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GUIDELINES FOR THE DESIGN OF COMBI TAXI FACILITIES

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SINOPSIS (AFR)

Die doel van hierdie dokument is om riglyne te verskaf vir beide die beplanning en ontwerp van kombi-taxi fasiliteite bestaande uit terminusse, staanplekke, haltes en oorstaangeriewe. Die riglyne bespreek in detail die basiese tegniese probleme en aspekte wat verband hou met die voorsiening van kombi-taxi fasiliteite. Die sluit in beperkings op die ligging van fasiliteite, die behoefte aan 'n spesifieke tipe fasiliteit, die kapasiteit en grootte van elke element, geometriese faktore en doeltreffende uitlegte, interaksie met ander modusse van vervoer en bykomende infrastruktuur.

SYNOPSIS (ENG)

The purpose of this document is to provide guidance on both the planning and design of combi taxi facilities consisting of terminals, ranks, stops and holding areas. The guidelines cover in detail the basic technical problems and issues related to the provision of combi taxi facilities. These are the locational constraints, the need for a specific type of facility, the capacity and size of its elements, geometric parameters and effective layouts, interface with other modes of transport and ancillary infrastructure.

SLEUTELWOORDE / KEY WORDS: COMBI TAXI, PLANNING, DESIGN, TERMINAL, STOP, RANK.

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The SARB approved the document entitled "Guidelines for the design of Combi Taxi Facilities" and authorised its distribution to the various Provincial Administrations, Core Cities, Research Organisations and Universities currently receiving grants from the UTF.

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SUMMARY

Intermediate public transport, paratransit, unconventional forms of public transport, the unincorporated sector of public transport, personalised public transport, these and other synonymous terms have been widely used to describe part of the road public transport sector which does not conform to the more familiar taxis and buses of the western world. Combi Taxis form part of this intermediate public transport.

The first paratransit regulations are dated back in 1635 when King Charles I restricted the number of horse-drawn carriages for hire in London, England. Nearly 200 years later the London Hackney Carriage Act of 1831 became the first comprehensive paratransit regulation to be developed.

In South Africa the paratransit taxi industry started in 1930. The progress was very slow. In the 1960's the industry was using the Chevs. In the 1970's the Valiants arrived and most taxis were Valiants. Since 1977 the sedan vehicle has been replaced by the combi taxi, which is now licensed to carry up to 15 passengers.

The important role of the combi taxi as an urban public transport mode in South Africa has been recognised and discussed extensively in a number of publications. It is accepted that in future combi taxi operations will expand, mainly because of increasing urbanisation, high population growth rates and deregulation.

This will result in additional needs for improved combi taxi facilities at terminal points. No comprehensive guidelines were found concerning the planning and design of taxi terminals, ranks and stops. This area has been neglected by researchers although it represents an area where specific guidelines can result in considerable benefits for all parties involved.

The present set of guidelines was developed following the appointment of the firm Van Niekerk, Kleyn & Edwards by the Department of Transport as a RDAC project for the National Transport Commission and consists of two separate phases.

The present report deals with the aspects of location, type, capacity and size of facilities, geometric layout, ancillary infrastructure and interaction with other modes of transport. Phase II of the study will address issues relevant to the planning and design of facilities such as management and control of facilities.

Chapter 2 highlights a planning procedure for the design of combi taxi facilities. The proposed planning procedure consists of the following seven steps: (i) identification of needs, (ii) definition of goals and objectives, (iii) selection of type of facility, (iv) definition of locational constraints, (v) calculation of size of elements within a facility, (vi) design of a layout and (vii) provision of ancillary infrastructure.

Chapter 3 discusses the first step of the planning procedure, the identification of needs. A list of factors that could be used to identify needs of passengers, operators and the community is produced. Factors such as walking distance, security, comfort, convenience, passenger attraction, accessibility, environmental impact, traffic congestion, etc. should be considered to determine the needs of various groups.

Chapter 4 discusses the second step of the planning procedure, the definition of goals and objectives. Major goals are to achieve mobility and convenience by means of reasonable costs and with minimum side-effects. A wide variety of objectives could be formulated such as to promote the use of combi taxis, improve system capacity and mobility, reduce congestion and accidents, etc.

Chapter 5 describes different types of facilities. Four different types of facilities are identified, namely stops, ranks, terminals and holding areas. A combi taxi terminal is an off-street facility at the end of one or more routes, a rank is usually within the road reserve where combi taxis can hold or stop for passengers boarding or aligthing. A stop is usually within the road reserve but combi taxis are allowed to stop only and not hold. A holding area is the area where combi taxis hold and there is no passenger activity.

Each type of facility has a different function and the need for a specific type of facility depends on the combi taxi operations, passenger and traffic considerations, costs, location and the adjacent land use. A procedure to identify the appropriate type of facility depending on the above factor is recommended.

Chapter 6 deals with the location of combi taxi facilities and the adjacent land use activities. Site selection is influenced by passenger and traffic considerations as well as by the effect the facility and the adjacent land use have on each other. Combi taxi facilities should be located so as to minimise passenger walking distances and must have easy but not direct access from major roads. The potential impact of facilities on adjacent land uses depends on the concentration of vehicles, operators and passengers as well as the time they spend at these facilities. Certain types of land use may be incompatible with combi taxi facilities, whereas it may complement others depending on the size and function of a facility. Some broad groups of land uses are examined and their compatibility with combi taxi facilities is discussed.

Chapter 7 examines the dimensions of popular combi taxis. The dimensions of a typical 16-seater combi taxi are established, to be used in designing elements of combi taxi facility. Turning characteristics at crawl speed show that combi taxis have a smaller turning circle than the South African design vehicle. Typical dimensions for trailers, used in long-distance operations are also given.

Chapter 8 discusses the size of facilities. The total area required for a combi taxi facility is the sum of the sizes of each of the elements involved. The size of pedestrian and loading islands depends on passenger volumes. The design of pedestrian areas is based on the concept of level of service with main criterion space. A minimum width of 2,0m is recommended for pedestrian islands therefore allowing for pedestrians to pass each other. The loading islands are the areas where pedestrians form queues to board combi taxis. A minimum width of 1,0m is required to accommodate a single line passenger queue. The number of loading lanes depends on the number of routes and for taxis operating. At least one loading lane should be provided for every route or destination. Loading lanes generally serve the functions of loading, queueing and holding and should have a minimum width of 2,2m. The proposed design capacity of a single loading berth is 375 passengers per hour for pre-collected fares and 180 passengers per hour if fares are collected at the door. In metropolitan areas the total number of berths provided can be determined by the 1:3 ratio, one berth for every three combi taxis using the facility. In smaller urban areas the ratio 1:2, one berth for every two combi taxis operating should be used. For long-distance combi taxi operations a ratio of 1 berth for every six combi taxis is appropriate.

Chapter 9 deals with the geometric layout and design parameters of facilities. Two types of terminal layouts are examined namely the oval island and the parallel island layout. It is conducted that the parallel island layout is preferred to the oval layout, as being space efficient and more suited to the nature of combi taxi operations. A range of geometric design parameters is given consisting of minimum, desirable and maximum values where applicable. Geometric design parameters are given for loading lanes, loading islands, pedestrian islands, off-loading bays, holding areas, circulation and access lanes in terminals as well as for on-street ranks and stops. Dimensions for long-distance combi taxi facilities are also proposed.

Chapter 10 discusses the interaction of combi taxi facilities with facilities for other modes, particularly bus and train.

It is recommended that as far as facilities is concerned, all modes competing should be given equal opportunities. This can be achieved by either providing a separate facility for

each mode at locations of passenger demand or by planning multi-modal transfer facilities. The joint use of on-street stops by combi taxis and buses is also examined. Stops should consist of enough bays for both modes. Bays should be clearly defined for use by each mode and separated with a barrier or kerb.

Chapter 11 discusses the ancillary infrastructure required at facilities. Depending on the needs this could include toilets, seats, shelters, information signs, dustbins, water, lighting, a dispatch office, a rest area for drivers, commercial activities, etc. The informal sector is also present in all combi taxi facilities. Hawkers provide a service to passengers and are there to satisfy specific needs. It is recommended that hawkers should be allowed to trade at combi taxi facilities.

1. INTRODUCTION

1.1 Objectives

The objective of this report is to provide guidance on both the planning and the design of combi taxi facilities consisting of terminals, ranks, stops and holding areas.

The planning and design of combi taxi facilities have become areas of increasing concern because of the important function and increasing numbers of combi taxis in South African cities. Well-designed facilities are important means of improving the efficiency of taxi operations and minimising the possible negative effects that may be caused by high vehicle and passenger turnover.

There are existing guidelines for the planning and design of bus facilities. However, distinct differences exist between bus and combi taxi operations. Firstly, the size of the vehicle used and consequently the number of passengers carried per vehicle are totally different. Secondly, combi taxis as opposed to buses, do not have fixed schedules and operate on internal rules as far as loading priorities and departures are concerned. The above differences considered jointly, indicate a need for a separate set of guidelines for the design of combi taxi facilities.

The guidelines cover in detail the following aspects:

* identification of type of facility required
* locational criteria for facilities
* capacity and size of different elements of a facility
* identification of effective layouts and design parameters
* interface of combi taxi facilities with those for other modes of transport
* ancillary infrastructure

The above aspects cover the basic technical problems and issues related to the provision of combi taxi facilities. There are a number of other issues relevant to the planning and design of combi taxi facilities such as the management and control of facilities which will be addressed in the second phase of this study.

As an introduction to the following guidelines, it should be emphasised that the planning of combi taxi facilities should to the greatest extent possible be carried out in logical integration with other transportation planning activities.

The guidelines presented in this report should be seen as general suggestions for determining space and facility requirements for planning purposes. It is hoped that they will be used as a basis for the planning and design of combi taxi facilities by planners, designers and others involved in the field of public transport. They are intended to guide and not restrict the practitioner, nor enforce conformity of design.

Although thorough investigations were carried out before figures and dimensions were proposed in the document it is recognised that deviations can and/or should be applied under specific circumstances. The emphasis therefore falls on "guidelines" and proposed figures and dimensions should not be seen as prescribed but rather as preferred or desired.

1.2 Study methodology

The Department of Transport appointed a firm of consultants to develop a set of guidelines for the design of combi taxi facilities. Following initial discussions with representatives of the metropolitan areas of Bloemfontein, Cape Town, Durban, Johannesburg, the East Rand, Pretoria, Port Elizabeth and Pietermaritzburg through the Combi Taxi Working Group of the CUTA* Planning Sub-committee, the objectives of this study were set.

A literature review consisting of a study of various forms of para-transit operations overseas as well as local combi taxi studies and surveys was carried out. A total of 70 reference publications were consulted, relevant information was extracted and was included in the document *Combi taxi facilities: Literature Review , Van Niekerk, Kleyn & Edwards, August 1988.*

Site visits to a number of combi taxi facilities in South Africa were undertaken. In total 48 facilities around the country were observed and drivers and passengers were interviewed in order to establish their needs and perceived problems. Discussions were held with experienced representatives of all the Metropolitan Authorities in order to identify existing or planned facilities, differences in operating characteristics between different areas, problems and

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* Committee of Urban Transport Authorities

proposed solutions and to obtain experienced opinions and advice. The information collected during the site visits, interviews and discussions was documented in the report *Combi taxi facilities: Inventory, Report 2, Van Niekerk, Kleyn & Edwards, November 1988.* In addition meetings were held with representatives of the Southern Africa Bus and Taxi Association (SABTA) and various other interested parties.

Based on the above information specific problems were identified, alternative solutions were created, evaluated and finally this set of proposed guidelines was prepared. During all phases of this study regular discussions were held with officials of the Department of Transport and all the other groups involved and their views were incorporated in these guidelines.

2. PLANNING PROCEDURE

In this report the phrase "planning procedure" refers to the steps undertaken during the course of deciding the nature of combi taxi facilities to be provided in an area. Thus the planning procedure is broad enough to include identification of needs, goal setting, surveys and data collection, analysis of alternative options, evaluation and decision making.

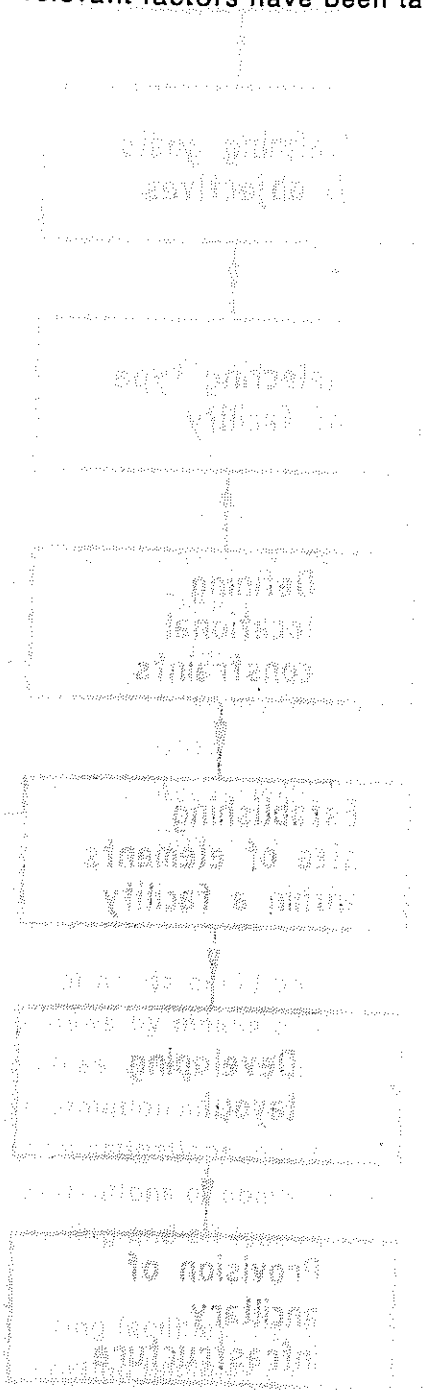
As an introduction to the following guidelines, it should be emphasised that the planning of combi taxi facilities should not be viewed as a process separate and distinct from other transportation planning activities. The provision of combi taxi facilities represents a response to identified needs. It would be short-sighted to approach the planning of combi taxi facilities with a perspective limited to combi taxis alone. The planning procedure should to the greatest extent possible be carried out in logical integration with other transportation planning activities.

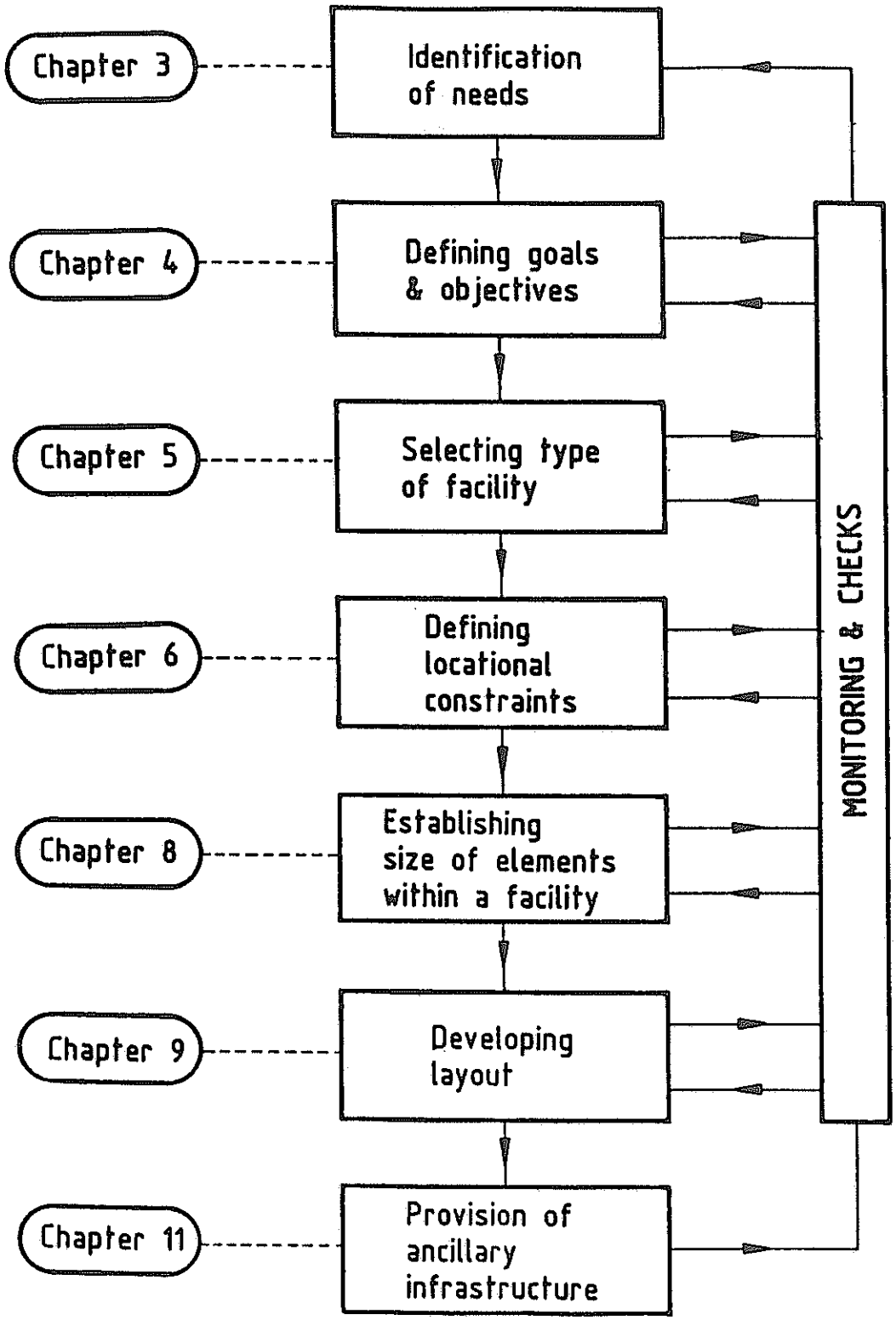
Planning procedures vary with community needs, existing resources and constraints. The one extreme is the simplest approach in which decisions are made with little or no analysis. This procedure can be characterised as "providing a combi taxi facility and waiting to see what happens". At the other end of the spectrum is the careful analytical approach using substantial amounts of empirical information and observed data for estimating the relationships between the various elements of a facility.

The flexible relatively informal nature of combi taxi operations and the changing conditions as far as the use of combi taxis is concerned, argues for a simpler, rather than a more complex, planning procedure. The proposed procedure is simple yet comprehensive and includes the following steps:

(i) identification of needs,
(ii) defining goals and objectives,
(iii) selecting type of facility,
(iv) defining locational constraints,
(v) establishing size of elements within a facility,
(vi) developing layout and
(vii) provision of ancillary infrastructure.

The seven-step procedure is shown in Figure 2.1 and the steps are discussed in detail in the relevant chapters. During the course of the planning procedure monitoring and checking of preceding steps as well as liaison with operators and passengers according to TSM procedures (9) are necessary to ensure that at any given time all relevant factors have been taken into account.





PLANNING PROCEDURE FLOW CHART

FIG. 2.1

3. IDENTIFICATION OF NEEDS

The first step in planning a combi taxi facility is to identify local needs. The principles of Transportation System Management (TSM) process (9) are applied and the major element in identifying needs is to evaluate the existing conditions. One approach is to look at the perceived problems and concerns of the different groups of the community: the passengers, operators and community at large. Table 3.1 lists some of the factors that could be used as a checklist in identifying the need for combi taxi facilities.

