8 million trips are undertaken daily by the present population (4.5 million) of the city. It is estimated that 12 million daily trips will be undertaken everyday by the projected population of over 5.5 million in 1991[8].

The land use pattern and spatial distribution of population, employment and activity centres of Tehran is such that most of the daily trips are undertaken across the city. This directional trips are so heavy that an average of

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(i) 70.35 Rials = 1 US dollar at the present market rate.

(ii) 1 Auto-kilometer is equal to the road length needed for one automobile (car) to travel 1 km or one bus to travel 1/3 km, considering one bus is 3 times the size of an automobile (see p. 71; reference no. 6).

245,156 persons travel daily from north to south and vice versa along 14 major north-south bus routes; and a total of 133,060 persons travel daily between points along 3 major east-west bus routes during the morning and evening peak hours(9).

With the above contributing factors of traffic congestion the driving habit of the people has added fuel to the flame to put the city into a 'vicious circle' of traffic chaos where the average peak-period traffic speed hardly exceeds 12 km per hour and, at an average, 4 persons are killed, 26 persons are injured and 295 vehicles (including alight damages) are damaged everyday(10).

How the problem is approached:

To ensure better and improved mobility the City Traffic Department, under the aupices of Tehran Municipality, is, only recently, taking traffic engineering and management measures. These measures include the channelisation of traffic, bus transport improvement via priority measures, restrain on-street parking and provide off-street parking facilities at suitable locations and improvement of road and intersection capacity. Moreover, as long term measures, the Municipality of Tehran, on the basis of the 'Comprehensive Plan', has undertaken plans to construct a 61.8 kilometer of underground railway (Metro) network and an integrated road network of 78 kilometer consisting of arterials and urban Expressways including an Inner Ring Road to serve the central part of the city. The projects are expected to be operational by late 1980s. The Metro, with an hourly capacity to carry fourty thousand passengers per direction during the peak hours, is expected to meet the long term directional demand for movement while the new road network will divert the through traffic around the city centre thereby improving the present traffic condition to a greater extent.

Table : 1 Population growth in the major cities of Iran, 1956-76.

Cities	Population			Population		
	1956	1966	Annual growth	1966	1976	Annual growth
Tehran	1,512,082	2,719,730	8.0%	2,719,730	4,496,159	6.5%
Isfahan	254,708	424,045	6.7%	424,045	671,825	5.8%
Mashad	241,989	409,606	7.0%	409,606	670,180	6.4%
Tabriz	289,996	403,413	4.0%	403,413	598,576	4.8%
Shiraz	170,659	269,865	5.8%	269,865	416,408	5.4%
Kermanshah	125,439	187,930	5.0%	125,439	290,861	5.5%
Ahwaz	120,098	206,375	7.2%	206,375	329,006	6.0%
Rejayeh	67,605	110,749	6.4%	110,749	163,991	4.8%

Source: National census of population and housing, 1956, 66 and 1976; Statistical Centre of Iran.

Table : 2 Estimated percapita income of Iran and Tehran, 1966-76.**

(in Rials)

Year	1966	1976	1977
Iran(1)	17,856	91,300	102,665
Tehran*	57,139	292,160	328,528

(1) Source: New 1977 Iran Year Book; Kayhan Research Associates, Tehran, 1977.

* It has been found in a study (see reference No. 5) that the percapita income of Tehran is 3.2 times higher than the national percapita income of Iran. The percapita income of Tehran has been estimated by multiplying the national figure by 3.2.

** The percapita income of Iran is the estimated figure of the revised fifth Five Year Plan of Iran.

Table : 3 Number of vehicles registered in Tehran, 1966-76.

Types of vehicles registered	1966		1976		1966-76
	No. of vehicles		No. of vehicles		Annual growth during the period.
	Total	%	Total	%	
Private car	77,420	54.8	627,185	69.0	71.0%
Taxi (Meter and telephone)	8,974	6.4	12,950	1.3	4.4%
City bus	1,442	1.0	2,947	0.3	10.4%
Govt. vehicles & Diplomatic mission vehicles	13,988	9.9	58,521	6.0	31.8%
Intercity trucks	7,752	5.5	55,475	5.7	61.6%
Delivery vans & city Trucks	3,000	2.1	27,011	2.8	80.0%
Intercity bus	2,562	1.8	17,725	1.8	59.2%
Motor cycle	26,119	18.5	177,404	18.0	57.9%
Total	141,257	100	979,218	100	59.3%

Source: Motor vehicle Registration Department, Tehran.

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A PROFILE OF TEHRAN'S TRANSPORT

(ADDENDUM)*

This addendum, to the original report under the above caption, updates the information provided in the parent report and gives a comperative performance effeciency of the passengers' transport modes in the city of Tehran.

Table A1 gives the estimated number of registered vehicles in Esfand, 1357 (March, 1979) in the city of Tehran. The total number of registered vehicles in 1356 (see ref. 11) have been increased by 10% to obtain the Esfand, 1357 figures. Comparing the previous growth rates the growth in the number of registered vehicles in the city should have been about 14% but considering the government financial restrictions on the purchase of cars and the political conditions during the second half of the year a 10% growth in the number of registered vehicles, other than Taxi and city buses, seems to be reasonable. The upto date number of meter Taxi and city bus (in operation only) was obtained from the Tehran Taxi Co-operatives and the United Bus Company respectively.

It has been observed that all the registered vehicles, for one reason or other, are not in operation everyday and as such it has been observed that 5% of the private cars, 10% of the government and diplomatic vehicles 5% of the service buses (school and office transport buses) and 15% of the motor cycles are not in operation everyday. Deducting these percentages from the respective totals the total number of vehicles in operation in the city have been obtained which agrees with the result of a recent study(6). As has been stated earlier, the number of city buses and Taxi in operation were obtained from the United bus company and Tehran Taxi Co-operatives respectively.

It has been observed that every operating car in the city produces 4 person trips daily with an average occupancy of 1.6 persons per car which means 2.5 trips per car daily. Using the same occupancy for Government and diplomatic vehicles an average of 2.24 trips daily per vehicle was obtained. Multiplying the average occuancy per vehicle by the daily number of trips per vehicle a total of 3.59 person trips per day per Government and Diplomatic vehicles have been calculated (Table A2).

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* Extracts from "The comprehensive bus lane plan for Tehran: A preliminary economic study,", City Traffic Dept., Tehran, May, 1979.

The total number of Taxi in Table A1 consists of meter, blue (fixed route Taxi) Airport Taxi and Tehran Telephone Taxi. The average dialy operating hours (10 hours), km of operation (175 km) and average revenue per operating Taxi was obtained from the Taxi Co-operatives. From the observation of 2,800 Taxi at 4 selected points of the city an average occupancy of 4.16 per Taxi was obtained. Using all these information the daily production of person trips per Taxi is estimated at 100.45 (Table A2).

The total daily passenger movement by city bus was obtained from the Computer printout of the 15 days (Farvardin 16 to 31, 1357) passenger flows on all the routes of the United bus company. The daily passenger flows, calculated on the basis of the above information, is 1.77 million persons for 1,700 operating buses. Dividing the total daily passenger flows by the total number of buses in operation the average daily person trip production per bus is estimated at 1,043 person trips. It has been assumed that there has not been an change in bus reidership during the period between Farvardin and Esfand, 1357 and as such the above figure has been used in this report.

On the basis of the estimation, the daily production of person trips per operating service bus is 50 while the daily person trip production per operating motor cycle is 2.04.

On the basis of the estimation summarised above, a total of 7.06 million person trips are produced daily by different passengers' modes in the city of Tehran (see Table A2).

It appears in Table A2 that the city buses constitutes only .14% of the total number of traffic in Tehran but produces 25% of the total daily person trips while private cars account for 68% of the total number of vehicles but produce only 45.5% of the daily person trips in the city.

Table : A1 Estimated daily productivity of the passengers' modes (Model solit) in Tehran (Esfand, 1357)

Modes of Transport	Number of Vehicles in Tehran		Person trips per		
	Registered	In operation	Vehicle	Mode (in ooo)	% share
1	2	3	4	5	6
Private car	788,749	749,312	4	2,997	42.5
Govt. Diplomatic cars	63,273	56,946	3.59	204	3.0
Taxi (all type)	18,300	15,555	100.45	1,562	22.1
City Bus (United Bus Company buses)	2,070	1,700	1043.00	1,773	25.1
Service Bus	3,655	3,473	50.00	173	2.5
Motor Cycles	200,318	170,271	2.04	346	5.0
Others *	153,426	-	-	-	-
Total	1,229,791	1,150,683	-	7,055	100.00

* Includes City Trucks, Pick-ups, Delivery vans, inter-city buses, etc.