TABLE 3.1 : FACTORS TO IDENTIFY NEEDS OF

PASSENGER	OPERATOR	COMMUNITY
Availability of facility	Availability of facility	Environmental impact
Walking distance	Passenger attraction	Traffic congestion
Security	Capacity	Economic efficiency
Ancillary facilities	Safety	Social issues
Comfort	Ancillary facilities	
Convenience	Cost	
Other transport mode	Accessibility	
	Control of services	

The identification of needs could be obtained by site visits, personal conversations and interviews by means of a questionnaire or as a by-product from other sources such as previous surveys, transportation studies, or community meetings. The information may already be available or the planning team may have to carry out investigations. Additional steps in the identification of needs could include observations of combi taxi routes, their general travel patterns, and passenger loading and off-loading characteristics.

In the case of existing facilities, Table 3.1 could be used to ascertain the performance of the existing facilities by identifying their satisfactory and unsatisfactory aspects.

4. DEFINING GOALS AND OBJECTIVES

The second step in the planning process is to define goals and objectives. *Goals* are "statements of idealised end-states of the total environment towards which planners strive when they plan a system or some facet of it" (7). The four major goals in urban transport planning are to achieve mobility and convenience by means of reasonable costs and with minimum side-effects (11). *Objectives* are "statements about desired factual states" (7), (9) or "specific statements of goals, achievable without reference to resource or budget constraints, and for which the degree of attainment can be measured through the use of criteria" (15). The objectives should address the identified needs and will vary according to these needs. A wide variety of objectives could be formulated identifying the general expectations of a planned facility. Examples of combi taxi facility objectives are:

- promote the use of combi taxis
- improve system capacity
- improve operational efficiency
- reduce congestion
- minimise conflicts with vehicle movements in the area
- reduce littering
- provide adequate peak hour capacity
- use space efficiently
- reduce accidents
- provide safety and comfort
- promote retail business in a specific area
- provide adequate facilities
- minimise conflicts between pedestrians and vehicles
- improve mobility
- reduce passenger delays

Objectives should be clearly defined and as far as possible be measurable and realistic.

The following definitions for the different types of combi taxi facilities were obtained. These agree in principle with definitions of equivalent bus facilities (7) & (8).

Combi taxi stop: A place usually within the road reserve at which combi taxis are allowed to stop, but not hold, for passengers boarding or alighting.

Combi taxi rank: A place usually within the road reserve at which a combi taxi is allowed to wait and/or stop for passengers boarding or alighting.

Combi taxi terminal: A location, usually off-street at the common end of one or more routes where combi taxis can wait and passengers can transfer, alight or board efficiently.

Combi taxi holding area: An area, usually off-street, where combi taxis hold before proceeding to loading points and where generally there is no passenger activity. A holding area can either be included within or be separated from a terminal facility.

Combi taxi facilities consist of a number of elements, as shown in Figure 5.1, which are defined below:

Combi taxi bay: A stopping space off the travelled way reserved for a combi taxi.

Berth: (loading, off-loading, holding, queueing) An authorized bay at a public transport facility where vehicles stop for passengers boarding or alighting and where vehicles hold or queue before proceeding to load.

Pedestrian island: An area from which vehicles are excluded for the protection of pedestrians.

Loading island: A pedestrian island especially intended for the protection of passengers from other traffic while they wait for and board or alight from public transport vehicles.

5. TYPES OF FACILITIES

Four different types of combi taxi facilities were identified, namely stops, ranks, terminals and holding areas.

Since there is some confusion about the terminology used today, mainly because of the use of the term "taxi" in a different way from the conventional taxi service and the term "rank" describing all types of combi taxi facilities, it was thought necessary to define the terms used in this report. A large number of references (1) were consulted in order to constitute these definitions. It is thus hoped that misunderstanding that has arisen as a result of different meanings attached to the same term, will be eliminated and that these definitions will contribute to the consistent future usage of the terms.

5.1 Definitions

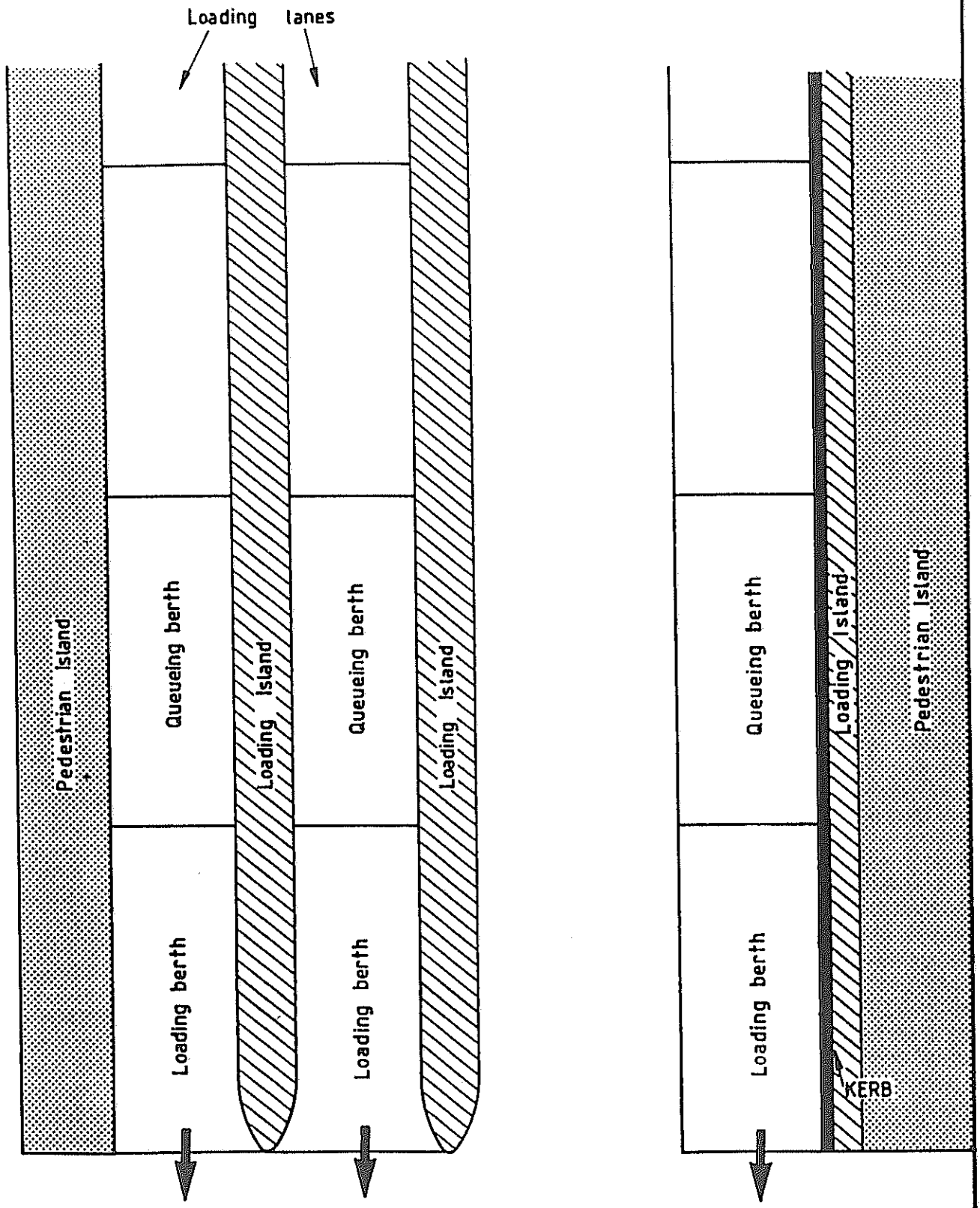
Combi taxi: A passenger vehicle used to provide a transportation service available to the public, distinct from conventional mass transit passenger vehicles, characterised by frequent but unscheduled operation of small vehicles designed to carry up to 15 seated passengers over generally fixed corridors with flexible routes with access by hail. (3),(4),(5),(6).

There are two clearly defined types of operations within the combi taxi industry in South Africa.

The first type of operation provides primarily a commuter transport service. Peak periods of demand are in the early morning and late afternoon, similar to those of conventional transit modes.

The second type of operation consists of the long-distance combi taxis providing an inter-urban passenger service. Long-distance combi taxis in general operate on routes longer than 30km and their peak is not clearly defined on weekdays. Their peak periods of demand are usually on Friday and Sunday evenings.

For the purpose of this report the term *combi taxi* will refer to the commuter type operation and will be distinguished from the term *long distance combi taxi*.



ELEMENTS OF COMPLEX FACILITIES FIG 5.1

5.2 Factors affecting type of facility

Each type of facility namely stop, rank, terminal and holding area has a different function which is appropriate in different circumstances.

The choice of the required type of facility depends on factors related to:

combi taxi operations
passenger considerations
traffic considerations
location and land use considerations
costs

5.2.1 Combi taxi operations

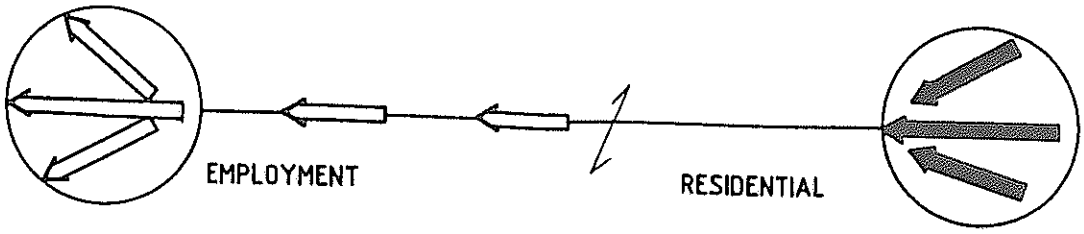
Combi taxis operate according to informal rules laid down by operators and their associations. They usually follow fixed routes and charge individual passenger fares. The fares, however, are not regulated by authorities. In addition combi taxis do not have fixed timetables, thus they enjoy total flexibility of schedule and fares. Due to their flexibility they can easily adapt to changes in passenger demand.

The passenger loading and off-loading characteristics of combi taxis differ substantially from the characteristics of the conventional modes of transit.

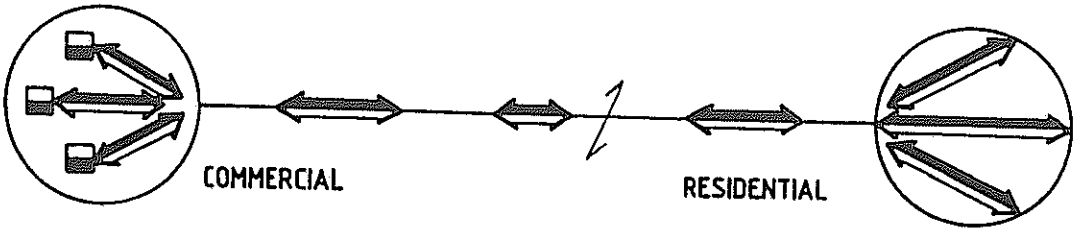
Examples of typical operations found in most South African cities are shown in Figure 5.2.

Figure 5.2(a) shows a typical operation of combi taxis during the morning peak hour, serving commuter trips from home to work. Passengers are picked up at a number of points in a residential area. There usually is a well defined piece of line-haul and passenger off-loading starts only when approaching the work areas. Within a major employment centre, passengers are distributed at a large number of points, usually at request and not always strictly defined. In this case a concentrated number of combi taxi trips are required from the home and work ends to ensure the efficient operation of combi taxis.

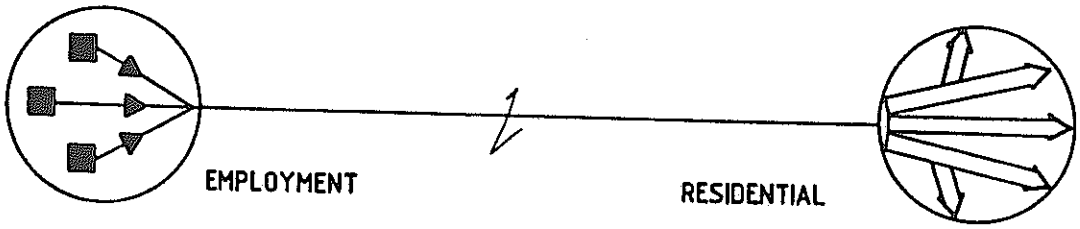
a) Morning Peak



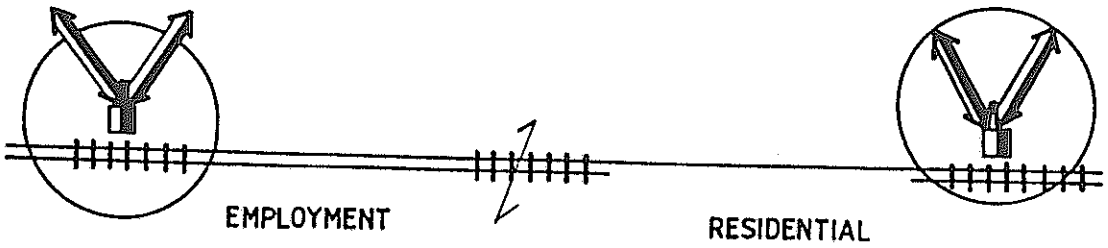
b) Off-Peak



c) Afternoon Peak



d) Terminal at railway station



LEGEND

- Passengers boarding on route
- Passengers alighting on route
- Boarding at terminal
- Alighting at terminal
- Railway station
- Route

EXAMPLES OF COMBI-TAXI OPERATIONS

FIG. 5.2

Figure 5.2(b) shows an example of an off-peak operation. Passenger movement is generally evenly distributed to both directions and volumes are relatively low. Passengers board and alight combi taxis at a large number of points located in both the residential and commercial areas. Passenger demand does not justify the continuous movement of taxis, therefore specific facilities are needed for combi taxis to wait, usually in the employment and shopping areas. In addition combi taxi stops are required in various places along the route.

Figure 5.2(c) shows the typical afternoon peak hour operation of combi taxis. There are one or more points in the work areas, where passenger demand is concentrated. Passengers usually walk to these points and board the combi taxis. Facilities capable of handling large numbers of passengers and vehicles are required. Passengers are distributed at various points in the residential area.

Figure 5.2(d) reveals a case where major facilities are needed at both ends of the route. This usually is the case when there are transfer trips with another mode of transport such as rail or bus in the residential areas. These facilities serve the feeder services provided by combi taxis.

The type of facility required as far as the combi taxi operations are concerned depends on the number of routes served, the need for taxis to wait at a facility and the location of the facility in relation to the route.

In general, stops are located along combi taxi routes and can serve more than one destination. Ranks are usually located at an end point of a route and ideally they should serve one route or one travel-corridor. Terminals could be used at an end-point when there is a need to accommodate a number of different routes. Holding areas are required when there is need for taxis to park and wait without passenger activities.

When identifying the need for a specific type of facility, special consideration should be given to the number of operators that will be using the facility and to differences amongst operators as well as passengers. The importance of these differences depends on the local conditions prevailing in the area of the planned facilities. There are examples of facilities operating efficiently and being used by a number of different operators. On the other hand there were other examples where co-operation and agreement on the operation of facilities could not be reached. The planner should be aware of these aspects and plan accordingly.

Figure 5.3 illustrates some examples of combi taxi facilities and how they interact with the combi taxi operation.

Figure 5.3(a) shows the basic system consisting of a combi taxi rank serving one route and a number of stops along the route.

Figure 5.3(b) is an example of a centralised major terminal facility where endpoints of various routes are concentrated in one specific area. Stops are located along the various routes.

Figure 5.3(c) is a similar example of a centralised terminal, but with insufficient storage space. A separate holding area is provided where combi taxis park and wait. The terminal facility is fed by the holding area according to demand.

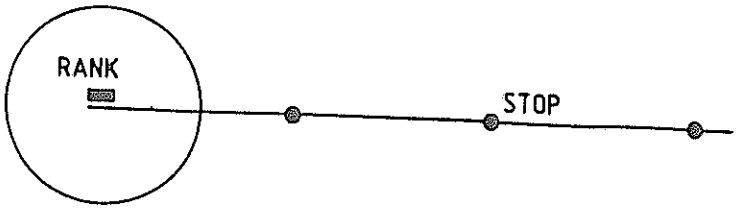
Figure 5.3(d) shows a holding area feeding various taxi routes according to demand. Each rank serves one route or one corridor and stops are located along the route. This system is usually found where insufficient or expensive land does not justify the provision of a major terminal.

Figure 5.3(e) is an example of a terminal located next to facilities of other transport modes like bus or rail. Combi taxis operate as feeders and stops are located along the routes.

5.2.2 Passenger considerations

Each type of facility fulfills a special need for the passengers. Passengers board, alight or transfer between various modes or between different vehicles of the same mode. A major consideration is that the type of facility required must provide for the convenience and safety of passengers. This can be achieved by minimizing their walking distance and the passenger-vehicle conflicts. Factors that should be considered when deciding on the type of facility required are the number of passengers expected to use the facility, the estimated passenger queue length and waiting times, the walking distance and the number of transfers.

a)



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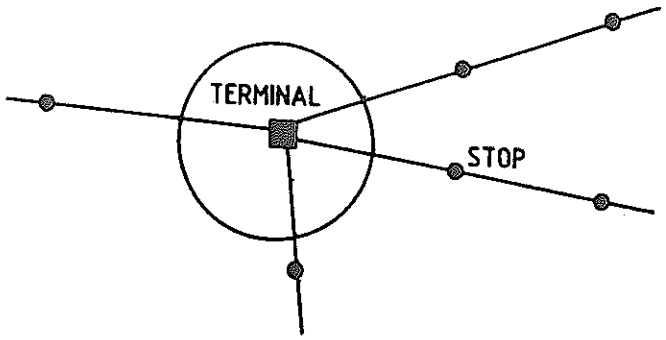

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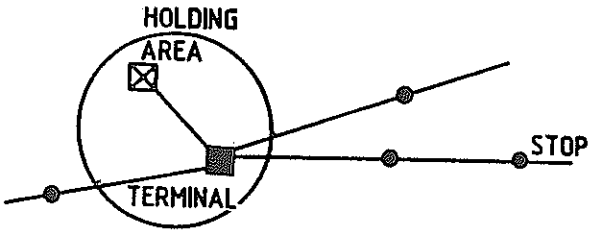
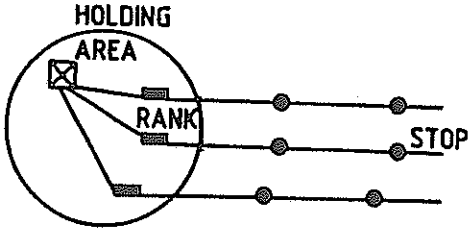


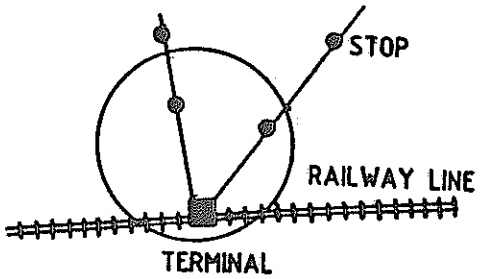
d)



LEGEND

- Stop on route
- Rank
- Terminal
- Holding area
- Route
- Rail

e)



EXAMPLE OF COMBI-TAXI FACILITIES

FIG. 5.3

5.2.3 Traffic considerations

The different types of combi taxi facilities, being stops, ranks, terminals and holding areas, attract different numbers of combi taxis to the area and influence to a greater or lesser degree the operation of the adjacent road system. A most important objective for the planner is to minimize conflict between combi taxi and other automobile traffic movements in the area of the facility. Four major factors should be examined when planning for a facility:

* the capacity of the road system
* the traffic volume
* the number of combi taxis
* traffic management measures

An on-street facility creates friction between combi taxis and other vehicles, but it really depends on the capacity and traffic volumes whether this friction is critical. In general on street facilities interfere with the smooth flow of traffic while off-street facilities with carefully designed access points, have a small effect on road congestion.