1. See the text of this Appendix for the process of estimation.

Table : A2 Comparative efficiency of passengers' modes in Tehran

(Esfand, 1357)

Modes	Number of Vehicles (in operation)		Modal Share of person trips	
	Total	%	Total trips (000)	%
Private car*	806,258	68.27	3,201	45.5
Taxi	15,555	1.32	1,562	22.1
City bus	1,700	0.14	1,773	25.1
Service bus**	3,655	0.31	173	2.5
Motor Cycle	200,318	17.00	346	5.0
Others ***	153,426	-	-	-
Total	1,180,918	100.00	7,055	100.00

* Includes 749,312 private cars and 56,946 Government and Diplomatic cars in operation

** School buses and bus transport provided by Government and private organisations to their employees.

*** City Trucks, Pick-ups, delivery vans and inter-city buses which are not traditional passenger carriers.

(b) Cordon における交通量調査

The Cordon showing the (13) counting stations. Time of the survey: 07 hours to 19 hours (continuous Counting stations)

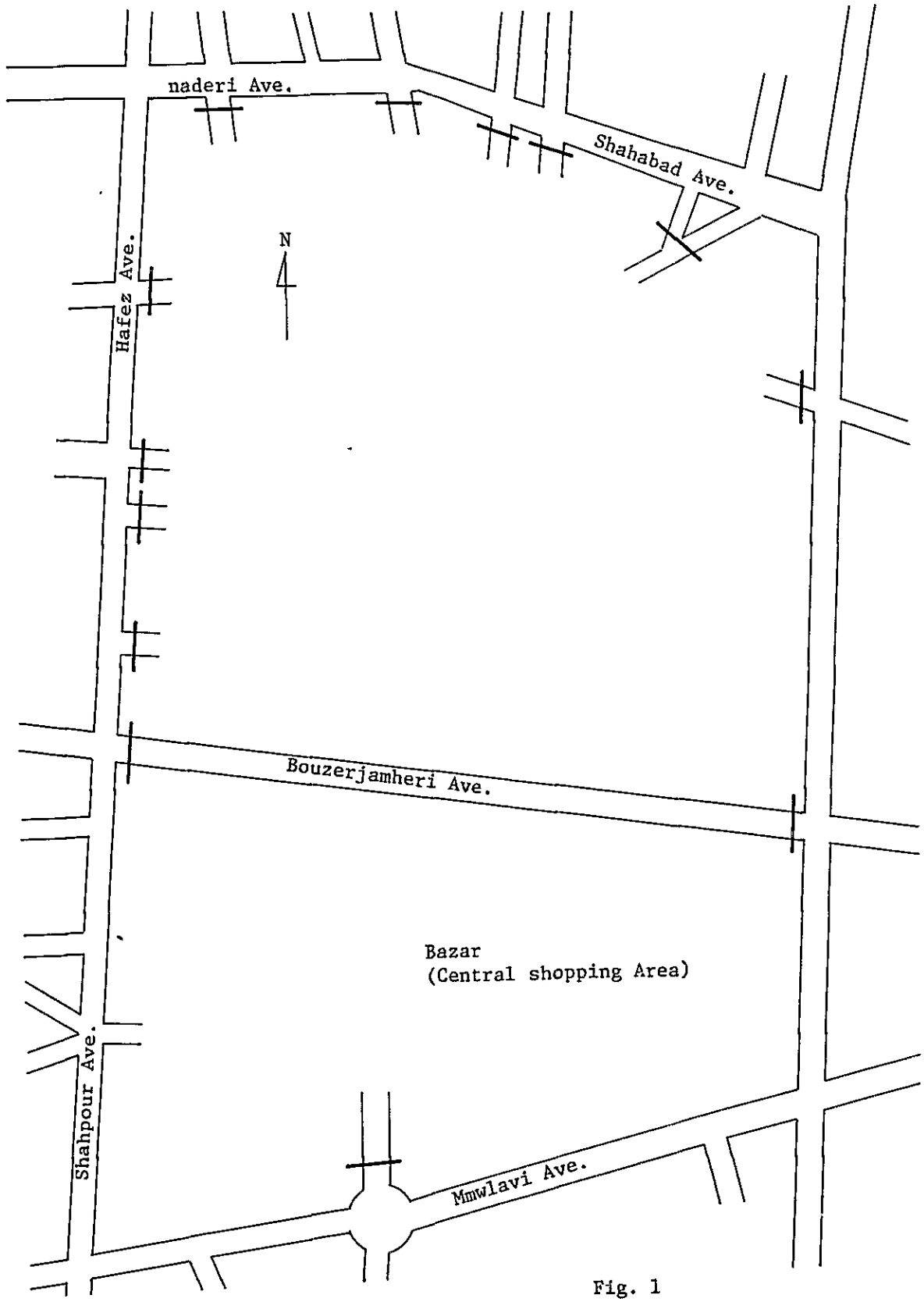


Fig. 1

TABLE : 1 Average and cumulative flow of private car per hour to and from the cordon (on Saturday - Sunday, 19-20 May, 1979)

Time	Entry	Exit	Cumulative entry	Cumulative exit	Accumulation of private car in the Cordon
7 - 8	13,137	6,832	13,147	6,832	6,305
8 - 9	11,914	6,506	25,051	13,338	11,713
9 - 10	9,394	7,173	34,445	20,511	13,937
10 - 11	8,279	7,443	42,724	27,954	14,770
11 - 12	7,489	8,151	50,213	36,105	14,108
12 - 13	6,559	9,115	56,772	45,220	11,552
13 - 14	6,029	9,877	62,801	55,097	7,704
14 - 15	6,710	9,507	69,511	64,604	4,907
15 - 16	6,877	7,561	76,388	72,165	4,223
16 - 17	7,126	7,811	83,514	79,978	3,538
17 - 18	6,884	9,303	90,398	89,279	1,119
18 - 19	6,752	9,373	97,150	98,632	1,482

The survey was undertaken by : City Traffic Department, Tehran

TABLE : 2 Average flow of buses and Taxi per hour to and from the cordon (on Sunday*, 20th May, 1979 only)

Time	Taxi		Bus	
	Entry	Exit	Entry	Exit
7 - 8	1,427	1,504	353	502
8 - 9	1,375	1,486	311	386
9 - 10	1,241	1,479	250	297
10 - 11	1,159	1,325	236	280
11 - 12	953	1,021	237	192
12 - 13	858	1,044	265	281
13 - 14	789	879	235	248
14 - 15	725	799	249	259
15 - 16	1,032	987	276	270
16 - 17	1,061	1,197	255	289
17 - 18	956	1,155	276	268
18 - 19	905	1,049	237	279

* It has been asuumed that the flows of bus and Taxi by hour same as above on Saturday.

The Survey was undertaken by : City Traffic Department, Tehran

(C) THE COMPREHENSIVE BUS LANE PLAN FOR TEHRAN: A PRELIMINARY ECONOMIC STUDY

By: Mohammad Jinnat Ali Mian

City Traffic Department
Tehran
Khordad, 1358
(May, 1979).

CONTENTS

SUMMARY

S.1 This report presents a preliminary economic study of the proposed comprehensive bus lane plan for the city of Tehran. The plan is intended to be implemented in 4 phases. The total length of the proposed network of bus lane plan, when considered on either side of the roads, is 267 km.which have been presented in phases on map G1 in Appendix G.

S.2 Considering the situation in Tehran, the bus lane is intended to be physically separated from non-bus traffic lanes. To maintain uninterrupted bus flow on the lane bus stops are intended to be relocated on the roadside djoubes. To enforce the effective operation of the bus lane 1,000 revolutionary traffic wardens will be employed by the Municipality of Tehran.

S.3 The estimation of the cost of bus lane seggregation and recolation of bus stops are separately shown in Appendix D. The relocation cost of each bus stop is estimated at 327,776 Rials. On the basis of this figure the relocation cost of 762 bus stops which fall within the 267 km of bus lane is 228,841,312 Rials. Since 30% of the total bus lane will remain open for access ways to roadside shops, garages and feeder roads so only 187 km of the bus lane have to be seggregated. The estimated seggregation cost of the 187 km of bus lane is 31,166,500 Rials. Thus the total implementation cost of the bus lane plan arrives at 260,007,812 Rials.

S.3:1 Other costs that are involved in the bus lane plan is the enforcement or policing cost and annual maintenance cost. On the basis of the estimation the average annual enforcement cost (the annual salary of 1,000 traffic wardens) is 360,000,000 Rials while the maintenance cost of the bus lane network is 260,007 Rials.

S.4 The principal items of benefit that could be accrued from the bus lane planare the following:

i. Savings in existing bus passengers' time
ii. Savings in bus time
iii. Fuel consumption savings

iv. Accident cost savings and

v. Reduction in environmental pollution.

S.4:1 Based on the estimation in Appendix F a total of 307,189 man hours will be saved daily by the total number of bus passengers presently using the buses on the routes to be covered by the bus lane network. At the rate of an average hourly income of 137 Rials[9,10] a total of 4,208,496 Rials will be saved daily. At an average, every bus will save 22.88 bus hours daily. That is, one bus on the existing network will produce 2.4 times passenger trips daily when operated on the proposed bus lane. In other words, with the same number of buses the frequency of service on each routes could be increased by 2.4 times when the bus lane becomes operational.

S.4 According to the estimation in Appendix C, a total of 23 litres of fuel is expected to be saved daily by a bus operated on the bus lane while the total daily saving for all the buses which are presently in operation on the routes intended to be covered by bus lane is 8,211 litres. A total of 2,959,730 litres of fuel is estimated to be saved daily by the (5%) car users who are expected to move to bus use. Thus on the basis of the estimation a total of 1,072,288,456 litres of fuel or 10,799,208,232 Rials will be saved per year on account of fuel consumption. (see Table F1 in Appendix F).

S.4:3 It is estimated in Appendix F that a total of 1,598 million Rials is expected to be saved per year on account of reduction of fatal motor vehicle accidents in Tehran on the ground that 5% of the existing car users will move to bus use when the bus lane becomes effectively operational.

S4:4 As has been shown in Appendix E and F, if the bus lane is effectively operated the level of air pollution by motor vehicles in Tehran will be reduced by 29.2 tons of pollutants per day or 10,658 tons of pollutants per year. Due to the impossibility of making the relevant information on the effects of a ton of pollutants the reduction in air pollution has not been quantified into monetary terms.

S.5 On the basis of the estimations carried out in this report the total benefits on the first year of operation of the 267 km of bus lane

network arrives at 13,996,100,972 Rials. The first year rate of return is estimated at 5,244% (see Appendix F).

S.6 The above result of the present study strongly suggests that the proposed bus lane plan is economically viable and its implementation and successful operation will pave the way for other traffic management innovations.

1. Introduction and Objective

1-1 The unprecedented increase in car ownership in the last fifteen years has given rise to many problems in the city of Tehran, which was not designed to cater for the traffic demand today. The result has been severe traffic chaos, increased traffic accident and deterioration of the urban environment.

1-2 To reduce traffic congestion and to preserve the continued attractiveness of the central business (CBD) and the viability of economic activities there the Traffic Department of Tehran under the auspices of the Municipality of Tehran has been considering to adopt a plan to introduce a bus lane network 267 km, when considered either side of the road (133.5 km when considered on side), to be implemented by four phases. The objective of this report is to present a preliminary economic study of the proposed bus lane plan and calculate the first year of return on the plan.

1-3 Since all the relevant information as to undertake an economic study of the proposed plan is not possible to make available within the time constraint the calculations and estimations in this report are based on results of previous studies and, where possible, relevant data have been collected through field survey and observation or by personal contacts.

2. Present Performance of the Passengers' Modes in Tehran

2-1 The city of Tehran has total of 1,617 km of bus routes for a total population of about 5 million (4.69 million)[10] which means for every 2,900 citizen of the city there are 1 km of bus route. Whereas, the European cities, at an average, have 1 km of bus route for every 10 citizens. The network speed of buses in Tehran is between 7 and 9 km per hour with the minimum of 3 to 4 km hourly speed in the CBD during the peak hours (see Appendix C). Whereas, the average bus speed in European cities is much higher than that of Tehran (pp. 68, ref. no. 7). However, the average bus speed irrespective of the peak and off-peak, has been observed at 5.4 km per hour in the CBD Tehran (see Table C4, Appendix C).

2-2 At an average, the United Bus Company, the sole public bus transport authority in the city, operates 1,700 buses daily on 154 bus routes

of the city the average length of which is 10.5 km (Table 2.1). The daily average length of which is 10.5 km (Table 2.1). The daily average movement of passengers by the fleet of 1,700 buses are 1.77 million (Table A1, Appendix A). It appears in Table A2 of Appendix A that buses consitute only .14% of the total number of vehicles in the city but meets 25% of the total passengers' transport demand; while cars counts for 68.27% of the total number of vehicles but meets only 45.5% of the passengers' transport demand rest of the demand is met by service buses and motor cycles.

2-3 In view of the relative productivity of the two principal passengers' transport modes (private cars and city buses) the traffic department of Tehran has been planning to implement the bus lane project as stated in para 1-2.

3. The Bus Lane Plan and Process

3-1 The details of the 267 km (when considered both sides of the roads) identified roads and corridors of the proposed bus lane plan, to be implemented in 4 phases, are presented in map G1 of Appendix G. Considering the conditions in Tehran the bus lanes are intended to be physically separated from other non-bus traffic lanes. The separation or seggregation could be done either by pre-fabricated cement slabs/ blocks of 1.5 meter length or by steel poles with more flexibility to take off. Without a detailed study of the respective advantages and disadvantages it is difficult to say which of the above two alternatives will be more efficient for bus lane seggregation. However, it has been observed in Appendix D that the seggregation by prefabricated slabs will be more efficient in the case of Tehran. More over, it is economic as well. To maintain uninterrupted bus flow on the bus lane all the bus stops along the bus lane are intended to be relocated on the djoubes which may take part of the sidewalks where necessary. The detailed layout of the bus lane with the bus stop is presented in Figure 3.1.

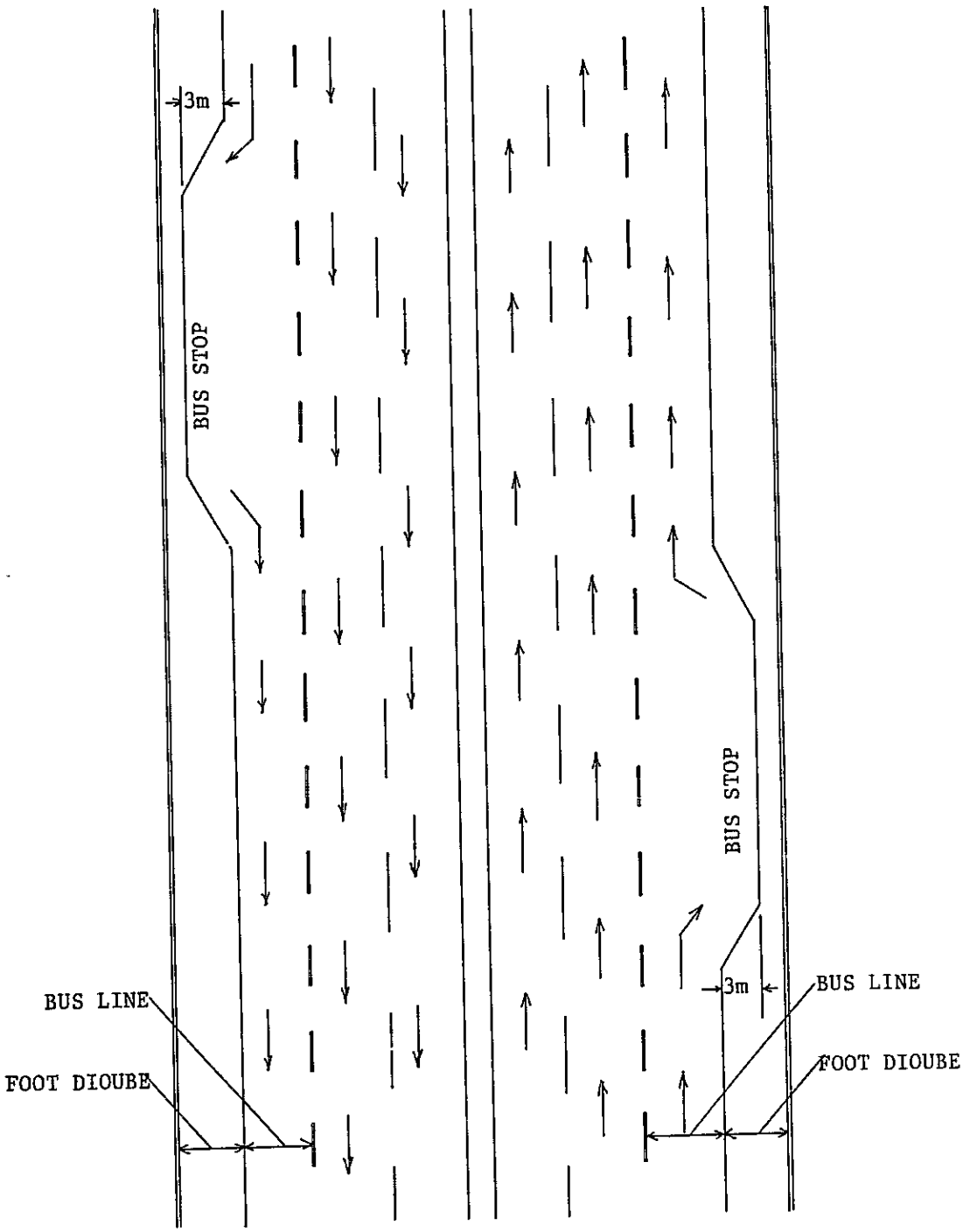
3-2 For efficient operation of the bus lane a total of 1,000 new traffic wardens are intended to be employed and necessary training to be imperted on them. The traffic wardens will be stationed at small distance to stop any tracepassings and to maintain free flow of buses on the bus lane.

Table : 2-1 The present bus route statistics of the city of Tehran*

(Esfand, 1357)

No. of bus routes			Total bus routes in km			Average length of each route in km			Total no. of bus stops	Average distance between bus stops (in meter)
Inner city	Outer city	Total	Inner city	Outer city	Total	Inner city	Outer city	Total		
145	9	154	1,285.5	331.2	1,617	8.87	36.81	10.5	4,650	348

* Source: Statistics Department, United Bus Company, Tehran.



BUS LANE WITH BUS STOP

Fig. 3-1

4. Implementation and System Operation Cost of the Bus Lane

4-1 The detailed process and principles of the estimation of the costs involved in the proposed bus lane plan implementation and its efficient operation is given in Appendix D. All the costs involved in the bus lane plan are divided into two principal categories with their respective sub-categories:

1. Implementation costs:

   (i) Physical seggregation cost of the bus lane
   (ii) Relocation cost of the bus stops on the djoubes
   (iii) Cost of the loss of on-street parking spaces to the bus lane

2. System operation costs:

   (i) Enforcement cost
   (ii) Maintenance cost of the bus lane network.

4-2 It has been estimated from the field study that 30% of the 267 km of bus lane has to be left open for accessways to the roadside shops, garages and feeder roads. So the total length of the bus lane to be seggregated is 187 km. Based on the estimation in Appendix D total seggregation cost of 187 km of the bus lane is 31,166,500 Rials at current prices Table D2, Appendix D. The average distance between bus stops in Tehran is 350 meters (Table 2-1). Based on this there will be 762 bus stops along the bus lane to be relocated on the djoubes. The estimation of the relocation cost of each bus stop has considered the following:

   (i) cost of cutting down trees from the existing djoubes
   (ii) relocation cost of the light posts from along the djoubes or sidewalks where the new bus stops to be located.
   (iii) engineering cost (steel culvert on the djoubes, soil digging and removals, asphalting and kerb) of each bus stop.

Based on the estimation in Appendix D the total cost of a new bus stop arrives at 327,776 Rials and the total cost estimated cost 762 bus stops at 228,841,312 Rials at current prices (Table D1, Appendix D). It has been found in Appendix D that a total of 37,400 on-street parking spaces will be lost to the bus lane while due to the diversion of 5% marginal car users to bus use will mean a total of 37,465

fewer parking spaces required daily in the city centre. So the loss in on street parking spaces will be compensated by the gains in parking spaces; and as such there is no cost involved in the form of the loss of parking spaces to the proposed bus lane. Thus the total implementation cost of the bus lane is 260,007,812.

4-3 The system operation cost includes the enforcement or policing cost and maintenance cost of the bus lane. On the basis of the present salary scale of the Municipality of Tehran the average monthly salary of a Traffic warden is 30,000 Rials. Based on this salary the Municipality has to spend a total of 360,000,000 Rials annually as the salary for the newly recruited traffic wardens numbering 1,000. This is considered to be the enforcement cost of the bus lane. Based on 1% of the implementation cost the annual maintenance cost of the proposed bus lane is estimated at 260,007 Rials. So the total annual system operation cost arrives at 360,260,007 Rials (Table D3, Appendix D).

5. Estimated Benefit and First Year Rate of Return

5-1 The estimation of benefits that could be derived from the successful operation of the proposed bus lane plan has been detailed out in Appendix F.