The hierarchy of the road system should also be considered. On-street facilities cause friction which is not desirable in high order roads. On the other hand traffic friction might not be important in secondary roads. An off-street facility with a well-designed access point to the road system will cause minimal disruption to the traffic flow. The spacing of intersections, the type of traffic control at intersections and one-way road systems are all factors that influence the type of combi taxi facility planned.

5.2.4 Location and land use

The planning of a combi taxi facility should take place in conjunction with the planning of the rest of an urban system. The type of facility planned depends to a large degree on the size of the urban area. Central major terminal facilities are usually provided in small urban areas. In these areas walking distances are short and off-street land is usually available in the central area or on the fringe. Small peripheral ranking facilities could be the solution to the large urban areas. These facilities can be located on-street at various points thus minimizing walking distances. In addition the traffic impact on the road system is kept low.

Availability of either off-street or kerbside space should be considered when determining the type of facility. Sometimes it is easier to allocate kerbside space than to find a vacant off-street piece of land. In that case on-street ranks could be provided instead of off-street facilities.

The different types of facilities have different impacts on land use. Different land uses are also differently affected by a particular type of facility. Cognizance should therefore be taken of the mutual influence of the facilities on the urban land use, which includes both formal and informal activities.

5.2.5 Cost

High land prices usually associated with central urban areas often discourage the development of off-street terminals. On-street facilities may not have direct costs involved, but they do have hidden costs such as impact on the traffic, inconvenience to passengers and lack of amenities.

Other costs that should be considered are construction costs as well as costs of operation and maintenance of the facility. The various types of facilities should be evaluated carefully considering all costs involved.

As a guide to a cost-benefit analysis, the following factors could be included in the evaluation of specific combi taxi facilities:

* cost of acquiring the land
* design and construction costs
* costs and benefits to operators
* passenger convenience
* costs of traffic impact
* impact on surrounding land use
* costs of operation and maintenance

5.3 Long-distance combi taxis

Long-distance combi taxis have distinctly different operating characteristics from commuter combi taxis. They have long holding periods and time has to be allowed for passenger and baggage loading and unloading.

In order to accommodate their differing service patterns, long-distance and commuter combi taxis should be kept separate. Ideally they should use different facilities located next to each other. In cases where this is not possible and facilities have to be shared, it is imperative that they use separate loading platforms clearly identified and suitably positioned to allow for the efficient use of the facility.

While ranks, terminals and holding areas are integral parts of long-distance combi taxi operations, the usefulness of stops for loading purposes in urban areas is doubtful. Usually long-distance combi taxis have a specific destination, load at a specific point and then proceed directly to the destination. If the need arises for passengers to alight at a variety of places within the urban area, then the commuter combi taxi stops could be used.

Operating characteristics, passengers, traffic, land use considerations and costs are important factors that need consideration when determining what type of facility to provide. The points raised when considering commuter type facilities apply here as well.

5.4 Procedure to determine type of facility

The type of facility needed depends on the relevant factors as discussed in Section 5.2. The following procedure is suggested to identify what type of facility is required.

(i) Establish combi taxi characteristics. Organise surveys or use existing data from relevant studies to determine the number of taxis that will operate from the planned facility, the number of routes and the relative location of the facility on the route pattern, the type of trip (commuter or long-distance) and identify the operators. Regular and frequent discussion with operators is essential.

(ii) Consider passenger requirements. Estimate the number of passengers expected to use the facility, the number of passengers boarding, alighting or transferring, their walking distance, waiting times and queue lengths.

(iii) Consider the impact of combi taxis expected to use the facility, on the other vehicular traffic by determining the respective traffic flows and the capacity of the road network.

(iv) Consider the size of the urban area to be served by the facility and the availability of land. Include in the considerations the hierarchy of the road system, the spacing of intersections, the circulation characteristics of the adjacent road system and land use to be affected by the facility.

(v) Calculate the costs involved for each type of facility. Consider the cost of land, construction costs, benefits and disadvantages for operators and passengers, the cost of impact on traffic and other surrounding land use as well as the costs of operation and maintenance.

6. LOCATION AND LAND USE CONSIDERATIONS

The combi taxi service is a good example of the manifestation of the supply and demand principle of the free market system. Although regulated to a certain extent, the supply of taxi services will attempt to meet the demand at the point of the least resistance. The location of a taxi facility should therefore resemble a good balance between sound planning principles and natural market forces.

Combi taxi facilities should be considered part of the urban environment and as such they have spatial implications. These facilities are location sensitive and the planning team should therefore exercise great care when selecting a location and consider all related aspects. Site selection would normally be influenced by passenger and traffic considerations as well as by the effect the facility and the adjacent land use have on each other.

The location and the type of facility should be considered in close relation to surrounding land uses, as the impact of different types of facilities on land use varies. The impact of a terminal on a particular land use may for example be much more severe than that of a taxi stop on the same land use. A central combi taxi terminal facility should be near the centre of activities and this is usually possible in small urban areas. Small satellite facilities which are often associated with large urban areas, could be positioned on the outskirts of the central area.

6.1 Passenger considerations

Combi taxi facilities should be located so as to minimise passenger walking distances. In the urban areas passenger destinations should therefore be identified before deciding on the location of facilities. This can be accomplished by means of passenger surveys on existing combi taxi services.

The location of the facilities in relation to passenger origins and destinations determines the distance and time of the walk trip. Ideally passengers would like a door-to-door service. In practice facilities should be within a 5 min walk (400 m to 500 m) of the highest employment concentrations in the area. When combi taxis serve shopping trips, facilities should be provided near the shopping areas so that walking distances of passengers carrying shopping bags

and parcels, are minimised. Long walk trips create passenger dissatisfaction and have an adverse effect on the safety and security of passengers. Long walking distances imply that large numbers of passengers have to cross main roads. In addition, sidewalks become congested, creating unpleasant and crowded conditions not only for combi taxi users but also for the public in general. Long walking distances also create opportunities for combi taxis to make informal stops at unsuitable places.

6.2 Traffic considerations

Easy, but not direct, access from major roads is essential for combi taxi facilities. The effect of a facility on the traffic in general depends on the capacity of the adjacent road network, the volume of other traffic using the road and the volume of combi taxis using the facility.

Before selecting the site, information concerning the existing road network and the hierarchy of roads and their traffic volumes should be obtained. The combi taxi routes through an area and the number of combi taxis per route can be superimposed on other vehicular traffic to evaluate the operating conditions of the road network and to determine the effect of the facility on the capacity of the road network.

On high-order roads there is no distinct difference between the effect of combi taxis and that of other vehicles on the speed or flow of traffic. This is due to less opportunities for stopping on such roads, caused by the limited roadside activities and the consequent lack of passengers. Locating a facility on high-order roads should be avoided as far as possible. However, if the need for a facility on such a road arises it should be located off-street and the access point should be designed so as to minimise conflict. Special consideration should be given to passengers crossing major roads and if necessary grade-separated facilities should be provided.

On low-order roads with high levels of roadside activity generating high levels of passenger demand, the low speed and frequent stopping of combi taxis affects other traffic. Facilities on these roads should be designed to reduce congestion.

In determining the proper location of on-street combi taxi facilities from a traffic point of view, it should be remembered that although passenger demand is concentrated near road intersections, facilities located at intersections are the cause of undesirable additional traffic conflicts. In general, on-street facilities have a lesser effect on other traffic if located in the middle of a street block. Combi taxis stopping at such a facility will not interfere with sight distances of either vehicles or pedestrians and waiting passengers will not use already crowded sections of the sidewalks.

6.3 Land use considerations

Spatial development in most urban areas is controlled by a variety of systems. The long-term planning policy is generally presented in the form of guide plans, structure plans, master plans, etc. The use of land is regulated by statutory town planning schemes via zoning, density and height restrictions, parking requirements, building lines, etc.

While long-term policy plans earmark land for particular future land use to ensure orderly development of the urban structure, town planning schemes guide the implementation of policy plans in order to promote health, safety, good order, amenity, convenience and the general welfare of an area. The designer of any combi taxi facility should therefore consider any long-term urban growth tendencies which could influence passenger demand as well as control measures which regulate the influence of land use.

The potential impact of facilities on adjacent land uses has always been a matter of concern. Initially it appeared that combi taxis provide a commuter type service. Although this is still a major element, the combi taxi service has recently expanded. In urban areas they now serve a broad range of land uses : shopping centres, offices, residential areas, industrial areas, schools, universities, hospitals, recreational and sport activities. The spatial requirements in urban areas and the effect on the urban environment consequently has increased.

The effect of taxi facilities on adjacent land uses depends on the concentration of vehicles, operators and passengers as well as the time they spend at these facilities. Major facilities attract large numbers of people and vehicles and therefore have a greater impact than minor facilities. Certain land uses generate more visits by combi taxi users than others and thus create the need

for a facility. Similarly, more combi taxi users at a facility generate specific land use activities. Furthermore, certain types of land use may be totally incompatible with combi taxi facilities, whereas it may complement others, depending on the size and function of a particular facility. The following discussion provides examples of the possible effects of combi taxi facilities on some broad groups of land uses.

6.3.1 Retail

Depending on the type and size of a facility the concentration of people has positive and negative effects on commercial activities in the vicinity of the facility. The purchasing power stimulates retail facilities offering consumer goods such as food, clothing, etc, as well as services like dry cleaners, hair dressers etc. Other types of retail may be adversly affected by crowding and possible littering, especially if they cater for luxury articles. Commercial activities located on the route of passengers moving between a facility and their final destination, are also similarly affected.

Providing a facility will thus affect a particular area either in creating opportunities for development or in changing its character. The type of business that will be attracted will depend on the needs of the combi taxi users. This might result in a change of the existing nature of activities in that those shops or services that do not meet the needs of the passengers might adapt or move. Other types of businesses, which depend on the passengers for their existence, will be established.

Possible reasons for locating businesses close to a taxi facility are:

- Due to waiting times at facilities, the need exists for refreshments, foods, etc.

- While waiting, certain personal services can be performed, eg. hair cut, shoes repaired etc.

- Low general mobility persuades some people to do bulk shopping (eg. groceries) near combi taxi facilities in order to shorten distances walked while carrying heavy parcels.

An indication of the type of shops located near major combi taxi facilities in order of frequency of occurrence is given in Table 6.1. This list is based on observations made during site visits and could be used as a guide to the needs of combi taxi passengers and the kind of development that can be expected in the vicinity of a combi taxi facility.

A complete list of all the shops observed near combi taxi facilities is given in Appendix A.

TABLE 6.1 : EXAMPLES OF COMMERCIAL ACTIVITIES IN THE VICINITY OF COMBI TAXI FACILITIES
Café - Tea room
Food - Take aways - Fast foods
Butchery
Supermarket
Furnishers
Clothing shop
Wholesaler
Restaurant
Bottle Store
Fruit and vegetable shop

A number of major shopping centres have allocated part of their parking facilities to combi taxis. In many cases this could be acceptable provided that an appropriate ratio of parking spaces to retail floor area, is maintained. A well designed facility and strict control will be required to ensure that the combi taxis remain within the area allocated to them.

6.3.2 Offices

Depending on the size, the development of combi taxi facilities near office buildings can pose particular problems due to noise and security. Noise from hooting and talking causes distraction and has an adverse effect on the productivity of office workers.

In addition people crowding at facilities create security problems at certain types of offices and security sensitive institutions.

The above-mentioned facts should be considered carefully and combi taxi facilities should preferably be located at least a block from the nearest security sensitive office areas.

At office-parks, should the demand for combi taxis exist provision should be made for facilities within the development.

6.3.3 Residential

In certain areas combi taxi facilities may lead to the expansion of economic activity but in residential areas they can cause socio-economic disruption and consequent depreciation of the value of surrounding residential property.

The provision of combi taxi facilities has been resisted in many residential areas because of the potential adverse effects on the environment. Combi taxi facilities often become an attraction point for informal business activities or a meeting place for people. Potential noise, littering and crime at combi taxi facilities have an impact on the life of residents. In addition combi taxis increase congestion in the narrow residential streets and affect existing activities.

It is therefore suggested that only small scale facilities (combi taxi stops) are considered in residential areas and only after thorough investigation of their potential impact on neighbourhood life. During this investigation opinions of residents must be obtained and weighed against the advantages or disadvantages of providing the facility.

If a facility is provided in a residential area it should be designed such as not to interfere with private entrances and should preferably be located on collectors or near open spaces and activity nodes.

6.3.4 Industrial

In industrial areas there often is space available for combi taxi facilities. The effects of potential noise, crowding and littering at a facility are less negative in these areas than in other areas.

Industrial parks and other industrial areas should provide for combi taxi facilities in a convenient location.

6.3.5 Educational

Noise and traffic safety aspects are two points of concern when locating a facility near a school, college or university. The functioning of an educational institute is adversely affected by noise. At primary schools and to a lesser extent at secondary schools, traffic safety is important due to the young age of the people concentrated in these areas. Although with careful design and location of the facility in relation to these institutions the negative effects could be minimised it is proposed that, where possible, facilities be located away from such institutions.

6.3.6 Other

Combi taxi facilities are to a certain extent compatible with a number of other land uses such as open spaces, sport venues, mining areas, other transport termini, etc. Provided that the potential impact of a facility on adjacent land use is acceptable, it can be located next to a number of different land uses.

6.4 Site availability

A number of other factors are important when considering the location of the facility. Availability of land and space as well as the size of the site are factors which should be considered in relation to the type of facility selected.

Total costs which include the actual land price and the cost of constructing the facility, should be considered. Soil stability, topography, earthworks required to prepare the surface of a site and the availability of services such as water, sewerage, electricity and drainage are all factors influencing the construction costs.

Furthermore the shape of the available site is important and has an effect on the layout of the facility and the utilisation of space. The zoning and ownership of a site also determines the availability thereof.

6.5 Procedure to determine location

The following procedure is suggested in order to determine the location of a facility:

(i) Assuming that the type of facility is decided upon, the first step is to identify alternative candidate sites. The purpose of this step is to select and describe areas that are logical candidates for new facilities. Selection is done by means of basic origin-destination studies, demand forecasts and by analysing all available long-term planning policy information, e.g. guide plans, structure plans, etc.

(ii) The second step is to rank the alternative sites in order to make a rational decision. The ranking procedure can be based on any of the well established decision making processes such as the Delphi procedure, the Analytical Hierarchy procedure, the Utility Analysis, etc.

While this ranking procedure determines the relative suitability of alternative sites, the top site need not necessarily be selected. Other factors that cannot be quantified may influence the decision. Discussions with the users of the facility, operators and passengers according to TSM procedures (9) will reveal any other factors influencing the site selection process and will ensure the co-operation of all interested parties.

7. DESIGN VEHICLE

The most commonly used combi taxi vehicles in South Africa are, in alphabetical order: the Ford Husky, Mitsubishi Starwagon, Nissan E20, Toyota Hiace and Volkswagen Microbus. Some of these vehicles are available in both a Short Wheelbase (SWB) and a Long Wheelbase (LWB) form with 10 or 16 seat configurations respectively. Their physical dimensions and number of seats are given in Table 7.1.

TABLE 7.1 : COMBI TAXI VEHICLE DIMENSIONS

DESCRIPTION	TOYOTA HI-ACE (SWB)	TOYOTA HI-ACE (LWB)	FORD HUSKY (SWB)	VW-MICRO BUS (SWB)	MITSU-BISHI STAR WAGON (SWB)	NISSAN E20 (LWB)
No of seats	10	16	10	10	10	16
Overall length (mm)	4 425	4 625	3 960	4 600	4 040	4 310
Overall width (mm)	1 720	1 720	1 690	1 845	1 690	1 690
Overall height (mm)	1 930	1 920	1 800	1 950	2 015	1 905
Wheelbase (mm)	2 295	2 495	2 200	2 460	2 200	2 350
Ground clearance (mm)	175	90	180	190	195	200
Front overhang (mm)	1 005	1 005	*	1 005	*	*
Rear overhang (mm)	1 125	1 125	*	940	*	*
Turning circle (diam):						
Kerb to kerb (m)	9,8	10,6	8,8	10,5	8,8	11,0
Wall to wall (m)	10,8	11,6	*	11,4	*	*

*Not available

Enquiries at vehicle manufacturers indicated that the general dimensions of combi taxis are not expected to change in future. Some changes might occur as far as seating configuration is concerned and the provision of an aisle in between seats is also considered. A bigger vehicle is possible, especially for long-distance service, but it will be based on a bus or midibus chassis and will use a diesel engine. It is therefore suggested that presently used combi taxi vehicles are considered for design purposes.

7.1 Dimensions

To find maximum dimensions the vehicles currently used as combi taxis were compared. These maximum dimensions are shown in Figure 7.1 and represent the typical combi taxi as being a combination of the longest, widest and highest vehicle with the largest turning circle. It must be noted that the maximum width does not include the size of side-view mirrors which can be up to 300 mm per mirror depending on the type used.

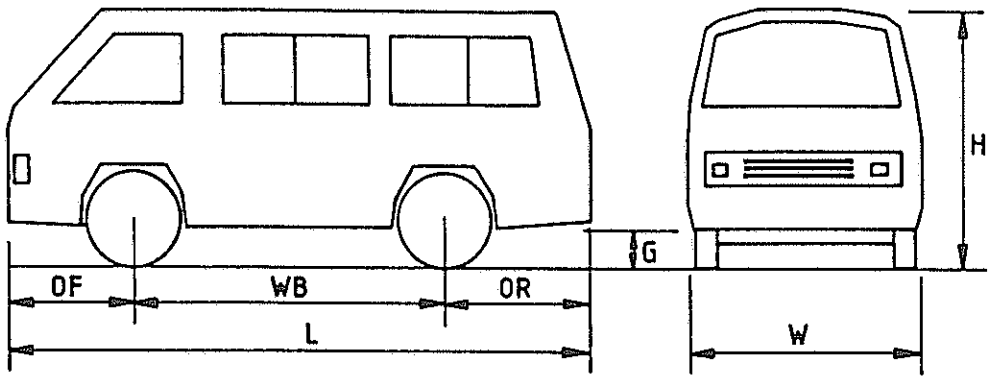
In some cases, the addition of roof racks and baggage on top of a combi taxi can increase the height of the vehicle significantly. This could have an effect on the design of certain types of facilities and special provision should be made.

7.2 Turning characteristics

Assuming that all turning manoeuvres within a combi taxi facility take place at crawl speed, the turning characteristics can be calculated on the principle that the vehicle turns about a point approximately in line with the rear axle.

In Figure 7.2 the dimensions and turning characteristics of the typical combi taxi are compared to the South African design vehicle as defined in the report *Parking Standards, Department of Transport, November 1985* (10).

The typical combi taxi is shorter than the design vehicle but slightly wider. However, one should note the differences in the front overhang and wheelbase dimensions. The length of the front overhang should be considered when vehicles are allowed to park with part of the overhang extending over the kerb.



L	Overall	length	4625	mm
W	Overall	width	1845	mm
H	Overall	height	2015	mm
WB	Wheel	base	2495	mm
OF	Front	overhang	1005	mm
OR	Rear	overhang	1125	mm
G	Ground	clearance	175	mm

TURNING CIRCLE: DIAMETER:

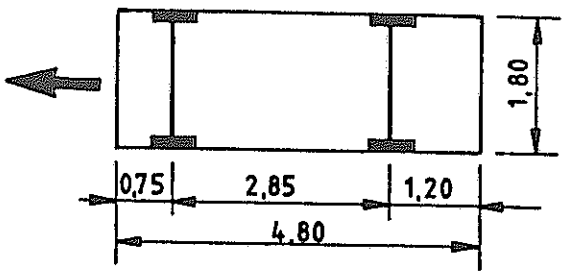
Kerb-to-kerb	11,0 m
Wall-to-wall	12,0 m

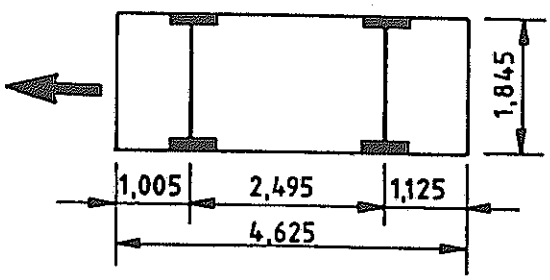
DESIGN DIMENSIONS FOR COMBI TAXIS FIG. 7.1

S.A. DESIGN VEHICLE *

TYPICAL COMBI TAXI

1. Dimensions





2. Turning dimensions

Kerb-to-kerb diameter 11,7m	Kerb-to-kerb diameter 11,0m
Wall-to-wall diameter 12,4m	Wall-to-wall diameter 12,0m

* Parking standards, DOT, PG3/85

COMPARISON BETWEEN THE S.A. DESIGN VEHICLE AND A COMBI TAXI FIG. 7.2

As far as the turning characteristics are concerned the 11,0 m kerb-to-kerb and 12,0m wall-to-wall turning circles of the typical combi taxi fall within the range of the South African design vehicle. Turning templates are provided in Appendix C.

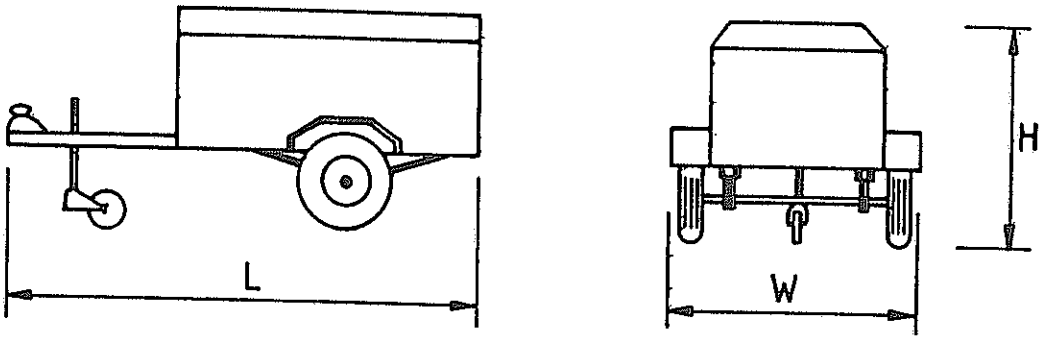
It is recommended that the South African design vehicle be used for design purposes of combi taxi facilities with allowance for a 255mm longer front overhang and consideration of the size of side-view mirrors.

7.3 Long-distance combi taxi trailers

Passengers travelling by long-distance taxis usually have more luggage than on commuter trips. Storage space in a combi taxi is very limited and in the 16 seater vehicles, nothing more than hand luggage can be stored inside the vehicle.

Although roof carriers are used to store some of the extra luggage, trailers are very popular and it is essential to include their usage in the design of long-distance taxi facilities.

The commercially available trailers vary in capacity and size. An average typical trailer is 3,0 m long and 1,6 m wide. The dimensions of a typical luggage trailer are shown in Figure 7.3.



L	Overall length	3000	mm
W	Overall width	1600	mm
H	Overall height	1020	mm

TYPICAL LUGGAGE TRAILER

FIG. 7.3

8. SIZE OF FACILITIES

Combi taxi facilities consist of different components depending on the type of facility. The principal elements of a facility are its pedestrian islands, loading, off-loading, holding and queueing berths and ancillary infrastructure. Whether a terminal, rank, stop or holding area, the total area required for a combi taxi facility is the sum of the sizes of each of the elements involved.

The size of a facility determines its capacity and therefore the service it provides to the users. The capacity of a combi taxi facility will be that of its weakest element, and exceeding the capacity will cause congestion, queues and general passenger dissatisfaction. The dimensions and values given are intended to complement design expertise and it is recognised that deviations can occur under specific circumstances.

In order to determine the required size the following elements, which are discussed in subsequent chapters, should be considered:

- passenger volumes
- loading area
- off-loading area
- holding area
- ancillary infrastructure

8.1 Passenger volumes

Passenger volume is the main factor that determines the size of facility elements such as the pedestrian and loading islands. Passenger volumes can be directly observed in case of existing services or can be obtained as estimates from transportation studies. These studies must address the modal split of personal trips to various modes of transport, including combi taxis.

If one looks only at the passenger-combi taxi interaction, the passenger needs are confined to pedestrian and loading islands. The pedestrian islands are areas where passengers can walk safely and are protected from traffic. The loading islands are the areas where pedestrians queue before boarding combi taxis.

The design of pedestrian areas should provide for peak passenger volumes, which usually occur during passenger boarding in the afternoon period. The concept of level of service is applied for pedestrian facilities in order to describe the degree of freedom to walk and select a walking speed, bypass slower pedestrians and avoid conflicts with others. The concept can also be applied to degrees of crowding in queueing areas and as an indicator of comfort, convenience and safety. Six levels of service are defined designated by letters from A to F, with A representing the best operating conditions and F the worst. While the information available in the document *Bus terminals and bus stations planning and design guidelines* (12) was considered, the present guidelines are based on the latest edition of the *Highway Capacity Manual* (13) and the *Guidelines for the Planning and Design of Pedestrian Facilities* (17). This provides more up to date criteria for the pedestrian level of service and gives higher space requirements which can compensate for the handling of parcels and other baggage often carried by combi taxi users.

8.1.1 Pedestrian Islands

The main criterion for pedestrian level of service is space. Supplementary criteria are average speed and flow rate per unit width. The concept of level of service is based on a capacity of 82 ped/min/m which is reached at level of service E. Table 8.1 shows the various criteria for pedestrian level of service (13).

TABLE 8.1 : LEVEL OF SERVICE ON PEDESTRIAN ISLANDS.

LEVEL OF SERVICE	SPACE (M^2/PED)	AVERAGE SPEED (M/MIN)	FLOW RATE (PED/MIN/M)
A	≥12	≥79	≤7
B	≥3.7	≥76	≤23
C	≥2.3	≥73	≤33
D	≥1.4	≥68	≤49
E	≥0.6	≥46	≤82
F	<0.6	<46	Variable

At level A walking speeds are freely selected and conflicts between pedestrians are unlikely. At level B walking speeds are still freely selected but pedestrians become aware of other pedestrians and respond to their presence in the selection of their path. At level of service C sufficient space is available to select normal walking speeds but minor conflicts will occur and speeds are somewhat lower. At level D freedom to select walking speeds and to bypass other pedestrians is restricted with considerable friction between pedestrians occurring. At level of service E capacity is reached and all pedestrians would have their normal speeds restricted, frequently adjusted with resulting stoppages and interruptions to flow. Finally, level of service F indicates congested conditions with frequent contact with other people and unstable flow.

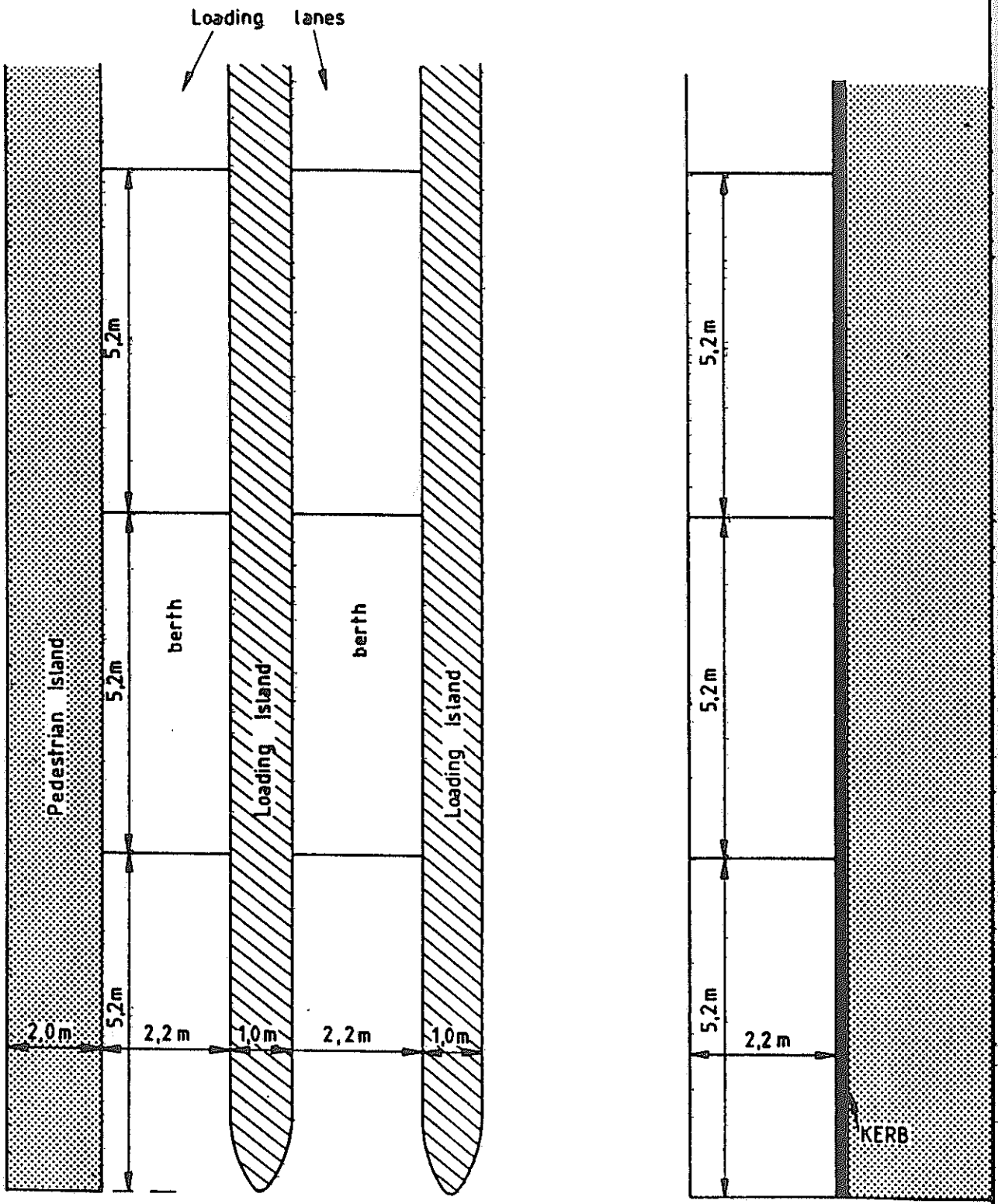
The appropriate level of service for design purposes will depend on the desired quality of service at a facility and on the pedestrian peaking characteristics. Usually a level of service C or D is an acceptable design standard but level of service E could also be acceptable for very short peaks. (i.e. less than 5 min).

The minimum pedestrian island width should be adequate to allow two pedestrians to conveniently pass each other. To avoid interference while passing each other, two pedestrians should each have at least 0,8m of walkway width (13) plus a buffer for the personal safety of the pedestrian. Therefore the recommended minimum pedestrian island width clear of any obstructions is 2,0m (Figure 8.1).

8.1.2 Loading islands

The loading islands are the areas where pedestrians queue while waiting to board combi taxis. The level of service of the queueing area is related to the average space available to each pedestrian and the degree of mobility allowed.

A minimum width of 0,7 m is required for body dimensions. The levels of service from A to F shown in Table 8.2 (13) are based on average pedestrian space and average space between each person (inter-person spacing).



Off-street facility
(Terminal)

On-street facility
(Rank)

MINIMUM LOADING AREA DIMENSIONS

FIG. 8.1

TABLE 8.2 : LEVEL OF SERVICE FOR QUEUEING AREAS

LEVEL OF SERVICE	AREA OCCUPANCY (M^2/PERSON)	INTER-PERSON SPACING (M)
A	>1,21	>1,2
B	0,93 - 1,21	1,1 - 1,2
C	0,65 - 0,93	0,9 - 1,1
D	0,28 - 0,65	0,6 - 0,9
E	0,19 - 0,28	<0,6
F	<0,19	Close contact

At level of service A passengers stand and circulate in the queueing area without disturbing others in the queue. At level B the circulation becomes partially restricted. At level of service C passengers standing and circulating in the queueing area disturb others, but the density is within the range of personal comfort. At level of service D standing without touching others is possible but circulation within the queue is severely restricted and waiting for long periods in this density is discomforting. At level of service E standing passengers have physical contact with others and queueing in this density can only be sustained for a short period without serious discomfort. At level of service F all persons within the queue are in direct physical contact with those surrounding them and the density is extremely discomforting.

For design purposes a level of service C or D providing an area of 0,28 m^2 to 0,93 m^2 per person seems adequate for short-term waiting purposes. However, a factor that should be considered is the shopping parcels often carried by combi taxi passengers. If the number of passengers carrying parcels is high,

additional space per passenger might be required to provide the same level of service. In this case a level of service C should be the minimum acceptable design standard. For practical purposes the recommended minimum loading island width is 1,0 m. This caters for the 0,7m required for body dimensions and also allows a clearance of 0,15m on each side (Figure 8.1).

8.2 Loading area

The loading area is the most important element of a combi taxi facility and the main factor determining the overall size of the facility. Depending on the type of facility, the loading area consists of one or more loading lanes. Each loading lane consists of a number of berths with different functions. Due to the priority departure system commonly used at combi taxi facilities the first and sometimes also the second berth in line, are used for loading purposes and the rest for queueing or holding purposes.

8.2.1 Loading lanes

The number of loading lanes provided depends mainly on the number of routes served by the facility, the number of combi taxis and the type of facility.

At combi taxi terminals it is imperative that at least one loading lane is provided for every route or destination. However, if the combi taxis operating on one route cannot be accommodated within the length of one loading lane then two or more loading lanes may be needed to serve this route. Loading lanes serving the same route should be located next to each other so that departure priority is easily controlled.

A loading lane should preferably be long enough to accommodate all combi taxis loading, queueing or holding for a specific route. A minimum length of 5,2m should be allowed per loading berth. However, observations showed that the average space occupied by each combi taxi, when stopping in a row, is 5,7 m. This is due to the fact that drivers leave bumper-to-bumper clearances of approximately 1 m and sometimes even more.

The minimum width of a loading lane is determined by the width of the vehicle. A minimum width of 2,2m is recommended in the case of off-street and on-street facilities as shown in Figure 8.1.

Loading lanes can accommodate independant arrivals/departures by having wider aisles. There could be circumstances (long-distance operation) that justify such a design, and the appropriate dimensions are discussed in more detail in 9.5

8.2.2 Berths

The number of berths supplied depends on the number of combi taxis expected to use the facility, the provision or absence of a separate holding area and the size of the urban area.

In the case of metropolitan areas where the berths perform the function of loading, queueing and holding, a minimum of one berth is required for every three combi taxis using the facility. The 1:3 ratio is based on the assumption that while one combi taxi is at the facility there are two taxis on the road, the one on an outbound and the other on an inbound trip.

In smaller urban areas where combi taxi routes are usually shorter, the minimum requirement is one berth for every two combi taxis operating. This assumes that for each combi taxi using a facility another one is travelling on the road at the same time.

In places where holding takes place in separate areas, the number of berths provided within the loading lanes must be adequate to ensure a continuous supply of combi taxis for boarding passengers. The further away the holding area is from the loading points the more berths should be provided in order to minimise passenger delays.

A factor that should be considered when deciding on the number of berths required is the capacity of a loading berth. The capacity of a loading berth can be expressed either as the maximum number of passengers that can be loaded into departing combi taxis or as the maximum number of combi taxis that can depart from the berth.

Provided that passenger demand exists, the number of passengers loaded into a combi taxi depends on the size of the combi taxi. At the moment the combi taxi fleet consists of a mixture of 10, 12, 14 and 16-seater vehicles. It is ex-

pected that the 16-seaters, with a carrying capacity of 15 passengers, will eventually dominate the market when the gradual replacement of the old smaller vehicles is completed. An occupancy of 15 passengers should therefore be accepted for design purposes. This does not apply in the case of long-distance combi taxis as passenger occupancies might differ due to the different operational characteristics and possibly different size of vehicles.

The capacity of a loading berth is reached when it is continuously occupied by combi taxis loading passengers and departing immediately. The capacity then depends on the passenger loading time per combi taxi.

Combi taxi loading times depend on the fare collection system, as well as the amount of parcels and shopping bags carried by passengers.

The shortest loading times occur when passengers do not carry any parcels and fares are collected by a marshal at the queue before the actual boarding time. When the combi taxi takes its place in the loading berth the marshal hands the fare to the driver and directs the passengers to the combi taxi. A system of pre-paid tickets will similarly result in short loading times. Another system of fare collection resulting in short loading times is by means of a "collector" who travels in the taxi and receives the fares in transit.

The longest loading times occur when passengers are moving slowly due to parcels and other hand luggage and fares are collected by the driver while passengers are boarding.

Table 8.3 shows a range of combi taxi loading times as obtained from observations, various combi taxi studies and other sources (1).

TABLE 8.3 : LOADING TIMES

		COMBI TAXI TIME (MIN)	PASSENGER BOARDING TIME (SEC/PASS)
Pre-paid Fares	min	2	8
	max	3	12
Fares collected	min	4	16
while boarding	max	7	28

Assuming an occupancy of 15 passengers the capacity of a single loading berth can vary from 20 to 30 combi taxi departures per hour in the case of pre-paid tickets. When fares are collected by the driver while passengers board, loading berth capacities can vary from 9 to 15 combi taxis per hour.