5-2 According to the original plan the bus lane network has been planned to be implemented in four phases. So the time lag between the implementation of the first and final (fourth) phase is not known as yet. Because the implementation of the successive phases are dependent on the success or viability of the preceding ones. However, the estimation of the first year benefit from the bus lane plan has been based on the network as a whole (267 km) and not on phased implementation as shown in map G1 of Appendix G. The estimated benefit that may be accrued from the bus lane plan has been divided into two categories:

(i) the benefits that has been quantified into monetary terms, such as, savings in bus passenger's time, savings in bus time, fuel consumption savings, saving in accident cost

(ii) the benefits that has not been possible to quantity into monetary terms, that is, the reduction in environmental pollution cost.

5-3-1 Comparing the bus speed at present network (5.4 km/h) and the expected bus speed (15.2 km/h) on the bus lane (see Appendix C) every passenger saves 49.5 minutes per day for his average bus journey of 5.79 km. The average daily passenger movements on the bus routes which are expected to be covered by the proposed bus lane is 372,351. At an average hourly income of 137 Rials the existing bus passengers will save 4,208,496 Rials daily.

5-3-2 Based on the estimation in Appendix F a bus on the bus lane will save 8.5 minutes per km of operation or 22.88 hours daily. On the basis of 16 hours of daily operation, a bus on the present network (without the bus lane) will produce the daily person trips equivalent to 2.4 buses (keeping the bus frequency the same) when operated on the bus lane (Appendix F). It is estimated that 357 buses are now in operation on the bus routes which will be covered by the proposed bus lane plan. So, this 357 buses will produce a total person trips equivalent to 821 buses if the bus frequency remains the same. In other words, with the same bus fleet the frequency of buses could be increased by 2.4 times when operated on the bus lane. That is, the total savings in bus time is equivalent to the annual capital cost of (821 - 357) = 464 buses. Taking 10 years as the average effective life of a bus the annual capital cost of a bus, in terms of opportunity cost at the present market price, is estimated at 70,650 Rials. Thus the total annual benefit on bus time savings is estimated at (464 x 70,650) = 32,781,600 Rials (Appendix F).

5-3-3 Due to the increased bus speed on the bus lane each bus will save 23 litres of deisel everyday (Appendix F). The total savings deisel fuel by 357 buses per day is estimated at 8,211 litres or 2,997,015 litres per year. At the rate of 2.10 Rials per litre of deisel the monetary value of the above are 17,243 and 6,293,732 Rials respectively. We considered that 5% of the marginal motorists will move to bus use when the bus lane becomes operational so 37,465 cars will go off the roads (Appendix B). At an average, each car in Tehran consumes 7.9 litres of petrolium daily. This means, the daily and annual savings in fuel consumption for the diverted cars

are 29,597,300 and 10,792,914,500 Rials respectively.(i)

5-3-4 As the bus lane becomes operational, on the basis of the assumption in Appendix B and estimation in Appendix F there will be 592 fewer fatal traffic accidents per year in Tehran. At the rate of 2.7 million Rials as the cost of a fatal accident in Tehran[19] 1,598 million will be saved every year on account of motor vehicle fatal accident in the city.

5-4 According to the estimation in the present study, when the bus lane plan becomes fully operational, there will be 29.2 fewer tons of pollutants produced daily by the motor vehicles in the city. That is, 10,658 fewer tons of pollutants will be produced every year (see Appendix E). Due to the difficulties in making the relevant data available the cost of the reduced air pollution has not been quantified in this report.

5-5 Based on the estimation in this study (Appendix A to F) the total monetary benefit for the first year of operation of the 267 km of bus route arrives at 13,996,100,872 Rials which are reproduced from Table F2 of Appendix F in Table 5.1 below.

Table : 5-1 COMPREHENSIVE BUS LANE PLAN FOR TEHRAN
Estimated First Year's Benefit
(Esfand 1357 prices)

Items of benefit	Daily (in Rials)	Annual (in Rials)
Savings in existing bus passengers' time	4,208,496	1,560,101,040
Savings in bus time	89,812	30,781,600
Fuel consumption savings	29,524,543	10,799,208,232
Accident cost savings	4,378,082	1,598,000,000
Total	38,190,933	13,998,100,872

(i) the cost per litre of petrolium is 10 Rials at present market price.

6. Comprehensive Bus Lane Plan for Tehran the First Year Rate of Return

6-1 On the basis of the estimated implementation cost, annual system operation cost and benefit that may be accrued from the proposed bus lane for the city of Tehran the first year rate of return is calculated with the help of the formula given below (see Appendix F):

$$F_yRR = \frac{B_1 - C_{me}}{K} \times 100$$

where

F_yRR = First year rate of return on the proposed bus lane

B_1 = Benefits estimated to be accrued from the bus lane on the first year of its operation

C_{me} = Estimation maintenance and enforcement (system operation) cost during the first year

K = Total implementation cost of the bus lane

Based on the calculation in Appendix F the first year rate of return arrives at 5,244%. This high rate of return, as has been estimated, strongly suggested, strongly suggests that the proposed bus lane plan is economically viable. However, there could be a number of criticisms of the result of this study which are presented in the next section.

7. Discussions and Conclusion

7-1 The first year rate of return on the proposed bus lane plan is estimated at 5,244% which seems to be a very high rate. But in an experimental bus lane project within a boundary of a square mile in Central London[7] a 177% first year rate of return was achieved.

7-2 Since the proposed bus lane plan of Tehran is several times more than that of London project and the average level of traffic congestion in Tehran is much worse than that of London so a significantly high rate of return in Tehran bus lane plan is highly desirable. However, there could be a number of short comings in the estimation of the cost and benefit in the present study which are outline in the following sub-paragraphs.

7-2-1 Despite much efforts, some estimations have not been possible to base on as accurate information as required. For example, the average daily km of operation per bus (156 km) could be higher than the actual daily operation per bus.

7-2-2 The cost of the back-wash effects of the bus lane such as, the effects of the bus lane on non-bus traffic and on business and commercial activities along the bus lane has not been considered in the estimation of the bus lane cost. Moreover, placement cost of the seggregating prefabricated slabs on the bus lane has not been considered. Finally, the publicity or advertisement cost that may be incurred to popularise the use of buses has also been considered.

7-2-3 They could be over estimation in the estimation of the savings in accident cost. Because, it is not certain, as has been assumed in Appendix B, that 5% of the existing marginal car users will completely go off the roads. Since the estimation of the accident cost saving is based on the 5% diverted cars so that estimation could be erroneous.

7-2-4 The estimation of the benefits for the generated bus passengers are also ingnored which could be a considerable amount to push the total benefit further up.

7-4 Had the above over estimations and under estimations been taken into consideration the first year rate of return on the bus lane plan could have been different to what we stated in para 7.1. Whatever may have been the short comings in the present estimation it is certain that the rate of return on the proposed bus lane plan would be positive. This strongly suggests that the bus lane plan is economically viable and successful implementation and effective operation of the plan could give the traffic of Tehran a new lease of life. Moreover, the successful operation of the bus lane network could help effective implementation of some subsidiary traffic management schemes, such as, closure of the inner CBD to private traffic, introduction of innovations like' park and ride', etc.

APPENDIX : A

DAILY PRODUCTIVITY OF PASSENGERS' MODES IN TEHRAN :

This Appendix estimates the daily total and modal share of person trips in the city of Tehran at present. The estimation has been done on the basis of the following principles and assumptions are shown in Tables A1 and A2.

1. The total number of registered vehicles in 1356 (see ref. No. 13) have been increased by 10% to obtain the number of registered vehicles in Esfand 1357 (March, 1979). Comparing the previous growth rates the growth during 1357 should have been 14% but considering the Government restriction on the purchase of cars and political conditions in the country during the second half of the year a 10% growth in the number of vehicles, other than Taxi and city buses, seems to be reasonable. The up to date figure on the number of Taxi and city bus (in operation only) was obtained from the Taxi Co-operatives and the United Bus Company respectively.

2. It was observed that all the registered vehicles, for one reason or other, are not in operation every day and as such it has been assumed that, at average, 5% of the private cars, 10% of the Government and Diplomatic vehicles 5% of service buses, and 15% of the motor cycles are not in use every day. Deducting these percentages from the respective totals we obtained the total number of vehicles in operation everday which agrees with the result of a recent study[3]. The number of Taxi and city buses in operation were obtained from the Taxi Co-operatives and United Bus Company respectively.

3. It has been assumed that every operating car in Tehran produces 4 person trips with an average occupancy of 1.6 persons per car (see refs. 3, 9, 11 and 12) which means 2.5 trips per car daily. Using the same occupancy for Government and Diplomatic vehicles an average 2.24 trips per day per car was obtained. Multiplying the occupancy and number of trips per car a total of 3.59 person trips per day by these type of vehicles have been calculated. Contacts with 25 Government organisations and Diplomatic Missions confirmed that the average daily number of trips per vehicle was around 2.35. However, the lower figure of 2.24 trips per day per Government and Diplomatic vehicles have been used in the present estimation.

4. The total number of Taxi in Table A1 consists of Meter Blue (fixed route Taxi) Airport and Tehran Telephone Taxi. The average operating hours (10 hours), km of operation (175 km) and average revenue (1,500 Rials) per operating Taxi per day was obtained from the Managing Director's Office of the Taxi Co-operatives. Observing a total of 2,800 Taxi at 4 selected locations of the city an average occupancy of 4.16 (including the driver) per Taxi was obtained. Using all these information the daily production of person trips per Taxi is estimated at 100.45.

5. The daily passenger movement by city buses was taken from the computer printout of the 15 days (Farvardin 16 to 31, 1357) passenger flows by routes. The daily average passenger flows calculated at 1,774,533 persons for the total of 1,700 operating buses. Dividing the average number of passengers by total number of buses in operation the average daily passenger movement by an individual bus is calculated at 1,043 person trips. It has been assumed that there has been no change in bus ridership since Farvardin 1357 and as such the above figure has been used.