As far as the number of passengers is concerned loading berth capacities can vary from 300 to 450 passengers per hour and from 135 to 225 passengers per hour respectively for the two different fare collection procedures. The capacity of a loading berth governs the capacity of a loading lane to such an extent that for all practical purposes they can be considered to be equal. Loading lane capacities can be higher than 450 passengers per hour in cases where there is simultaneous loading at two loading berths in a row. In these cases capacities of up to 600 passengers per hour can be reached. However, such high capacities require strictly disciplined queueing, fare collection systems, marshals to direct passengers and to control drivers. This is inconsistent with the informal nature of combi taxi operations.

The recommended range of combi taxi loading times for the two different fare collection procedures is illustrated in Figure 8.2. As a guideline for design purposes the capacity of loading berths can be summarised as:

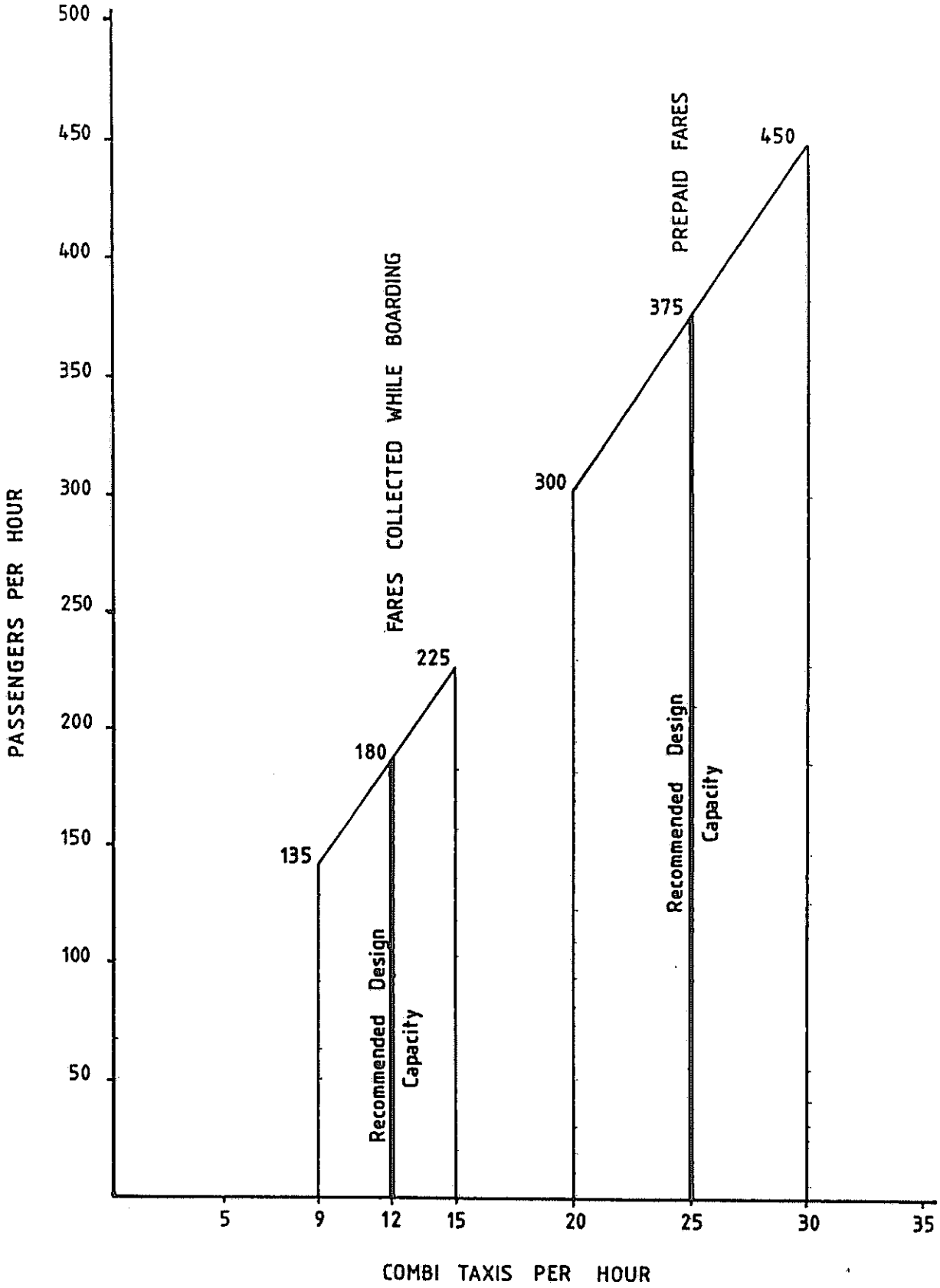
- Pre-paid fares: 25 combi taxis per hour giving 375 passengers per hour

- Fares collected while boarding: 12 combi taxis per hour giving 180 passengers per hour.

In the majority of cases the second guideline, representing the low level of sophistication and informal operation of combi taxis, should be applied. The situation might change in the future and if a system of pre-paid tickets is introduced, the first guideline will apply.

8.3 Off-loading area

The proper functioning of a combi taxi facility calls for separate loading and off-loading areas. This is essential in terminal facilities as it prevents conflicting movements of passengers. However, in ranks and stops this is not practical because of lack of space and here it should be accepted that some conflict is likely to occur.



CAPACITIES OF LOADING BERTHS

FIG. 8.2

As a result of the method of operation of combi taxis within a terminal, there is a need for a seperate off-loading area even where a terminal does not serve passengers boarding and alighting at the same time. Observations during site visits showed that in almost all cases passengers were off-loaded first and only then would combi taxis proceed to the loading area.

The size of the off-loading area depends on the number of taxis arriving at a terminal, the average occupancy and consequently the off-loading time per taxi during the peak hour.

The average passenger occupancy of taxis arriving at terminal facilities is generally lower than the occupancy of taxis loading and leaving facilities during peak periods. As a guideline an average occupancy of 8 passengers per taxi will result in a range of off-loading times of between 1,0 to 1,5 minutes. This will determine the capacity of an off-loading berth as 40 to 60 combi taxis per hour. However, this assumes an even arrival pattern at the terminal which is very uncommon for combi taxis. As combi taxis do not run on fixed schedules, they often arrive at terminals in platoons. Off-loading berths should be able to accommodate all combi taxis arriving in a platoon, so it is often desirable to observe the rate of arrivals at a terminal and then decide on the number of off-loading berths required.

Queueing theory principles can be applied to estimate the number of off-loading berths required for given rates of arrival and off-loading times (14). Assuming an off-loading time of 1,5 minutes per combi taxi, the number of off-loading berths required for different rates of arrival, with a probability of $p < 0,05$ overflowing, are given in Table 8.4.

TABLE 8.4 : NUMBER OF OFF-LOADING BERTHS REQUIRED

RATE OF ARRIVAL COMBI TAXIS/HOUR	NUMBER OF BERTHS *
100	5
200	9
300	12
400	15

*Probability of overflowing $p < 0,05$

In extreme cases where, due to local circumstances, combi taxis arriving at a terminal have either very high or very low occupancies, off-loading times might differ from the above-mentioned range and surveys should be carried out to determine the actual off-loading times and capacity of an off-loading berth.

The minimum dimensions of the off-loading berths should be the same as the ones for the loading berths as discussed in paragraph 8.2.

8.4 Holding area

Providing there is adequate space, a holding area should preferably be part of a combi taxi terminal facility. However, it can also be located independantly, some distance from other facilities. In both cases the size of the holding area depends on the size of the loading area, the distance from the loading area and the various activities taking place.

When considering the size of the holding area, the minimum requirements for the number of berths as discussed in paragraph 8.2.2 must be examined. Any shortage of spaces should be accommodated by the holding area. In cases where the holding area is located some distance from the loading area, the number of spaces required could be relaxed as the number of combi taxis that will be on the road at any given moment increases. In this case the type of communication between the loading and holding areas should also be considered. Observations showed that communication between the two areas was either by means of two-way radio or by a spare vehicle acting as a messenger service.

Activities other than waiting can take place in a holding area. Observations showed that holding areas were used for minor vehicle repairs, washing and cleaning of a vehicle, as well as resting of drivers. If such additional activities occur in holding areas, more space must be provided.

The dimensions of the holding berths and circulation aisles within a holding area should comply to the South African parking requirements (10).

8.5 Ancillary infrastructure

The provision of ancillary infrastructure such as toilet facilities, seats, shelters, waste bins, public telephones, shops and informal trading areas influence the overall size of a facility. The area required for the ancillary infrastructure will obviously differ according to the specific needs identified. However, the area occupied by ancillary infrastructure should not represent the dominant activity of the combi taxi facility but only a secondary supporting activity limited to a specific size.

As an indication of the size of some ancillary infrastructure elements the following guidelines are given.

The number of toilets required depends on the location of the facility and the surrounding land uses. Assuming that 40% of 1 000 peak hour passengers are present in the peak 15 minute period and 10% of these use a toilet for an average time of 2 minutes per person, toilet-time requirements would be 80 minutes over the 15 minute period. Thus 5,33 toilets per 1 000 peak hour passengers would be required. A male/female ratio of 2 toilets for male and 3 toilets for female could be applied. The size of a single toilet can vary from 1 m^2 for portable ones to 2 m^2 for permanently built ablution blocks.

The area for the informal sector depends on the extent of informal activities which again depend on the local circumstances prevailing in different parts of the country. In general the number of hawkers observed at the 48 combi taxi facilities was low. At 34 facilities there were less than 6 hawkers, at 10 facilities 6 to 10 hawkers were present and at 4 facilities there were more than 10 hawkers. An area of approximately 5% of the total area of the facility would intuitively seem adequate for the informal sector but it also depends on the provision of built-in counters, seats and shelters.

8.6 Long-distance operation

Long-distance combi taxis have long turn-around times due to the distances travelled. Loading of passengers is relatively slow as luggage must be secured either in trailers or on roof-racks and this delays departures.

Holding is a major operating characteristic of long-distance combi taxis and space should be provided either at the loading places or separately.

As a guideline the following minimum space should be provided for long-distance combi taxis : one berth to every six combi taxis operating. This assumes that one combi taxi is at the facility, loading or holding, two combi taxis are on the road travelling towards the destination, two travelling from the destination and one is loading or holding at the destination side of the trip.

It must be noted that the recommended ratio of 1:6 (1 berth for 6 combi taxis in operation) must be applied to the total number of combi taxis operating from both ends of a specific route. This can be determined by surveys of all long-distance combi taxis entering the survey area, thus including the ones that are registered in other areas.

8.7 Procedure to determine size of facility

The size of a facility depends on the size of the various elements included in the facility. In order to determine the size of a facility the following procedure is suggested:

(i) Determine the number of loading lanes required according to the number of routes expected to operate from the facility and considering the type of facility planned.

(ii) Determine the size of pedestrian and loading islands by estimating the number of passengers to be loaded for each route. Passenger volumes can be observed or obtained from transportation studies.

(iii) Determine the total number of loading, queueing and holding berths required present and future by considering the number of combi taxis operating and the loading capacity of a berth according to the fare collection system and other local operational characteristics.

(iv) Determine the need for a separate off-loading area and the number of off-loading berths required.

(v) Decide on the provision of a holding area either as part of the facility under consideration or as a separate facility located some distance away.

(vi) Decide on the provisions of ancillary infrastructure and its extent. Determine the area required for the ancillary infrastructure.

(vii) Calculate the overall size of the facility by adding up the sizes of the various elements and allowing adequate space for vehicle access and circulation purposes. Consider anticipated future growth and make allowances to accommodate future demand.

9. LAYOUT AND DESIGN PARAMETERS

Many combi taxi facilities visited during the course of this study were found to be no more than open areas with possibly some paved areas, lane markings and dustbins. In a few areas the specific operation of combi taxis was considered in the design and these facilities included loading lanes, off-loading and holding areas, shelters, seats and other amenities (2).

The purpose of this chapter is the development of possible layouts for combi taxi facilities and the recommendation of basic geometric design parameters, which should not be seen as prescribed but rather as preferred or desired. Accepting that the size and shape of the available site are the main determinants of a layout, the following guidelines should be seen as an aid to the designer to provide space efficient, convenient, comfortable and safe layouts for both passengers and operators.

The following principles apply to all types of combi taxi facilities and should be taken into account in the layout when designing the facility:

i. Passengers board and alight combi taxis on the left hand side of the vehicle.

ii. One-way movements within a facility are generally safer and easier controlled than two-way movements.

iii. All vehicle movements should be in the forward direction of travel. The only exception should be the holding area where reversing in or out of standard parking bays may be considered.

iv. Passengers should have clearly defined queueing areas for boarding combi taxis. Walkways should preferably be raised by kerbs and clearly separated from vehicle movements.

v. A clockwise or anti-clockwise direction for circulation should be considered depending on the number of access points to the road system, the main direction of approach and turning movements of the combi taxis as well as the volumes of other street traffic.

9.1 Terminal

During the site visits two types of combi taxi terminal layouts were observed, namely the parallel island layout and the oval island type as shown in Figure 9.1(a) and 9.1(b) respectively. Both layouts originate from similar bus terminal layouts and are used throughout the country. The distinct and clear differences between combi taxi and bus operations as well as between vehicle dimensions and their turning characteristics suggest that the oval type facility does not provide space efficient layouts for combi taxis.

In terms of space utilization Figure 9.1 shows that for a specific site, a parallel island layout can accommodate more combi taxis than an oval island layout. Therefore the parallel island layout is more space efficient than the oval island layout and should be prefered. In addition, different routes can be accommodated on separate loading lanes and combi taxis can be easily controlled, thereby enhancing the convenience of both passengers and operators. However, there are cases where oval island layouts may be used. One advantage of the oval island is that pedestrian/vehicle conflicts are reduced. A wide oval island can accommodate high numbers of passenger transfers and the informal sector more efficiently than parallel island design.

The layout of a combi taxi terminal will be determined by the need for:

- separate off-loading, loading and holding areas,
- the provision of ancillary infrastructure
- pedestrian movements and safety.

The following guidelines refer to Figure 9.2 which shows an example of a combi taxi terminal layout:

- A seperate off-loading area should be provided. Off-loading areas should be situated near the entrance point to the terminal or alternatively as close as possible to passengers' final destinations. The required size of the off-loading area has been discussed in Chapter 8.

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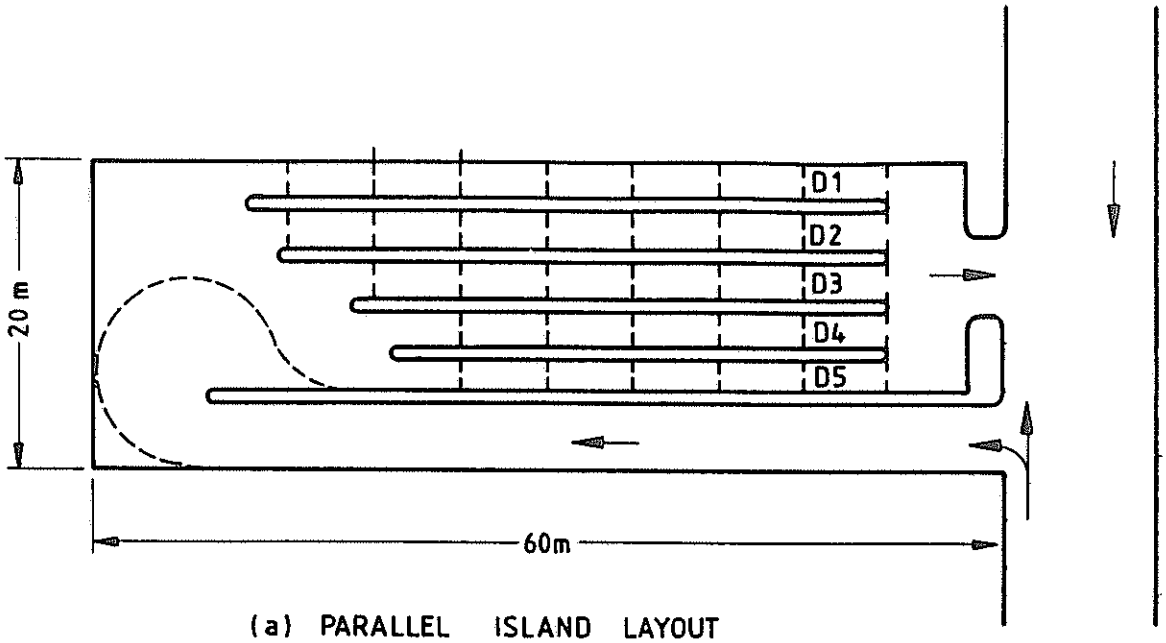
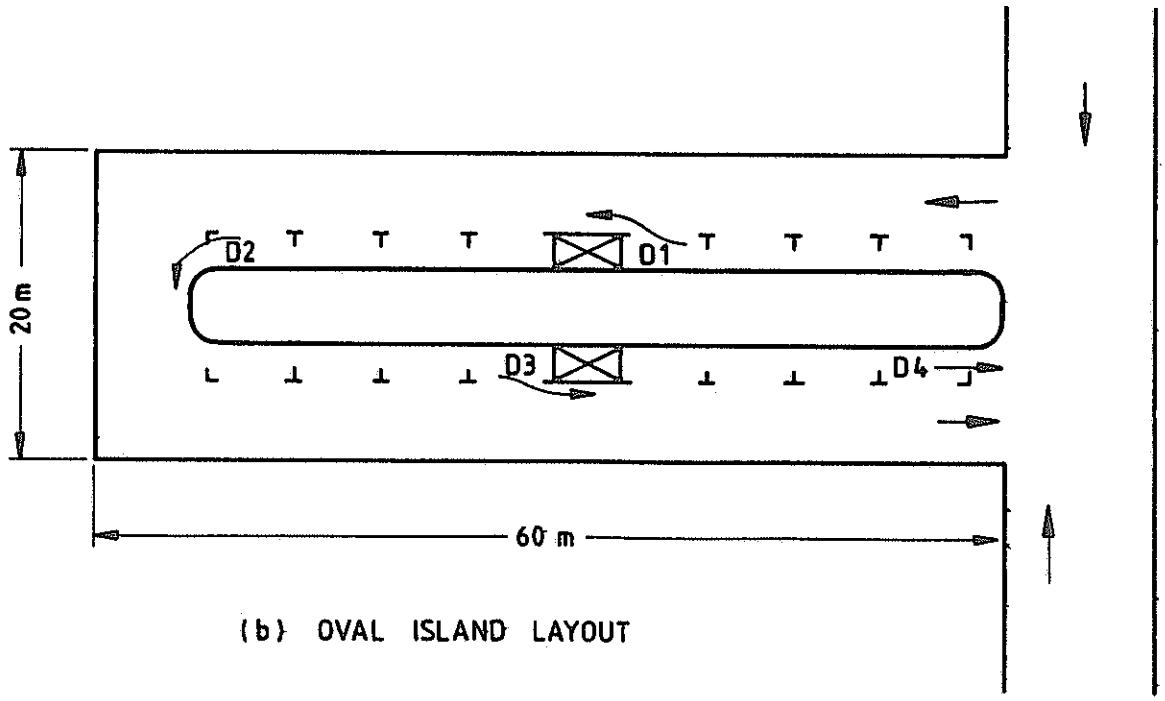


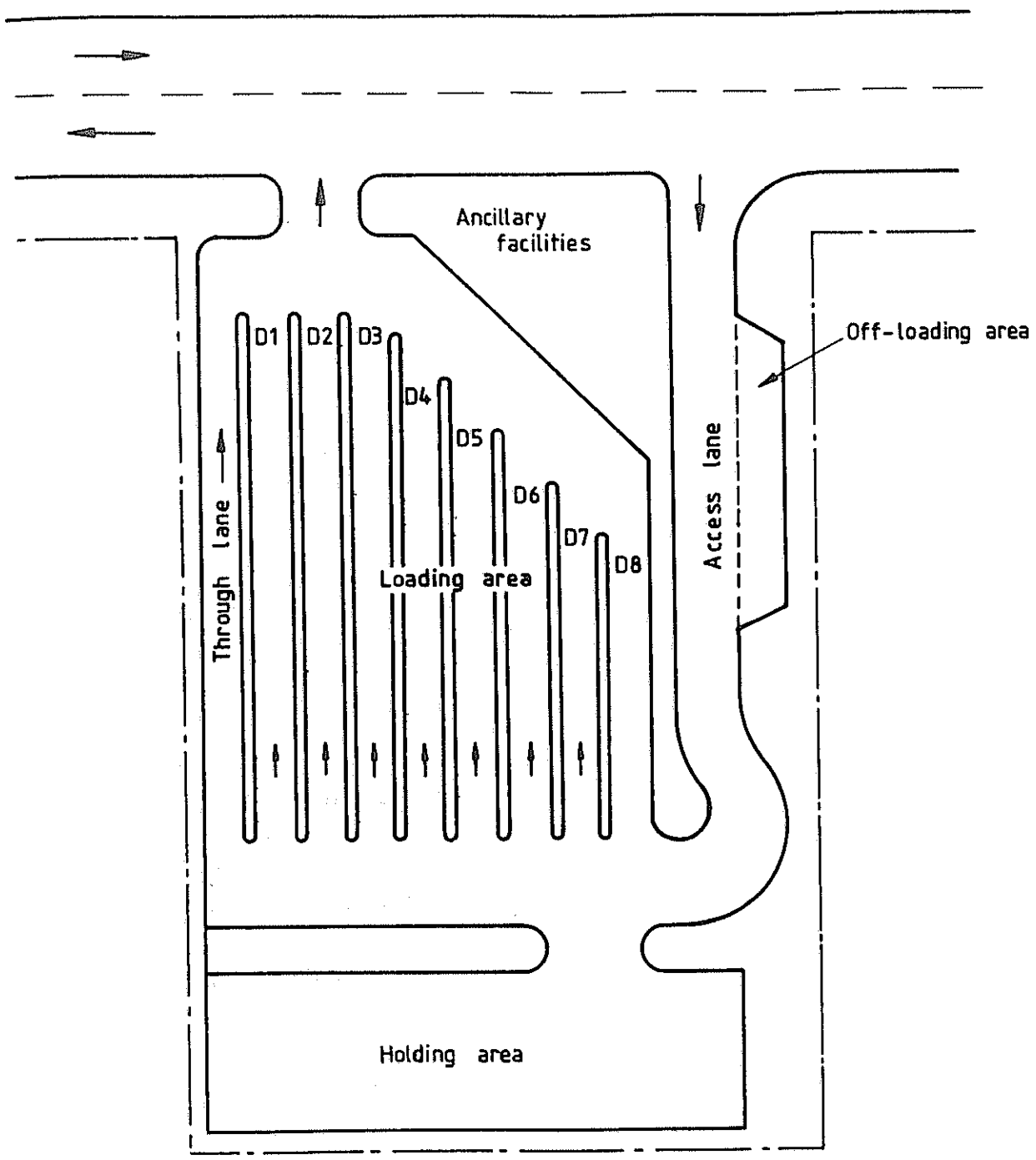
(a) PARALLEL ISLAND LAYOUT



(b) OVAL ISLAND LAYOUT

D1 : DESTINATION 1

PARALLEL AND OVAL ISLAND TERMINAL LAYOUTS Fig. 9.1



AN EXAMPLE OF A COMBI TAXI TERMINAL LAYOUT

Fig. 9.2

- The loading area should preferably consist of parallel loading lanes separated by passenger loading islands. Loading lanes should be parallel to the long side of the stand, provided that enough lanes can be designed to accommodate the full spectrum of destinations (one destination per lane).

- Provision should be made for combi taxi holding within loading lanes and loading lanes should be long enough to accommodate queueing and waiting combi taxis. A holding area within a terminal facility need only to provide for secondary activities such as cleaning of vehicles, rest for drivers and long term parking of combi taxis. When space is restricted and holding cannot be provided for all combi taxis within loading lanes, a separate holding area is needed to accommodate the overflow of vehicles.

- In general through lanes are not required in a terminal. Site visits showed that wherever a through lane was provided, it was not used as such but rather as a loading lane. However, if sufficient space is available a through lane could be provided to allow for direct exit from the holding and off-loading areas.

- Loading lanes need not have the same length. There usually are a few dominant routes with high demand and these routes should be allocated to the longest loading lanes. Routes with low demand can be allocated to shorter loading lanes. This can result in a triangular shaped area where ancillary infrastructure can be located.

- Combi taxis should form queues in loading lanes and the front of the queue should be as close as possible to the passenger demand or alternatively to the exit point of the terminal. Pedestrian circulation should ensure that passengers are directed to the ends of queues on loading islands.

- Pedestrian/vehicle conflicts should be minimized.

- Pedestrian islands and paths should be located in accordance with the natural flow of pedestrians which normally is the shortest path.

- Provision should be made for physical disabled passengers by means of ramps to raised loading and pedestrian islands.

9.1.1 Geometric standards

It is important to design a layout according to good geometric standards as this ensures the smooth operation of a facility.

Inadequate geometric standards create circulation problems and may cause damage to signs, vehicles and other facilities. On the other hand excessive geometric parameters result in poor control of the vehicles within a facility and low utilisation of space.

Figure 9.3 shows an example of a combi taxi terminal, consisting of loading, off-loading and holding areas as well as an area allocated for ancillary facilities. This does not represent a standard layout and should only be seen as an example used to highlight the dimensions of the various elements.

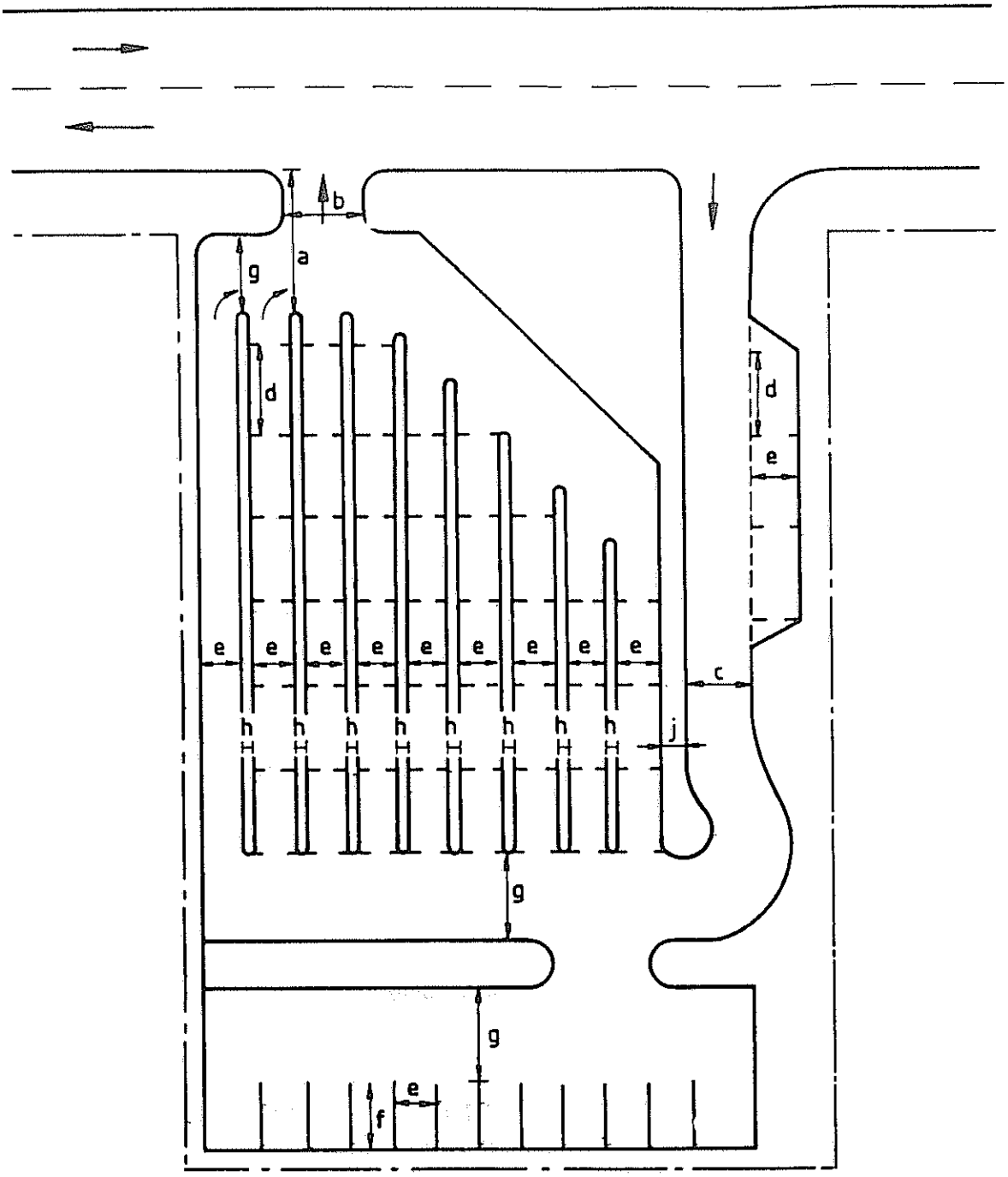
The range of geometric design parameters given in Figure 9.3 consists of minimum, desirable and maximum values.

The minimum values represent the absolute minimum dimensions necessary for the forward movement of vehicles at a very low speed. They apply to terminals where painted islands are used to channelize and control vehicles and pedestrians and should not be used with raised islands.

The desirable values represent required dimensions with some allowance for driving habits and normal manoeuvering speeds as expected within a terminal facility. They are to be used as the recommended standards for both painted and raised islands.

Maximum values are given only to some parameters. It is felt that exceeding these maximum values will have an adverse effect on the proper functioning of the facility. For example, it was observed that if the total width of a loading lane and a painted loading island (e + h) was more than 4,0m combi taxis would form two queues, thus not leaving any space for boarding passengers.

The following discussion examines in detail the geometric design values given in Figure 9.3 for each of the elements of the terminal.



	a	b		c	d	e	f	g*	h	j***	e+h***
		1 way	2 way								
MIN**	13,0	3,5	6,0	3,5	5,2	2,2	5,0	7,0	1,0	2,0	-
DESIRABLE	15,0	4,0	7,>	4,0	5,7	2,5	5,0	7,5	1,3	2,4	-
MAX	-	-	-	4,5	6,0	2,8	5,0	8,0	1,8	-	4,0

* Depends on parking angle (Ref. 10)
** Applies only when painted islands are used
*** Always raised island with non mountable kerb

PROPOSED DIMENSIONS AT COMBI TAXI TERMINALS Fig. 9.3

Loading area: The loading area consists of the loading lanes (e), loading islands (h) and loading bays. Loading lanes should not be less than 2,2m and not more than 2,8m wide. A 2,2m wide lane allows for the movement of combi taxis with 0,2m clearance on each side.

Lanes wider than 2,8m are not space efficient and could result in combi taxis trying to form two queues instead of one, or trying to overtake each other.

Loading islands should have a minimum width of 1,0m. This allows for a single passenger queue catering for 0,7m required for body dimensions and a clearance of 0,15m on each side. Painted loading islands should not exceed 1,8m in width since this will increase the possibility of drivers using them as loading lanes. The total width of any loading lane and painted island should not exceed 4,0m.

The pedestrian island (j) separating the loading area from the access/circulation lane should be at least 2,0m wide, thus allowing for two pedestrians walking next to each other and a buffer between the pedestrian and the kerb edge on the side of the circulation lane of 400mm. This island must be raised by a non-mountable kerb to enforce vehicle movement around it and increase safety. Loading bays (d) do not need to be paint marked but an average length of 5,7m per loading bay is required.

Off-loading area: The off-loading area consists of the off-loading bays, usually parallel to the kerb, and should have the same dimensions as the loading bays. The off-loading bays should allow for non-independent arrivals and departures and should be clearly marked. Ideally the off-loading area should be separate from the loading area.

Holding area: The holding area consists of the circulation aisle and the holding bays. The holding area functions as a parking area and therefore the design parameters given in the Parking Standards (10) should be used. Aisle width depends on the circulation pattern and the angle of the parking bays. A separate holding area in combi taxi terminals should be provided to accommodate secondary activities as discussed in Chapter 9.1.

Circulation and access lanes: Circulation and access lanes should be designed in such a way that all combi taxi movements are feasible in a forward

direction. Special attention should be given to turning circles according to the dimensions given in Chapter 7. A 5,5m turning radius is the absolute minimum kerb-to-kerb radius of a combi taxi at crawl speed. Taking into account different driving skills this could result in a driver not being able to turn in one manoeuvre. A 6,2m turning radius provides an appropriate minimum standard. Turning templates to be used for design purposes are given in Appendix C. The width of one-way circulation lanes should not exceed 4,0m in order to discourage stopping of combi taxis in this lane.

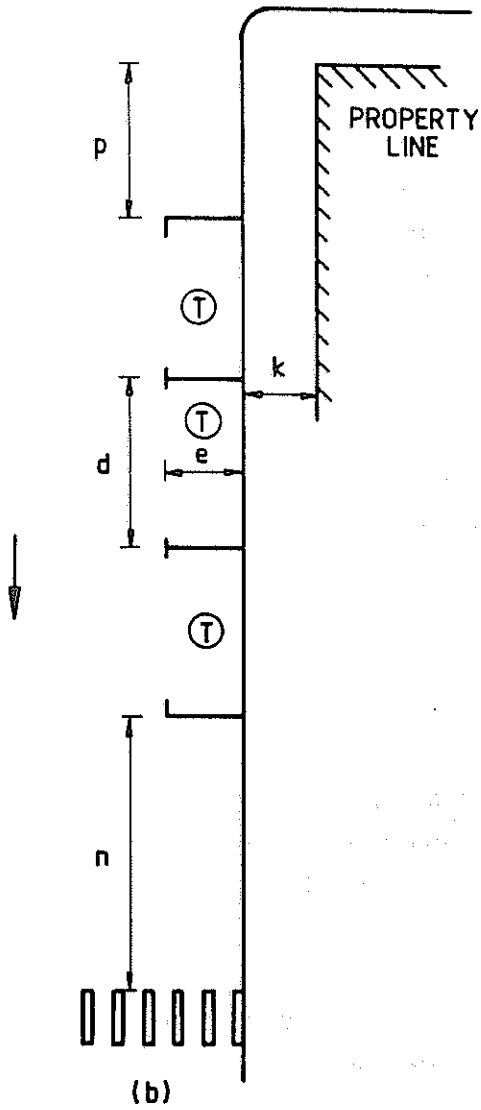
9.2 Rank

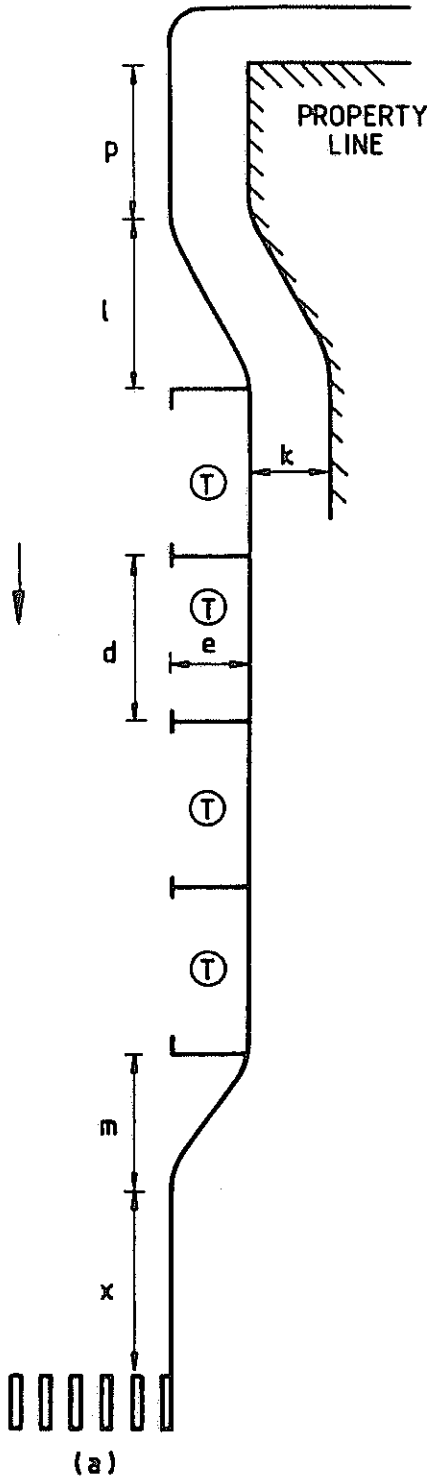
On-street ranks consist of berths parallel to the kerb. Basically there are two types of ranks. Berths can be on-street next to the kerb or they can be recessed forming lay-bys, as shown in Figure 9.4.

The rank should operate similarly to a loading lane in a terminal facility. Ideally therefore, only one destination should be served by the rank and combi taxis should operate on a non-independent departure system. The recommended basic dimensions of the bay are the same as for the bays at a terminal. The front bay in the rank functions as a loading berth while the remaining bays are used for off-loading purposes and combi taxis waiting to load.

An important consideration on the layout of a rank is the width of the sidewalk. Sidewalks should be wide enough to allow for passenger queues and other pedestrian traffic. A minimum of 2,6m will allow for a single line queue and two pedestrians walking side by side. The actual required sidewalk width can be derived from the total number of passengers and pedestrians according to the criteria discussed in Chapter 8.

Ideally, all on-street ranks should be recessed in order to reduce conflicts and the likelihood of rear-end collisions between combi taxis and other vehicles in the traffic stream. Combi taxis do not usually encounter problems, like buses, in re-entering the traffic stream from a recessed bay as their vehicle characteristics (acceleration, speed etc.) are similar to those of a car. Figure 9.4(a) shows the guideline dimensions for recessed on-street ranks.





	d	e	k	l	m	n	p	x
MIN	5,2	2,2	2,6	5,5	4,5	9,0	5,0	6,0
DESIRABLE	5,7	2,5	3,3	-	-	-	-	-
MAX	6,0	2,8	-	-	-	-	-	-

PROPOSED ON-STREET RANK DIMENSIONS

Fig. 9.4

In central streets ranks are often provided by removing public parking at the kerbside. The dimensions required are shown in Figure 9.4(b). The dimensions of a typical on-street public parking bay which are 2,2m wide and 6,0m long are adequate for combi taxis and no modification is required. The minimum distances from a street corner and a pedestrian crossing which apply to parking bays (16) should also apply to combi taxi ranks. Therefore a rank should be at least 9,0m away from a pedestrian crossing and 5,0m from the property line at a street corner to ensure adequate sight distance. A recessed rank should be at least 6,0m from a pedestrian crossing. This will allow a combi taxi to move fully into the traffic lane before stopping at the pedestrian crossing.