6. Service bus includes the school buses and the bus transport provided by different government organisations and private companies. The average occupancy for such buses has been considered to be 25 persons per bus units. Considering two trips, to and from work or school a total of 50 person trips per operating bus unit per day has been used to calculate the total daily passenger trips by this mode.

   From the on the spot observation an average occupancy of 1.02 occupancy per motor cycle has been calculated to estimate the total daily person trip production by this mode.

   Assuming two trips per motor cycle, a total of 2.04 person trips per operating motor cycle per day is calculated.

7. Vehicles which are not traditional passenger carriers, such as city trucks, pick-ups, delivery vans, etc. have been grouped as 'others' in Table A1. These vehicles have not been considered in the estimation of person trips. The inter-city buses are also included with this type of vehicles. Though the inter-city buses carry passengers, they are excluded from person trip estimation on the ground that at least one end of the trips by such buses are outside the city limit.

Table : A1

Estimated daily productivity of the passengers' Modes (Modal split) in TEhran[1]
(Esfand, 1357)

Modes of Transport	Number of Vehicles in Tehran		Person trips per		
	Registered	In operation	Vehicle	Mode (in 000)	% Share
1	2	3	4	5	6
Private car *	788,749	749,312	4	2,997	42.5
Govt. diplomatic cars	63,273	56,946	3.59	204	3.0
Taxi (all type)	18,300	15,555	100.45	1,562	22.1
City bus (United Bus Company buses)	2,070	1,700	1,043.00	1,773	25.1
Service bus	3,655	3,473	50.00	173	2.5
Motor cycles	200,318	170,271	2.04	346	5.0
Others	153,426	-	-	-	-
Total	1,229,791	1,150,683	-	7,055	100.00

* Includes City Trucks, Pick-ups, Delivery vans, inter-city buses, etc.

1. See the text of this Appendix for the process of estimation.

The estimation based on the procedures and assumptions put forward above shows that there are 7.06 million person trips daily in Tehran. The daily modal split, on the basis of the present estimation is 45.5% person trips by private cars (including government and diplomatic vehicles), 22% by Taxi, 25% by city bus, 2.5% by service bus and 5% by motor cycles (Table A1).

The actual number of person trips in Tehran can only be determined after a detailed survey. However, two highly contradictory estimates based on same statistical information done before are SOFRETU[11] and Kain[12] study. SOFRETU estimated a total of 11.5 million person trips daily in the city in 1360 while Kain estimated a total of 7.3 million person trips daily in the same year. Due to the time lag it is difficult to relate the result

Table : A2

Comparative efficiency of passengers' modes in Tehran
(Esfand, 1357)

Modes	Number of Vehicles (in operation)		Modal Share of person trips	
	Total	%	Total trips (000)	%
Private car*	806,258	68.27	3,201	45.5
Taxi	15,555	1.32	1,562	22.1
City bus	1,700	0.14	1,773	25.1
Service bus**	3,655	0.31	173	2.5
Motor cycle	200,318	17.00	346	5.0
Others***	153,426	-	-	-
Total	1,180,918	100.00	7,055	100.00

* Includes 749,312 private cars and 56,946 Government and Diplomatic cars in operation.

** School buses and bus transport provided by Government and private organisations to their employees.

*** City Trucks, Pick-ups, delivery vans and inter-city buses which are not traditional passenger carriers.

of the present estimation with those of the above two. The most recent study[9] that has estimated the daily person trips and modal split in Tehran was done in 1355. This study estimated a total of 5.97 million person trips daily with the modal share being 43% for bus, 12% for Taxi and 45% for private cars. The study did not explain the process of estimation. It just referred to the results of the SOFRETU and Kain study obtained the 1355 daily person trips through a rough procedure the confines of this report do not permit the criticism of the results of other studies to validate the estimation done here. More over, the accuracy of the daily person trips in Tehran will not have adverse effect on the benefit estimation of the Bus lane project. So, we conclude that the daily person trips estimated in this study is fairly accurate.

APPENDIX : B

DIVERSION OF CAR AND TAXI USERS TO BUS USE

The experiences in the experimental bus lane projects suggest that there is considerable diversion of private car users to bus use when the buses become more reliable. For example, it was observed on a 2.1 mile (3.4 km) stretch of bus lane along Fairview in Dublin[7] that the volume of private cars reduced by 32% while the passenger loadings in buses on Fairview increased by 13.1%. This indicates that of 32% motorists some diverted to other alternative roads while the others moved to bus use. The experiences of bus lane projects in other European cities(i) also suggest that considerable number of private car uses switch over to bus use.

The proposed bus lane project in Tehran will be remarkable in the world from the view point of its length. When all the four phases will be operational Tehran will have a total of 267 km bus lane while the whole of Europe has got only 100 km of bus lane in operation. So it is difficult to relate the diversion of private car users to bus use in European cities to the case of Tehran. However, a gallup roll, asking the car users and Taxi riders whether they woull move to bus use when the bus lane becomes operational, could ascertain the approximate percentage of the car users and Taxi riders switching over to bus use. But the resources of the study does not permit that. Nevertheless, for benefit estimation of the bus lane we have assumed 5 levels of di diversion for car and Taxi riders. We have also assumed that there will be no diversion from Government and diplomatic Missions' cars to bus use.

Since the level of diversion is dependent on how efficiently the system of bus works. So of the 5 levels of diversion let us assume that diversion level 2 will be attained. That is, 5% of the private car users and 15% of the Taxi riders will switch over to bus use (see Table B1).

If the proposed bus lane project operates efficiently, which is dependent on the United Bus Company and the enforcement authority, the level of diversion is expected to increase and it may exceed level 5 as considered in Table B1.

However, the estimation of benefit of the bus lane project has been based on diversion level 2.

(i) see p. 56-59, ref. no. 7

Table : B1

Assumed levels of diversion in terms of vehicles and person from private Auto-users and Taxi riders to bus use

	Diversion level : 1			Diversion level : 2			Diversion level : 3			Diversion level : 4			Diversion level : 5		
	Private car** 1%	Taxi 10%	Total	Private car 5%	Taxi 15%	Total	Private car 10%	Taxi 20%	Total	Private car 15%	Taxi 25%	Total	Private car 20%	Taxi 30%	Total
Vehicle	7,493	1,555	9,048	37,465	2,333	39,798	74,931	3,111	78,042	112,396	3,888	116,284	149,862	4,666	154,528
Person	29,972	156,249	186,221	149,862	234,374	384,236	299,724	312,499	612,223	449,587	390,624	840,211	599,449	468,749	1,068,198

** It has been considered that no diversion will take place from Government and Diplomatic cars and such the estimation of diversion is based on private cars only.

APPENDIX : C

FUEL CONSUMPTION BY DIFFERENT VEHICLES

This Appendix shows the fuel consumption by different types of vehicles in conditions with and without the proposed bus lane plan. The consumption of fuel varies according to the traffic speeds and the gradients of the roads. Since the effect of road gradients will remain the same in the conditions with and without the bus lane, so the effect of road gradients on fuel consumption is nil in this context. However, to estimate the fuel consumption savings due to the in production of bus lane we have to consider the fuel consumption changes in the city buses and the savings of fuel due to the diversion of the marginal motorists (5%) to bus use.

It is observed in other cities of the world that the fuel consumption is lowest when conditions cause an average speed of about 55 km per hour and is particularly in low traffic speed, being double the minimum at 16 km per hour[8]. The relationship of fuel consumption with traffic speed could better be explained with the help of the following equation:

$$C = a + \frac{b}{V}$$

Where:

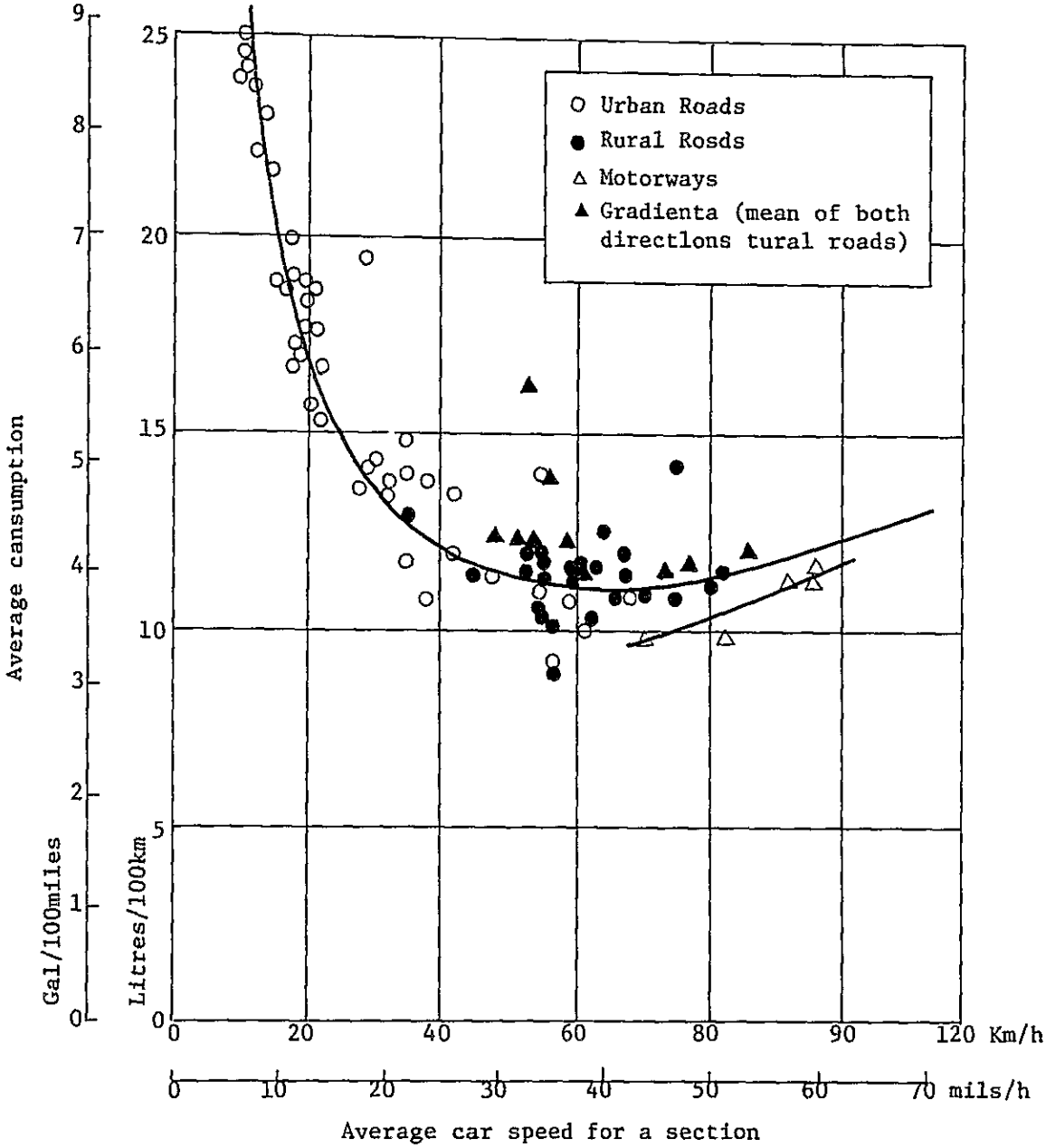
C = consumption of fuel in litres per 100 km of operation

V = average traffic speed in km per our

a and b = are the constants.