9.3 Stop

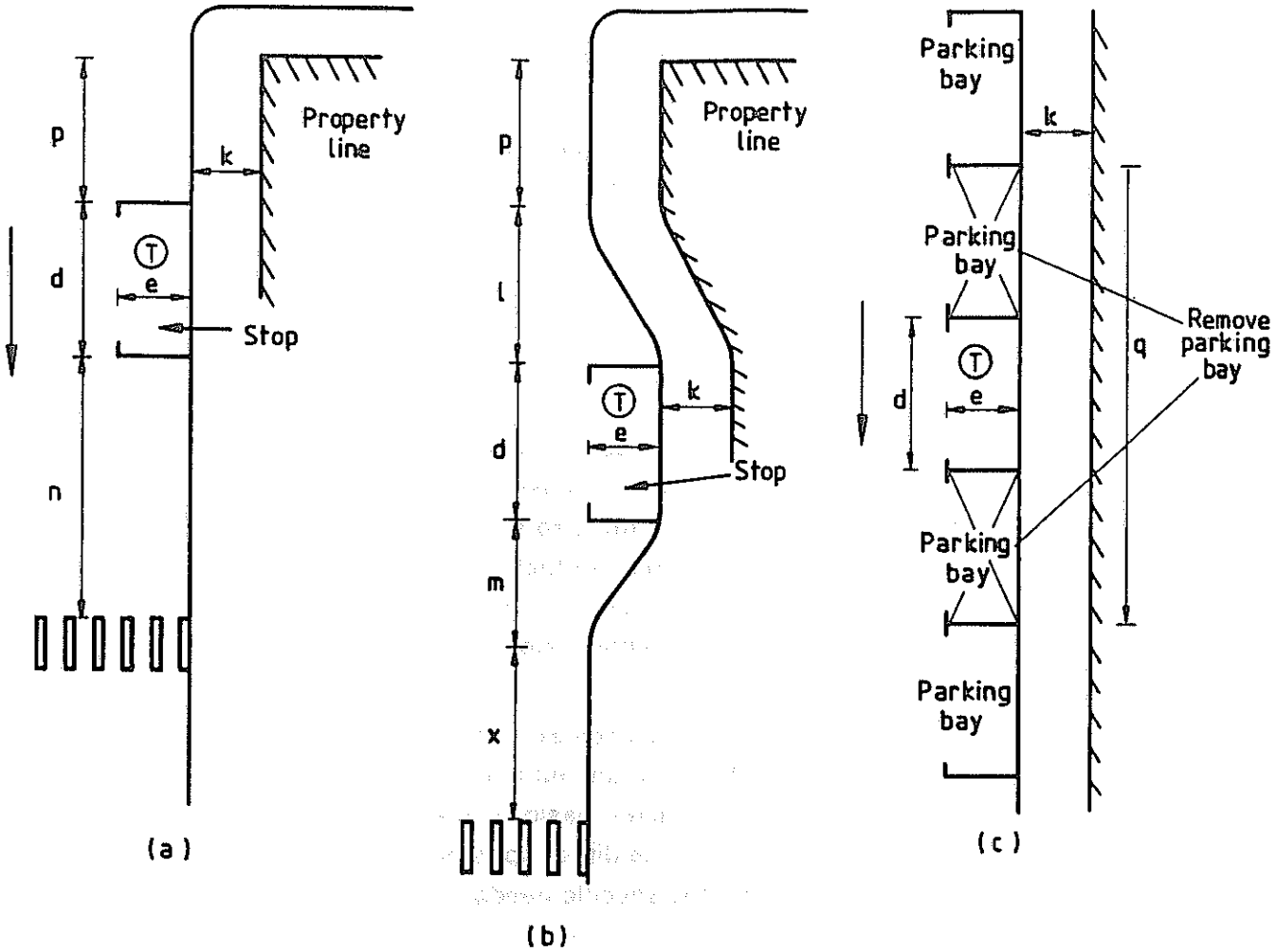
It is important to distinguish a combi taxi stop from a rank. While both are usually within the road reserve the function of a stop differs from the function of a rank. The time a combi taxi spends at a stop is usually short as holding is not allowed at a stop. The only function of a stop is for passengers to board or alight a combi taxi.

Figure 9.5 shows the proposed dimensions for a combi taxi stop with a single bay. Dimensions for a multiple-bay combi taxi stop can be derived similarly.

Figure 9.5(a) shows the dimensions of a single-bay combi taxi stop at the kerb side. There are no parking bays on either side of the stop. The stop must be at least 9,0m and 5,0m from a pedestrian crossing and a street corner respectively.

Figure 9.5(b) shows the proposed dimensions for a combi taxi stop in a lay-by. The dimensions shown for the tapers are the minimum requirements for a combi taxi to pull in or drive out of a recessed bay. The minimum distances of 5,0m from street corners and 6,0m from pedestrian crossings should also be kept, as shown.

Figure 9.5(c) shows a combi taxi stop in a parking lane. In order to provide a single-bay combi taxi stop three parking bays should be removed in order to allow for the easy vehicle movement in and out of the stop.



	d	e	k	l	m	n	p	q	x
MIN	5,2	2,2	2,6	5,5	4,5	9,0	5,0	15,2	6,0
DESIRABLE	5,7	2,5	3,3	-	-	-	-	-	-
MAX	6,0	2,8	-	-	-	-	-	-	-

PROPOSED ON-STREET STOP DIMENSIONS

Fig. 9.5

Failure to do so can result in the combi taxi stopping in the traffic lane and obstructing other traffic. For a multi-bay combi taxi stop the number of parking bays that need to be removed are the number of taxi stopping bays plus one bay in front of and one bay behind the taxi stop.

The sidewalk width should be at least 2,6m to allow for a single-line queue and other pedestrian flow. The required width can be derived from the total number of passengers and pedestrians using the sidewalk, according to the criteria set in Chapter 8.

9.4 Holding area

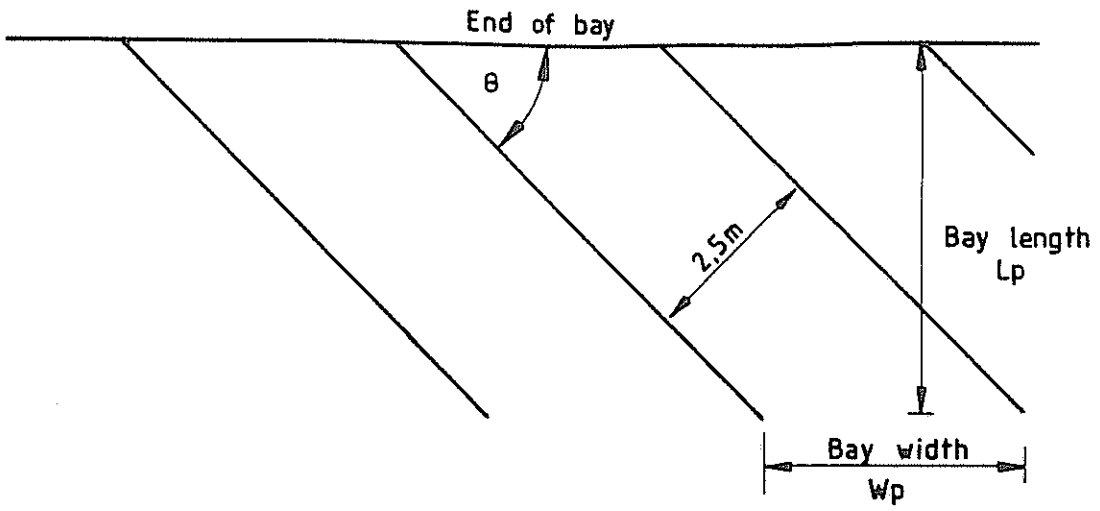
A holding area should be designed as an off-street parking facility according to the Parking Standards (10). The desirable bay width, the aisle width and the length of the bay vary according to the parking angle and the pattern of holding bays (interlocking or non-interlocking). Figure 9.6 shows the two types of angle parking namely with vehicles interlocking and with no vehicle interlocking as well as the guideline dimensions for different parking angles.

In some cases a holding area might be used for purposes other than only vehicle storage. Depending on the location and the function of the holding area other activities such as cleaning vehicles, basic maintenance and minor repairs could be expected. In these cases the dimensions given in Figure 9.6 should be altered in order to cater for the specific needs.

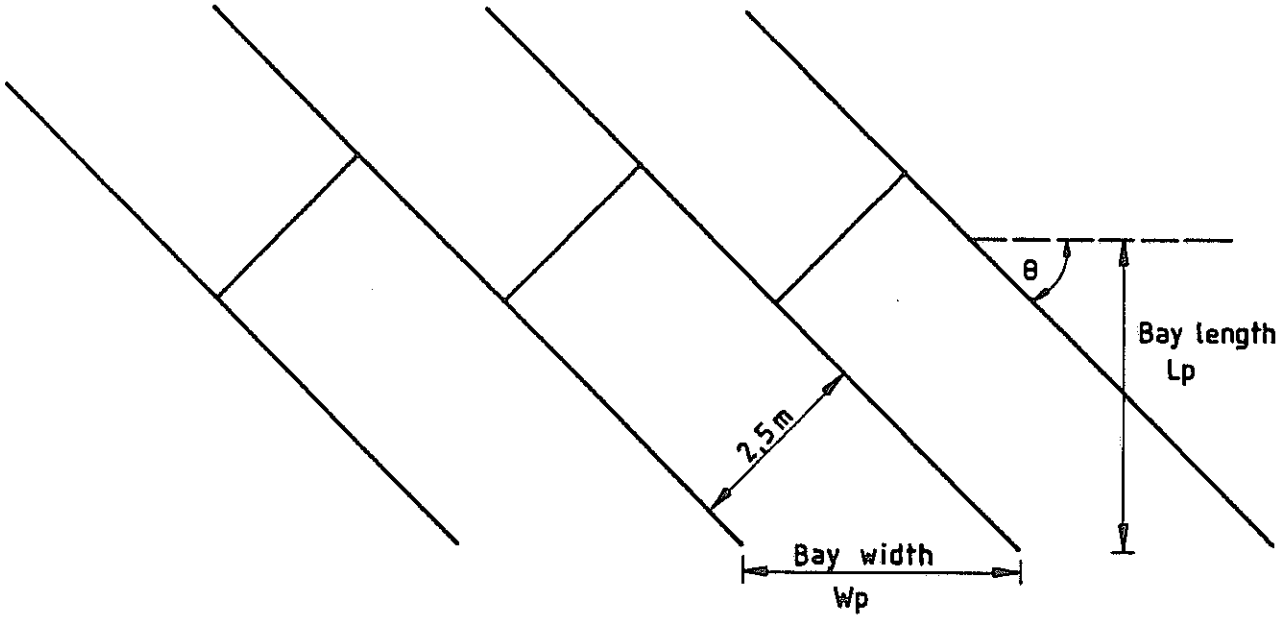
9.5 Long-distance operation

Long-distance operations are characterised by the long passenger waiting and loading times, and by the large amount of personal luggage carried. These differences are reflected in the spatial needs of the operators and passengers which affect the layout and geometric design parameters of a long-distance combi taxi facility.

The main difference between commuter combi taxi and long-distance combi taxi facilities is in the loading area. Figure 9.7 shows the guideline dimensions of a loading area. These dimensions apply to loading areas either within terminal facilities or at on-street facilities.



NO VEHICLE INTERLOCKING



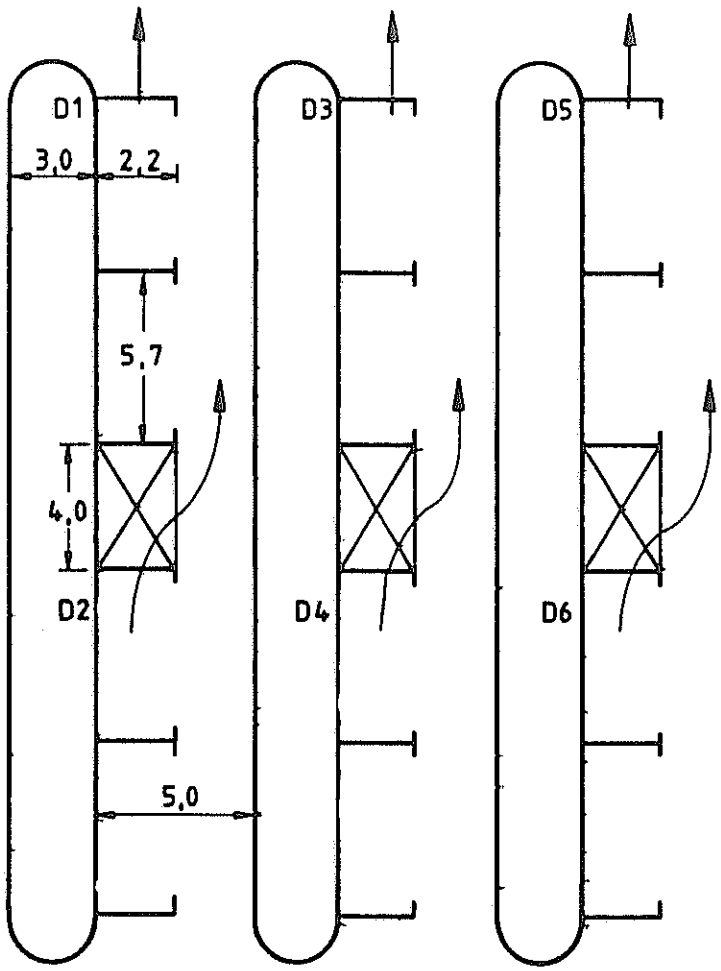
VEHICLE INTERLOCKING

PARKING ANGLE θ	BAY WIDTH Wp	BAY DEPTH Lp		AISLE WIDTH	
		INTERLOCKING	NO INTERLOCKING	2-WAY	1-WAY
90°	2,5	5,0	5,0	7,5	7,5
60°	2,9	4,8	5,3	5,2	4,4
45°	3,5	4,2	4,9	5,2	4,4

Ref. Packing Standards DOT, PG 3/85

PROPOSED HOLDING AREA DIMENSIONS

Fig. 9.6



D1 : Destination 1

PROPOSED DIMENSIONS FOR LONG DISTANCE COMBI TAXI TERMINALS Fig. 9.7

The pedestrian island should have a minimum width of 3,0m and preferably be raised by kerb. This allows 1,4m width for a single-line queue of passengers with their luggage and 1,6m width for two-way pedestrian flow.

The loading lane plus aisle width should be 5,0m wide in order to allow for independent combi taxi departures. The recommended dimensions for loading bays are 2,2m wide by 5,7m long. An additional 4,0m in length is required to allow a taxi to drive out of a loading berth, and should be provided for each destination at the front of the queue.

On-street facilities should comply with the minimum distances from street corners and pedestrian crossings previously discussed in Paragraphs 9.2 and 9.3 for commuter service facilities.

The type of vehicle used for long distance services might change in future to larger vehicles. At this stage the vast majority of vehicles used are combi taxis. However, the planner should be aware of the possibility that vehicle dimensions might change and therefore design parameters will have to be adjusted accordingly.

Long-distance combi taxis sometimes make use of trailers in order to store luggage. The frequency of trailer usage as well as their dimensions vary significantly. As a result of these variations the dimensions of berths cannot be standardised to accommodate all possible vehicle-trailer combinations. The degree of trailer usage and their dimensions should be established in each case and if necessary adjustments to the previously developed standards should be made.

9.6 Procedure to determine layout

Assuming that the size of the various components of a facility is determined according to the method discussed in Chapter 8 and given the shape and size of the available site, the following procedures are recommended to determine an effective layout:

(i) Consider passenger circulation requirements, their origin and destination.

(ii) Examine the access to the road system and decide on a vehicle circulation system.

(iii) Select the location of the loading area and its orientation (parallel to street etc). Position the other elements of the facility (off-loading and holding areas, ancillary infrastructure) in relation to the loading area.

(iv) Locate pedestrian islands and crossings by following the shortest path.

(v) Choose appropriate geometric standards depending on the type of operation (long-distance or commuter service) and the costs involved.

(vi) Prepare alternative facility design layouts.

(vii) Discuss the proposed layouts with operators and evaluate the performance of each design.

(viii) Refine and iterate the process until an optimal design has been prepared.

10. INTERACTION WITH OTHER MODES

The function of a transportation terminal is to provide an interchange enabling passengers to change from one mode of transport to another. In the case of combi taxi facilities passengers normally arrive or depart by bus, train, combi taxi or by walking. A very small percentage may also arrive by private vehicle in the form of park-and-ride or kiss-and-ride.

The question of competition between the various modes is often raised. Especially the interaction of combi taxis and buses at terminals and other facilities is a sensitive issue. Pending the implementation of deregulation it is very difficult to foresee the changes that may occur and the extent to which these changes will affect the various modes. However, the following general observations, based on overseas experiences (1) can be made to indicate some relationships between the provision of combi taxi and bus services. These observations are not guidelines but must be viewed as thoughts and ideas which may serve as a basis for further discussions among interested parties.

- The presence of a large number of combi taxis on the roads stopping anywhere to load and off-load passengers, constitute a substantial obstruction to the efficient and fast operation of buses and other vehicles.

- The door-to-door type of service offered is an important advantage of combi taxi. It is well known that a transfer is a considerable deterrent with transfer waiting times equal to three times the on-bus times and adds additional elements of discomfort and uncertainty.

- Combi taxi services often improve the viability of conventional bus services by providing a supplementary capacity during peak periods and therefore reducing the size of a fleet of buses and its under-utilization during off-peak periods.

- The introduction of a combi taxi service seems easier in situations where it complements rather than competes with conventional public transport. Unfortunately the two tend to grow in competition, the growth in combi taxis often being the direct result of poor provision of bus services.

- Surveys indicate that reasons given for the use of combi taxis were convenience, comfort, speed and non-availability of bus service. Neither cost or safety were emphasized as reasons for use of combi taxi services.

- In many cases it seems right to provide the two basic services, namely combi taxi and bus. A taxi service plays a specific role in meeting the unstructured travel demands of users while a bus service is needed to cater for the mass travel demands of users making regular and scheduled trips.

- Competition between different vehicles in the same markets may make the sector economically efficient, but it may not be equitabe for the community as a whole. Therefore, when load factors are low, the economics of operating a bus suffer accordingly. The benefit of operating large vehicles on bus services is that they can efficiently move large numbers of travellers at low rates. Competition from smaller vehicles inevitably affects the load factor and hence economic viability of large vehicles, which by their nature of size and operations are less demand responsive.

- Small cities involve shorter passenger journeys which can be handled at reasonable rates by combi taxi services.

- The mass movement of passengers in large cities, often involving long journeys, are more suited to bus service networks or for that matter suburban trains.

- In many cities around the world services similar to combi taxis are complementing conventional bus services. However, they tend to concentrate on high density corridors and ignore the sparse flows of passengers elsewhere. Thus the bus service undertaking suffers from the need to cross-subsidise less profitable routes. Combi taxi services, by their entepreneurial nature, have to be profitable.

The above observations indicate that debates about the desirability of combi taxi operations competing with other modes of transport, will end inconclusively. In the view of this report it is therefore suggested that there is a scope for both types of public transport, combi taxis and buses, in urban centres.