But the time resources of this study does no permit such detailed analysis. However, the variation of fue consumption with traffic speed is shown in figure C1.

Table C1 gives the average fuel consumption at different speeds per 100 km of operation by bus and cars in Central London while Tables C2 and C3 gives the fuel consumption figures by bus and cars in Tehran. It appears from a comparision of the Tables that the consumption of fuel by buses in Tehran (53.81 litres per 100 km) agrees with the mean of the fuel consumption by buses in Central London at speeds between 5 and 10 km per hour. From this we deduce that the average network speed of buses in Tehran is between 6 and 9 km per hour. This has been substantiated by the result of a brief smaple survey of bus speeds on Engelab (Shahreza) Ave. The survey, undertaken on two Saturdays



The Variation of fuel consumption of an average vehicle with the average car speed for a section

Fig. C1

Source: The effect of road and traffic conditions on fuel consumption, RRL Report LR226; Road Research Laboratory, England, 1968.

Table : C1

Observed fuel consumption by vehicle type in Central London at different speeds**

(Lires per 100 km)

Speed (km/h)	5	10	15	20	25	30	35	40	45	50	55	60	65	70
All cars (1)	25.54	16.67	13.35	11.56	10.40	9.89	8.57	8.14	7.13	7.73	8.39	9.23	10.13	11.25
Bus (empty) (2) increase when	34.44	29.58	25.45	22.54	20.65	19.27	19.07	19.66	20.88	-	-	-	-	-
Buses are fully (3) loaded	64.50	58.00	54.50	46.50	38.00	34.00	24.00	17.50	-	-	-	-	-	-
Full loaded buses*	56.65	46.74	39.37	33.02	28.50	25.82	23.65	23.10	-	-	-	-	-	-

** Source: Calculated from the figures in Tables 7 and 13 of Ref. no. 8

Notes:

1. The average of the fuel consumption by Viva Vaxahall and Forg Zephyr has been taken as the average fuel consumption by all cars (see Table 7 of ref. no. 8)
2. In ref. no. 8, to estimate the fuel consumption by bus when empty has been considered equal to a 12 ton empty truck.
3. A 3/4 loaded 12 ton truck has been considered equal to a fully loaded bus (see p. 12 of ref. no. 8). To estimate the % increase fuel consumption in a fully loaded bus the percentage increase in fuel consumption for full loaded truck has been to the fuel consumption in empty bus (truck).

Table : C2

Average fuel and oil consumption by City Bus in Tehran

(Esfand, 1357)

No. of buses in operation	Consumed items	Daily total consumption (in Litre)	Daily consumption per bus (in litre)#	Consumption per 100 km of operation	
				Litres	Cost in Rls.**
1,700	Fuel	140,000*	82.35	52.56	526
	Oil	3,333*	1.96.	1.25	75
Total	-	143,333	84.01	53.81	681

* Source: Stores Department, United Bus Company, Tehran (8th Farvardin, 1358).

** Cost in current (1357) prices.

On the basis of 156 km of operation per bus daily (see ref. 3).

Table : C3

Estimated average daily fuel consumption by Taxi and private car in Tehran

(Esfand, 1357)

Vehicle	Average daily km of operation	Daily average consumption of fuel		Average fuel consumption per 100 km of operation	
		Litres	Cost (in Rials)	Litres	Cost (in Rials)++
Private car	56.07*	7.9**	79	14.1	141
Taxi	175(1)	24.6(2)	246	14.1	141

* Extracted from Table 3.1 p. 67 of re. no. 7.

** Estimated from the figures of the fuel consumption cost of Table 4.1 of ref. no. 7.

(1) See Appendix A of this report.

(2) Estimated on the assumption that the average fuel consumption per km of of operation of Taxi is same as that of private car.

++ All costs are in current (1357) prices.

Table : C4

Bus journey time on Engelab (Shahreza) Ave. (between 24th Esfand and Shalnaz Square) on Saturdays (15th and 22nd Aurdibehesht, 1358)

Run no. (Ordinally)	Distance covered (km)	Bus journey time (Minutes)				Bus running speed (km/h)	Bus journey speed (km/h)	Average loading time per passenger (Seconds)	Average unloading time per passenger (Seconds)
		Stop time at			Total journey time				
		Running time	Bus stops	Intersections					
1	5.16	54	4.5	4.5	63	5.7	5.0	2.1	1.9
2		51	4.0	4.0	59	6.1	5.3	2.0	2.1
3		44.8	3.0	3.2	51	6.9	6.1	2.4	1.3
4		47.5	5.8	4.6	5.8	6.5	5.3	3.0	2.9
Average (Mean)		49.3	4.3	4.1	62	6.3	5.4	2.3	2.2
Standard deviation		3.5	1.0	0.55	8.8	0.43	0.41	0.40	0.41

(15th and 22nd Aurdibehesht, 1358), show that the average hourly bus speed on the road is 5.4 km per hour and bus speed on most of the inner city routes is observed to be this figure. But the bus speed on outer-city bus routes, due to the lower traffic volume, is higher than what observed on Shahreza Avenue. So 9 km per hour would be the representative network speed of buses in the city of Tehran. This means that the average feel consumption per 100 km of bus operation is 54 litres and the daily consumption per bus being 84 litres with 156 km of operation per bus daily.

To estimate the daily savings in fuel consumption by buses when they operate on the bus lane we need to know the average hourly speed of buses on the bus lane. But until the buses are operated on the proposed bus lane we cannot determine the hourly speed of buses on the bus lane. In such situation, for benefit estimation of the bus lane, it is assumed that the bus speed on Fridays, when there is almost no traffic impedence on bus movement, would be the representative bus speed on bus lane. Of course, the actual bus speed on the bus lane is expected to be higher than the present Friday bus speed. Based on a sample survey, carried out on two Fridays during Aurdibehesht, 1358, the average hourly bus speed is 15 km per hour (see Table C5) which, we assume, is the bus speed on the bus lane. This means that the average fuel consumption per 100 km of bus operation will be 39.37 (Table C1) litres and the daily consumption per bus being 61.4 liters. From the comparison of the present bus journey time (Table C4) and bus journey time on the bus lane (Table C5) it is clear that a bus, at an average, saves (62-18) 44 minutes per 5.16 km of travel. That is, 8.5 minutes can be saved by a bus per 1 km of travel on the bus lane consumption for car and Taxi. Since 5% of the marginal car users(i) will divert to bus use, so the savings in fuel consumption for private cars will be to the extent of the daily fuel consumption by the car users who will switch over to bus use.

(i) In diversion level : 2 of Table B1 in Appending it has been considered that 15% of the Taxi riders will switch over to bus use. This does not mean that 15% of the operating Taxi will go out of the street. They will operate but with less number of passengers. So in the estimation of fuel consumption saving Taxi has not been included. That is, the total number of Taxi in the city street will remain the same.

Table : C5

Bus journey time on Engelab (Shahreza) Avenue (between 24th Esfand and Shahnaz Square) on Fridays (14th and 21st Aurdibehesht, 1358)

Run no. (Ordinally)	Distance covered (km)	Bus journey time (Minutes)				Bus running speed (km/h)	Bus journey speed (km/h)	Average loading time per passenger (Seconds)	Average unloading time per passenger (Seconds)
		Running time	Stop time at		Total journey time				
			Bus stops	Intersec-tions					
1	5.16	12.4	2.2	2.6	17.2	25.8	17.8	1.5	1.3
2		13.5	2.7	2.9	19.1	23.4	16.1	1.7	1.2
3		14.0	2.1	2.6	18.7	22.4	16.6	1.4	1.1
4		15.1	2.3	2.1	19.5	20.6	15.6	1.3	1.4
5		11.2	2.0	2.8	16.0	27.2	19.0	1.9	1.2
6		12.0	2.3	4.2	18.5	25.5	16.6	1.3	1.6
7		12.4	2.0	2.6	17.0	24.6	18.4	1.5	1.3
8		13.3	2.5	3.2	19.0	23.5	16.1	2.1	1.4
Average (Mean)		13.3	2.1	2.9	18.0	24.1	15.2	1.5	1.3
Standard diviation		1.4	0.37	0.58	1.9	1.96	2.15	0.41	0.14

Table : C6

Bus speed and daily fuel consumption per bus
in conditions with and without the bus lane in Tehran

	Present	On the bus lane
Bus speed (km/h)	5.4	15.2*
Daily fuel consumption per bus (litres)	84.01	61.0**

* The observed bus speed on Friday (see Table C5) is considered as the expected bus speed on the bus lane.

** Calculated on the basis of 39.37 litres per 100 km of operation and 156 km daily operation per bus.

APPENDIX : D

THE SYSTEM COST OF THE BUS LANE

The total system cost of the bus lane plan includes the total implementation cost, enforcement cost and the cost arising due to the loss of the on-street parking spaces along the bus lane. The implementation cost consists of two elements, i.e., bus lane seggregation cost and cost of relocating bus stops on the djoubes covering part of the sidewalks. The bus lane implementation cost has been estimated first.

Bus lane implementation cost:

The two ingredients of the implementation cost is shown separately in Table D2. The seggregation could be done either by prefabricated cement slabs 1.5 meter length or by steel/iron poles of standard dimensions. It is difficult to assess which of these two will be better in the case of Tehran. However, we estimate the costs of both the alternatives and see which one is cost effective; of course we have to consider other factors such as flexibility, enforceability and applicability of the two alternatives in the case of Tehran.

(i) Seggregation cost based on prefabricated Cement slabs: If the seggregation is done by prefabricated cement slabs of 1.5 meter length, the average cost of which is 500 Rials, and put them 1.5 meter apart the total number of slabs required is 62,333 to seggregate the total length of 187 km[(i)] bus lane. The total estimated cost of these slabs is 31,166,500 Rials (see Table D2).

(ii) Seggregation cost based on steel/iron poles: With average distance of 1.5 meter between poles a total of 145,846 poles are required to seggregate 187 km of bus lane. The cost of a pole is 350 Rials at current prices. So the total seggregation cost arrives at 43,633,331 Rials.

From the comparison of the costs in (i) and (ii) it appears that the prefabricated cement slabs are cost effective. Moreover, considering the conditions in the city of Tehran seggregation by prefabricated slabs will be

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(i) It has been estimated from field study that 30% of the 267 km of bus lane has to be left open for access to shops garages and feeder roads. So the total length of the bus lane to be seggregated is 187 km.

more effective and efficient than the seggregation by steel/iron poles. So in the estimation of the implementation cost alternative (i) has been considered.

Relocation cost of the bus stops:

To ensure uninterrupted flow of bus on the bus lane all the bus stops along the bus lane are intended to be relocated on the djoubes covering a part of the sidewals. The toal are of each bus stop, at an average, is measured to be 90 square meter (see figure 2 in the text) of which 36 square meter is djoube to be covered by steel culvert and rest to be asphalted. However, the engineering costs that are involved in the relocation of bus stops are shown in Table B1. The other items of costs that are involved in bus stop relocation are (a) relocation of light posts and (b) cutting down trees from along the djoubes/sidewalks.

(a) Relocation cost of light post: The light posts in Tehran are located at 35 meters apart along the sidewalks or djoubes. It has been observed, during the field study, that at an average 0.5 light post per bus stop has to be relocated. It is gathered from the relevant sources of the Department of Tehran Electricity supply authority that the average relocation cost of a light post is approximately 2,000 Rials.

(b) Cost of cutting down trees: The streets of Tehran are adorned with trees alongside. It has been observed during the field study that, at an average, five trees have to be cut off from each bus stop. Considering the climatic condition and motor vehicle pollution (2,075 tons of pollutants are released into the atmosphere daily[i]) in Tehran it is difficult to estimate the social cost of taking a tree off the sidewalks or djoubes. However, the cost of cutting down a tree should consider the plantation cost, maintenance and watering cost since plantation the environmental cost of not having a tree, etc. For example, the trees provide shade for the pedestrians during the sunny weather of the summer, increase the scenic beauty of the city roads and they absorb the motor vehicle and other pollutants. It has been observed that a hectare of various leafy trees can absorb 30 to 50 tons of atmospheric dust annually and bushes planted at random reduce noise level by 2 to 5 db(A) phr 100 meter[6]. So only after a detailed study we can estimate the cost of cutting down a tree off the djoubes or sidewalks. Considering the situation in Tehran

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(i) see p. 89 of ref. no. 14

Table : D1

Estimated relocation cost of bus stops along the bus lane
(at current prices)#

Cost items	Units per bus stop	Unit cost (in Rials)	Total cost for a single bus stop (in Rials)	Total cost of all 762 bus stops* (in Rials)
Cutting down trees	5	500	2,500	1,905,000
Relocation of lightpost	0.5	2,000	1,000	762,000
Steel/iron culvert on the djoube	36^2 meter	6,780	244,080	185,988,960
Soil digging & removals	90^2 "	339	30,510	2,324,620
Base, etc., & asphalting	54^2 "	709	38,286	29,173,932
Kerb	38 meter	300	11,400	8,686,800
Total	-	-	327,776	228,841,312

At Esfand, 1357 prices.

* The distance between bus stops, at an average, is 350 meters. The total number of bus stops (762) has been claculated by dividing the total length of bus lane (267 km) by 350.

Table : D2

Estimated total implementation cost of the bus lane project
(at Esfand, 1357 prices)

Cost items	Unit cost (in Rials)	Total cost (in Rials)
Lane seggregation by prefabricated cement slab	500	31,166,500
Relocation of bus stop	327,776	228,341,312
Total		260,007,812

Table : D3

Estimated annual system operation cost of the Bus lane
(at Esfand, 1357 prices)

Maintenance cost	260,007
Enforcement cost*	360,000,000
Total	360,260,007

* Total annual salary of 1,000 traffic wardens to be recruited to ensure the efficient operation of the bus lane plan. Monthly salary of each traffic warden is 30,000 Rials.

it is advisable to avoid cutting the trees off the bus stops. Nevertheless, in the present situation it is assumed that the total social cost (plantation, maintenance and environmental cost) of cutting down a tree from the roadside is equal to the sale proceeds of the wood of the individual tree irrespective of length and diameter. The only cost considered here is the labour cost of cutting down a tree. It has been found from personal contacts with the knowledgeable sources that the average labour cost of cutting a tree is approximately 500 Rials at current prices.

The construction cost of a bus stop: The construction or relocation cost of each of the trapezoid shaped 90 square meter (the dimension is given in figure 2.1 of the text) bus stop includes the construction of 36 square meter heavy steel culvert on the djoube, digging and soil removals, construction of the base and asphalting the surface and construction of 38 meter of kerb separating the bus stops from the sidewalk. The estimated engineering cost of all these items are shown in Table D1. On the basis of the present estimation the total relocation cost of a bus stop is 327,776 Rials at current prices.

The next cost item involved to the proposed bus lane plan is the policing or enforcement cost. It has been decided that a total of 1,000 revolutionary traffic wardens will be appointed and necessary training will be imperted on them to enforcement the efficient operation of the bus lane plan. On the basis of the present salary scale of the ordinary traffic wardens of Tehran Police Department the average monthly salary of each of the new traffic wardens will be 30,000 Rials. So the total enforcement cost per year arrives at (30,000 x 1,000) = 360,000,000 Rials.

Another cost item that has to be considered in the estimation of the system cost of the bus lane is the loss of on-street parking spaces along the proposed bus lane. On the basis of 5 meter kerb per on street parking space a total of 37,400 on-street spaces[(i)] will be lost to the bus lane network. But it is estimated in Appendix B that a total of 37,465 cars will go off the roads because their riders will switch over to bus use. That is, there will 37,465 fewer parking sapces be required in the city when the bus lane becomes operational. So the loss of parking spaces will be compensated by the gains in

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(i) Out of the total network of 297 km of bus lane 309 or 80 km remains open for acces ways to roadside shops, garages, feeder roads, etc. so only 167 km could be used for on-street parking (i.e., 67,000/5 = 37,400)

parking spaces.

Since the present study will calculate the first year Rate of Return on the proposed bus lane so, we need to estimate the total annual system operation cost of the plan. The total annual system operation cost of the bus lane plan comprises of the annual enforcement cost, estimated above, and annual bus lane maintenance cost. Information on annual road maintenance cost in Tehran was not possible to make available. In such situation we have to use the standards in European countries. The average road maintenance cost in England is 1% of the construction cost[15]. We also consider here that the average annual maintenance cost of the bus lane will be 1% of the annual implementation cost. It has been confirmed from the Road Works Department of Tehran Municipality that the effective life of a newly constructed road is 10 years. We also assume that the effective life of the bus lane (the seggregating slabs, etc.) is also 10 years. So dividing the total implementation cost (260,007,812 in Table D2) by 10 the total annual implementation cost is estimated at 260,007 Rials on the assumption that the total implementation cost will be evenly distributed over the 10 years effective life of the bus lane. Based on 1% of the annual implementation cost the total annual maintenance cost of the bus lane plan arrives at 260,007 Rials.

The total annual system maintenance cost is thus estimated at 360,260,007 Rials (see Table D3).

APPENDIX : E

ENVIRONMENTAL POLLUTION BY TRAFFIC IN TEHRAN

The traffic noise and exhausts from motor vehicles are the principal nuisances of the urban life. The consumption of petrol and diesel in motor vehicles releases pollutants like carbon monoxide, Hydro carbons, Nitrogen dioxide, Sulphur dioxide, lead, etc. It has been observed in a study[17] that every 1,000 litres of petrol burned produces 392 kilograms of pollutants while every 1,000 litres of diesel burned produces 177.8 kilograms of pollutants/ exhausts (see Table E1).

According to a study done in 1976 the traffic of Tehran produced 2,075 tons of pollutants everyday[14]. Estimation based on the figures in Table E1 shows that the motor vehicles in Tehran, at present produces, 3,460 tons of pollutants daily. But according to a recent study[16] done in the Iranian Department of the Environment shows that the traffic of Tehran, at present, produces 3,793.62 tons of different pollutants everyday.

Table : E1

Average emissions from petrol and diesel engines in kilograms per 1,000 litres of fuel burned*

Components of exhaust gas	Petrol engine	Diesel engine
Carbon monoxide	274.0	7.1
Hydrocarbons	24.0	16.4
Nitrogen dioxide	13.5	26.4
Sulphur dioxide	1.5	4.8
Organic acids	0.5	3.7
Aldehyde	0.5	1.2
Solid particles	1.4	13.2
Lead (mg m^{-3} exhaust gas)	5^{-30}	-
3,4 benzpyrene (mg m^{-3})	72.0	107.0

* Extracted from Table 1.7 of ref. no. 17

The traffic exhausts buses health hazards. Research shows that deseases like cancer, heart ailments, bronchitis etc., has relationship with the traffic exhausts[6]. Considering the hazards of traffic pollution in Tehran it is desirable here to undertake a cost analysis of the pollution by Traffic. But relevant data on the effect of air pollution is not available and as such only the air pollution reduction expected to be attained from the increased bus speed on the bus lane and diversion of private car (37,465 cars) users to bus use is shown here.

Due to the increased speed on bus lane each of the 357 buses(i) will consume (84 - 61) = 23 litres fewer fuel daily (see Appendix C). Based on this figure 8,211 fewer litres of fuel will be consumed by the United bus Company buses. The city buses consume diesel. Since the average production of pollutants per 1,000 litres of diesel is 177.8 kilograms (Table E1), a total of 14,514 (or 14.5 tons) fewer kilograms of pollutants will be produced by the city buses in Tehran.

Appendix B shows 37,465 cars will go off the city roads as their users, being marginal car users, are expected to move to bus use. So (37,465 x 7.9 litres) 295,973 fewer litres of petrol will be consumed daily. Since the production of pollutants per 1,000 litres of petrolium burned is 387 kilograms (see Table E1), there will be 14,660 kg (or 14.7 tons) fewer kilogram of pollutants in the city everyday. Thus the total reduction in pollutants, as the bus lane becomes operational, is (14,514 + 14,660 = 29,274 kg) 29.2 tons per day, i.e., 10,658 tons per year.

APPENDIX : F

ESTIMATED BENEFIT OF THE BUS LANE AND FIRST YEAR RATE OF RETURN

The proposed bus lane (267 km) plan covers partially or wholly about 70 bus route of the total inner-city bus route network. Due to the time constraint the bit by bit benefit estimation, which needs detailed data collection on each smallest part of the bus lane, has not been possible. So we assume:

(i) that the 1,285 km inner-city bus routes (Table 2.1 in the text) are evenly distributed in all parts of the city and the number of buses in operation and passengers movements on each of the routes are also evenly distributed.

(ii) that the proposed bus lane routes (267 km) are evenly distributed all over the inner city area which means that the bus lane constitues 21% of the total inner-city bus routes.

(iii) that the number of buses in operation on the bus lanes are 21% of the total number of buses (1,700) in the network as a whole and the passenger movements are also 21% of the total daily passenger movements (1.67 million). This means, a total of 357 buses are in operation on the routes which fall within the proposed bus lane plan and this 357 buses carry 372,351 passengers, at the rate of 1,043 passengers daily per bus.

The benefit estimation, in this study, has been based on the above assumptions.

The principal benefits that are expected to be accrued from the bus lane plan fall within the following heads:

(i) Savings in time of the existing and generated (from private car users) bus passengers.

(ii) Savings bus time

(iii) Savings in fuel consumption

(iv) Savings in environemtnal pollution cost and

(v) Savings in accident cost.

Savings in bus passengers' time:

It has been stated in Appendix C that, at an average, daily operation per bus in Tehran is 156 km and each bus carries 1,043 passengers per day (Table A1,

Appendix A). It has been observed in a study(i) that the average trip length per bus passenger is 5.79 km.

Based on the bus speeds in the conditions with and without the bus lane (Table C6, Appendix C) every passenger, travelling by buses on the bus lane, saves 8.5 minutes per km of travel or 49.5 minutes daily. So the total savings in journey time for the existing 372,351 bus passengers is 307,189 hours daily. On the basis of 137 Rials hourly income of the people of Tehran[9,18] a total of 4,208,496 Rials is saved in the form of bus passengers' time daily in Tehran. Due to the lack of sufficient information the savings in time for the generated passengers (those who are expected to move from car and Taxi use to bus use) has been omitted here.

Savings in bus time:

Based on, average daily operation, each bus saves 8.5 minutes per km of operation and 22.88 bus hours daily. Considering 16 hours as the average daily operating time for a bus, one bus now can produce a total passengers trips of 2.3 buses daily when operated on the bus lane. So the 357 buses which are being operated on the 'yet to be operational' bus lane routes could produce a total passengers trips equivalent to 821 buses when the bus lane becomes operational. So the total daily/annual savings in bus journey time is equivalent to 821 buses when the bus lane becomes operational. So the total daily/annual savings in bus journey time is equivalent to the annual capital cost of (821 - 357) = 464 buses. Based on the available information the average annual capital cost of a bus is 706,500 Rials. To estimate the total annual savings we have to consider the annual opportunity cost of 706,500 Rials. Considering the present lending rate(ii) the opportunity cost of this sum is 70,650 Rials which we take as the annual capital cost of a bus. So the total savings in bus journey time is (464 x 70,650) = 32,781,600 Rials per year or 89,812 Rials per day. Another interpretation of the savings in bus journey time is that with the existing fleet size (357 buses) the frequency of buses on each of the bus routes could be increased by 2.3 times when the bus lane becomes operational.

Savings in fuel consumption::

The aregare daily and annual savings in fuel consumption is given in Table F1. It has been observed in Appendix C that the average hourly speed of

(i) see Hassan A. Ronaghy; op. ci.

(ii) present lending rate is 10%.

buses will increase from the present 5.4 km/h when they are operated on the bus lane. Due to the increase in speed of buses the average daily fuel consumption per bus will drop from the present 84 litres to 61 litres per day. (Table C6, Appendix C). Based on these figures every bus, when they are operated on the bus lane, will save 23 litre of fuel daily. So the total fuel consumption savings for the 357 buses becomes 8.21 litres daily or 2,997,015 litres annually. At the rate of 2.10 Rials per litres the daily and annual value of the fuel consumption savings arrive at Rials and Rials respectively.

Table : F1

Estimated fuel consumption savings

	Daily savings in		Annual savings in	
	Litres	Rials	Litres	Rials
Bus* (Diesel)	8,211	17,243	2,997,015	6,293,732
Car**	2,959,730	29,597,300	1,079,291,450	10,792,914,500
Total	2,967,941	29,614,543	1,072,288,465	10,799,208,232

* Buses which will be operated on the bus lane.

** Cars which will go off the road as bus lane becomes operational.

Since 37,465 cars (5% of the total number of cars) are considered to go off the city roads on the assumption that the users of these cars will move to bus use (see Appendix B) when the bus lane becomes operational. So, based on 7.9 litre daily fuel consumption per car (Table C3, Appendix C), a total of 2,959,730 fewer litres of fuel will be consumed in the city per day or 1,079,291,450 fewer litres per year. On the basis of 10 Rials per litres of fuel total dailyaand annual savings respectively becomes 29,597,300 and 10,792,914,500 Rials.

Savings in environmental pollution cost:

Motor vehicles produce noise and pollutes the air. The production of pollutants by motor vehicles is correlated with the consumption of fuel. Based on the estimation in Appendix E, there will be 10,658 fewer tons of pollutants released annually (or 29.2 fewer tons daily) by the traffic of

Tehran if the bus lane becomes operational. Due to the difficulties in obtaining the relevant information on the effects of a ton or a kilogram of pollutant on human health or on mortality rates the cost of the pollutants has not been quantified into monetary terms. Since the level of traffic noise in terms of db(A) will remain almost the same in the conditions with and without the bus lane so the estimation of the noise level reduction has not been shown in the report.

Accident cost savings:

The number of accidents in the city is related with the number of vehicles in operation. At an average, there are 16 fatal accidents annually per 10,000 vehicles in Tehran[19]. We have considered that at least 5% (or 37,465 cars) of the private car users (see Appendix B) will move to bus use. So there will be 37,465 fewer cars in the city roads. Based on the annual number of fatal accidents per 10,000 vehicles, there will be 592 fewer motor vehicle accident fatalities in Tehran when the bus lane becomes operational. The total monetary cost of a fatal accident as estimated in a recent study[19] is 2.7 million Rials. So a total of (592 x 2.7 million Rials) = 1,598 million Rials will be saved annually in the form of fatal traffic accident in Tehran when the bus lane project becomes operational.

Table : F2

Comprehensive bus lane plan for Tehran estimated annual benefit*
(Esfand, 1957 prices)

Items of benefit	Daily (in Rials)	Annual (in Rials)
Savings in existing bus passengers' time	4,208,496	1,566,101,040
Savings in bus journey time	89,812	30,781,600
Fuel consumption savings	29,514,543	10,790,208,232
Accident cost savings	4,378,082	1,590,000,000
Total	38,190,933	13,996,100,872

* Due to the increase in bus speed and diversion of 5% of the private car users to bus use there will be an annual reduction of 10,658 tons of pollutants in the city which has not been included in this Table (F2)

due to the problems of quantification of the pollutants into monetary terms the reduction in pollution has not been included in Table F2.

The estimated total benefit:

On the basis of the estimation in this study the total annual expected benefit out of the bus lane plan, when effectively operated, is Rials 38,190,933 Rials (Table F2). Based on the total cost of the bus lane plan and the estimated benefit, net of annual maintenance and enforcement cost, the first year Rate of Return is calculated in the following page.

The first year rate of return:

The first year Rate of Return on the proposed bus lane plan is estimated with the help of the following formula:

$$F_yRR = \frac{B_1 - C_{me}}{K} \times 100$$

Where

R_yRR = Estimated first year rate of return on the bus lane plan

B_1 = Estimated first year's benefit on the bus lane (Table F2 Appendix F)

C_{me} = Estimated annual maintenance and enforcement cost of the bus lane (Table D3, Appendix D)

K = Total implementation cost of the bus lane plan (Table D2, Appendix D)

So the $F_yRR = \frac{13,996,100,872 - 360,260,007}{260,007,812} \times 100 = 5.244\%$

APPENDIX : G

Map showing the bus lane plan
by phases.

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No.3 Justificative Note
- Regarding the Track-Laying Mode
- Regarding the Design of the Current Rail RATP SOFRETU

No.4 Justificative Note Regarding the Carriages Main Dimensions
RATP SOFRETU

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No.19 Net Work Planning of the Roads

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