10.1 Multi-modal operations

It has been observed that both official and unofficial combi taxi facilities in central areas are in many cases closer to the core of the central business district than are the main bus facilities. It has also been observed that in many cases combi taxis are operating at bus stations. This has the following effects:

- friction between bus and taxi operators
- underutilization of available space at a facility
- delays to bus departures
- gradual take over of the facility by combi taxis.

These problems can to a large extent be alleviated by careful planning of a well-integrated comprehensive transport system allowing for complementary interactions among different modes. However, major conflicts between combi taxis and conventional public transport are possible. These conflicts should be minimized as far as possible by proper design and planning of facilities. In the absence of strong supporting evidence, it is difficult to justify broad policies that would restrict combi taxis and buses to different areas.

As far as facilities are concerned, therefore, all modes competing should be given equal opportunities. This can be achieved by either providing a separate facility for each mode at locations of passenger demand, or by planning multi-modal transfer facilities.

10.1.1 Multi-modal transfer facilities

The primary function of a transfer facility is to accommodate passenger transfers between different forms of transport. Well-designed transfer facilities improve the utilisation of all modes using the facility.

In some urban areas, especially the larger ones, there may be up to six forms of transportation which could utilize common transfer facilities:

commuter bus service
long-distance bus service
commuter combi taxi service

long-distance combi taxi service
rail service
park/kiss and ride

Each service fulfills a special need for the travelling public and furthermore, each service requires specific conditions in order to operate as efficiently as possible.

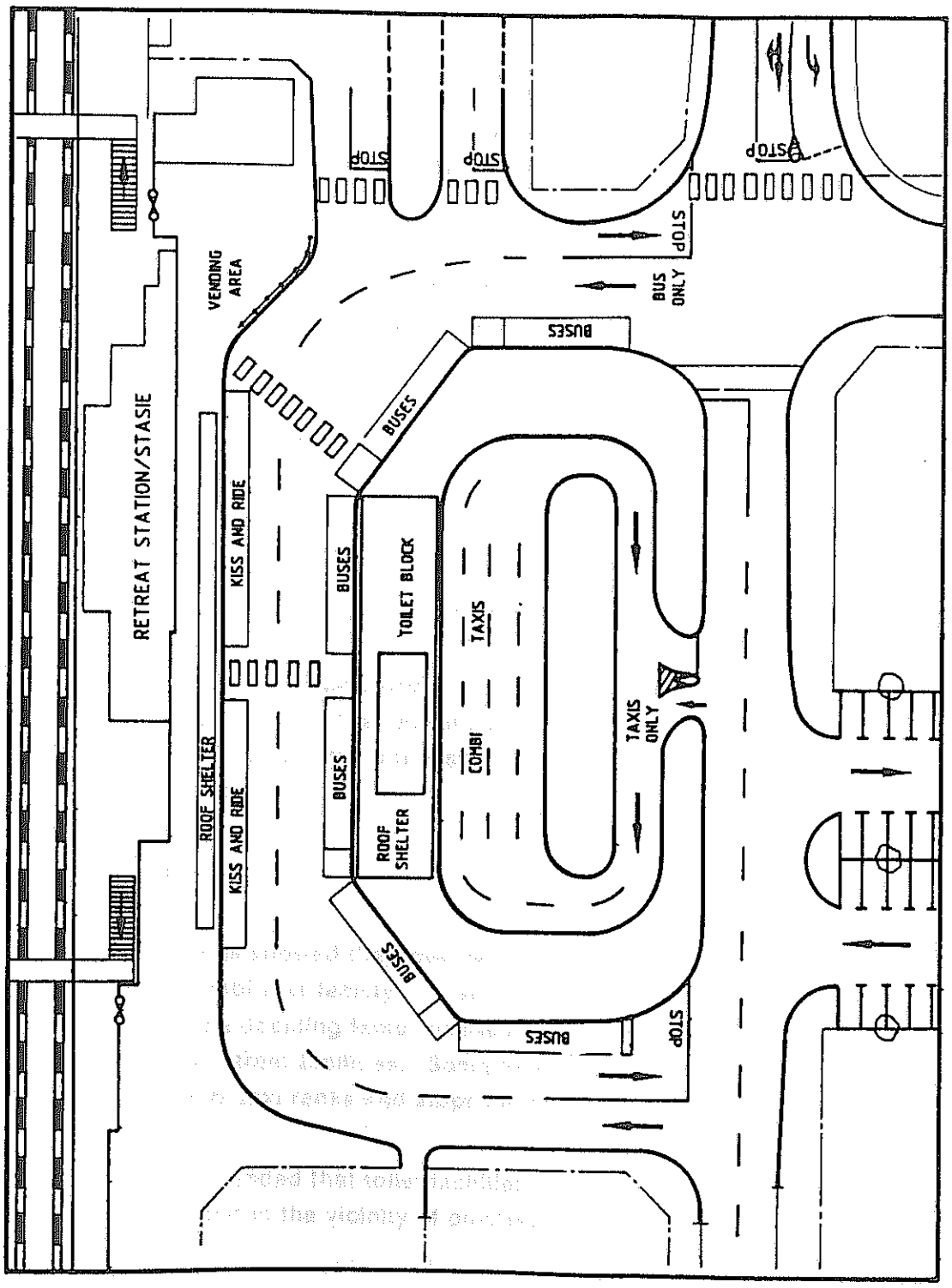
Figure 10.1 shows the layout used at the Retreat Railway Station in Cape Town. This layout allows transfers between rail, bus and combi taxis. The combi taxi facility consists of an oval island with a clockwise one-way circulation pattern. The bus facility is located around the combi taxi facility in an anti-clockwise circulation pattern. Provision for kiss-and-ride is made in front of the entrance to the railway station.

Throughout the planning process of a transfer facility it is important that the planner considers the needs of passengers and operators that are going to use the facility. The section of the transfer facility allocated to each mode must firstly meet the requirements of each mode and should be designed such as to accommodate the dominant vehicle of the particular mode. The following guidelines should also apply:

* There should be minimum conflict with vehicles of other modes
* Each mode should use clearly defined loading areas separated from other modes.
* Vehicle access and egress as well as circulation within the transfer station should be kept separate for each mode.
* Special considerations should be given to pedestrian movements, as they usually have to cross loading areas of different modes in order to gain access to pedestrian islands.

10.1.2 On-street stops

Planners and local authorities are often faced with a decision on the joint use of on-street stops by buses and combi taxis. Theoretically an on-street bus stop could be used by combi taxis. In practice, however, the unscheduled operation of combi taxis results in random arrivals at bus stops and causes disruption in the operation of the bus service. It is therefore recommended that stops should not be used jointly by the two modes.



BUS - RAIL - COMBI TAXI TRANSFER STATION (Retreat, Cape Town) Fig. 10.1

Preferably on-street stops should consist of enough bays for both modes. Bays should be clearly defined and physically separated with a barrier or kerb. This will ensure that each mode will use the space allocated to it, and will not disrupt the operation of the other mode.

In many cases though, an on-street stop jointly used by both modes and complying with the recommended layout of separating each mode, will still require close co-operation between the combi taxi and bus operators.

11. ANCILLARY INFRASTRUCTURE

The ancillary infrastructure consists of those facilities which are needed for the orderly functioning of a combi taxi facility and those related to the well-being and convenience of both passenger and driver.

The provision of ancillary infrastructure depends on the needs of passengers and operators which are closely related to the following factors:

- type of facility (terminal, rank, stop)
- size of facility
- operation (commuter or long-distance)
- number of passengers
- climate and other local conditions
- adjacent land use activities

The list of ancillary infrastructure that could be provided, is endless. The following elements and the relevant discussion cover the main ancillary facilities as observed during the site visits and as discussed with drivers, passengers and authorities.

11.1 Toilets

Observations showed that toilet facilities are a primary prerequisite for a successful combi taxi facility. In some cases the availability of toilet facilities could be the deciding factor on the location of a facility. This particularly applies to on-street facilities. Some local authorities do attempt to locate on-street combi taxi ranks and stops near existing toilet facilities.

It is recommended that toilet facilities are provided at all off-street combi taxi terminals and in the vicinity of on-street ranks and stops.

Toilets can be permanent or temporary, but in both cases they must be able to withstand frequent use. They must be easy to keep clean so that they can remain attractive to use.

Security at toilet facilities has always been a problem. Toilets must be well lit and ventilated and must not be associated with the concealment for robbers. Discussions with combi taxi users showed that privacy is very important and therefore semi-open toilet facilities are not acceptable. The design should be a compromise between the provision of privacy and enhanced security.

11.2 Seats

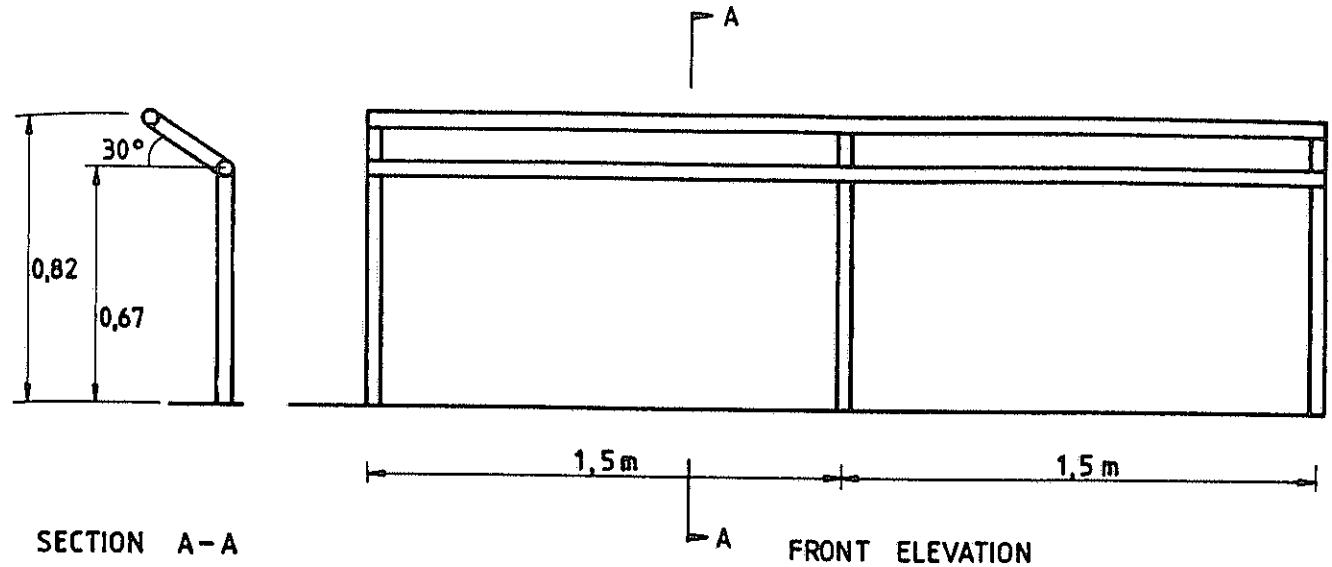
Seating at combi taxi facilities can be provided for passengers in queues and for passengers in a general social area.

The priority non-independent departure system used at commuter combi taxi facilities and relatively short queueing times do not justify the use of seats in the queueing area. Provision of seats in parallel loading islands for queueing passengers will result in a considerable increase in the width of the island and consequently total space requirements for the facility will increase.

This is not the case at long-distance combi taxi facilities. Combi taxis depart independently and passengers usually have to wait in queues for some time and most of them carry parcels and luggage. This creates the need for some kind of seating arrangement.

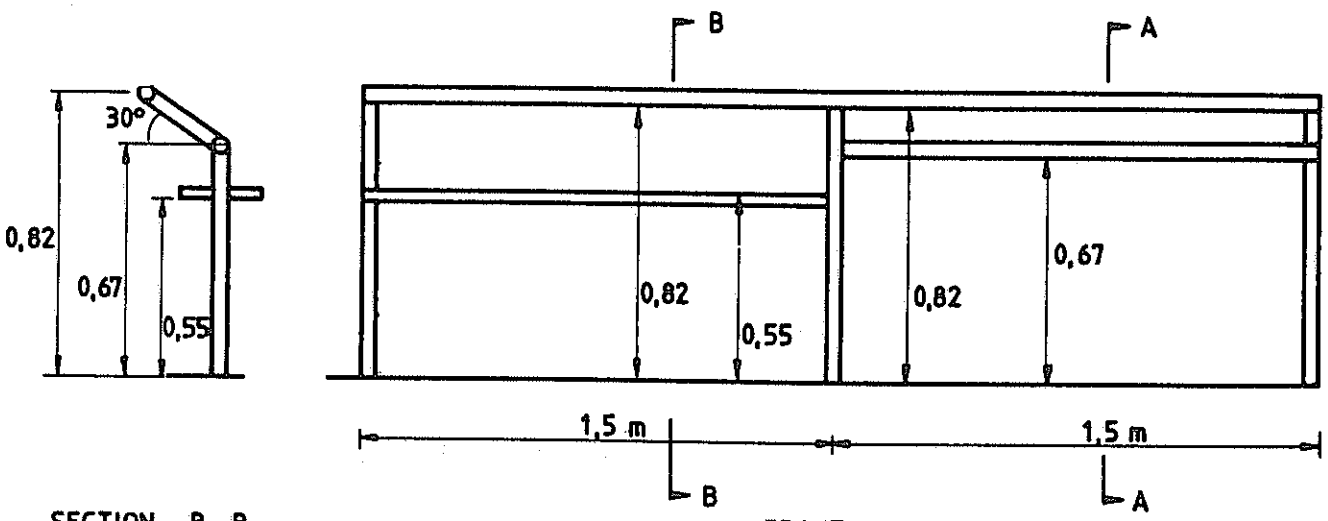
The width of the loading island in long-distance combi taxi facilities allows for the installation of a spacesaver type of seat as shown in Figure 11.1 This type of seat consists of rails arranged in a way to provide for resting of the body in an almost standing position (Figure 11.1a) or for temporary seating (Figure 11.1b). This seating arrangement, which was first implemented at the Golden Acre bus terminus in Cape Town, is cheap to construct, and cannot be easily damaged. It can be painted in bright colours, thus enhancing the appearance of the combi taxi facility.

It is therefore recommended that seats are provided for queueing passengers at long-distance combi taxi facilities. However, seats are not essential in the loading areas of commuter combi taxi facilities. The seats can be of the rail type discussed above or of any other type as long as they are strong and durable.



SECTION A-A

FRONT ELEVATION



SECTION B-B

FRONT ELEVATION

NOTE:

Tubular metal of minimum diameter 60mm to be used

SEATING REST

Fig. 11.1

In the case of off-street terminals, seats can be provided in a separate area. Passengers can sit, rest and socialize in this area which must be of such nature that passengers can have a direct view of the combi taxi loading area.

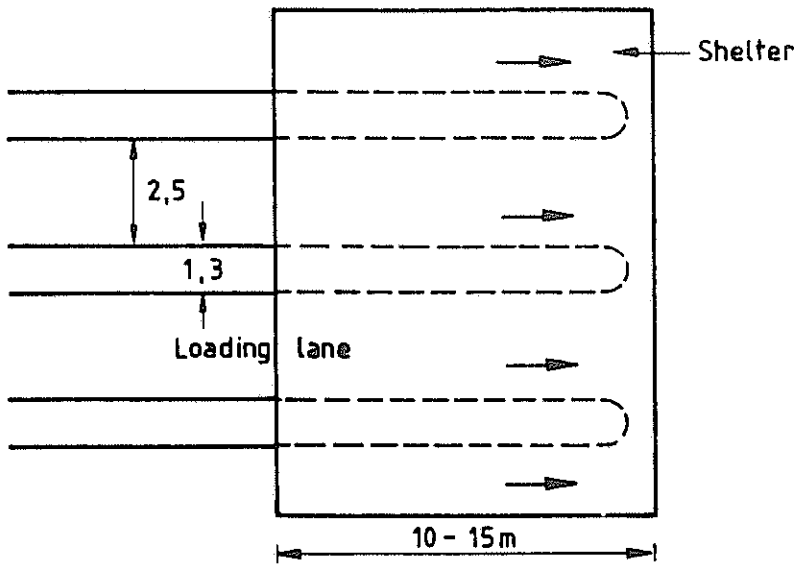
11.3 Shelters

An important requirement for any combi taxi facility is shelters providing protection against adverse weather conditions. Shelters are generally provided for the comfort and well-being of passengers and operators. However, in many cases it was observed that shelters were also essential in the operation of the facility. During heavy rainfalls, passengers seek protection from the rain in sheltered areas in the vicinity of a combi taxi facility. This has the following effects:

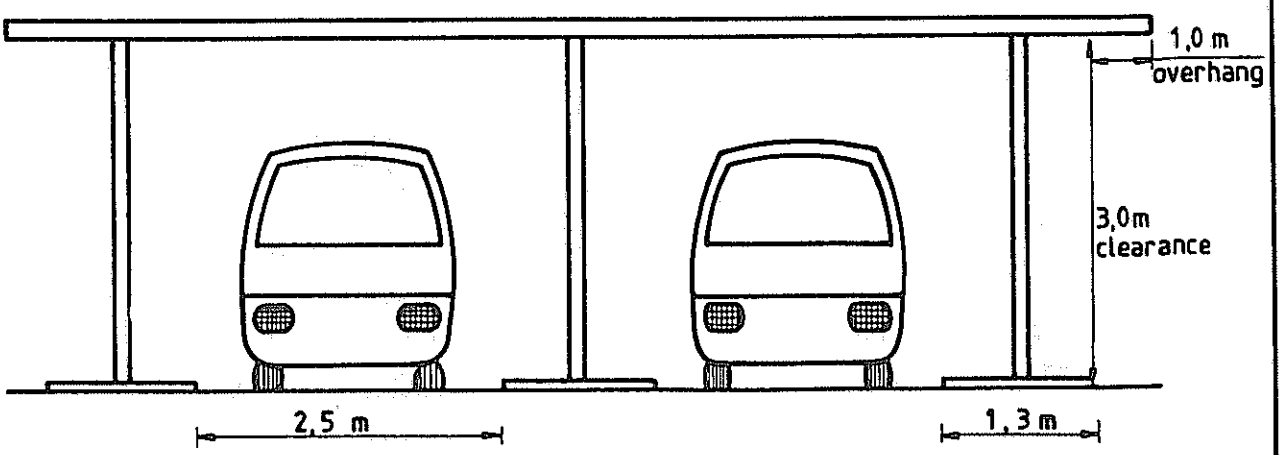
- crowding in front of shops where there usually is shelter
- combi taxis not using the facility but stopping in front of the shops where passengers are waiting
- congestion on the roads adjacent to the facility
- underutilization of the facility

The highest priority for shelters within a combi taxi facility is at the loading area. Shelters in commuter combi taxi facilities need only be provided at the front part of the loading area where passengers queue and then board combi taxis, as shown in Figure 11.2. A length of 10m to 15m of the loading area will provide protection for the first 2 to 3 vehicles and for the queueing passengers. A vertical clearance of 3,0m should be allowed. Such height will cater for a combi taxi with roof racks and luggage.

Shelters at long-distance combi taxi facilities should be provided at the loading area and cover each individual loading island as shown in Figure 11.3. A minimum vertical clearance of 3,0m is recommended. Such a height would allow for a combi taxi with roof-racks and luggage loaded on the roof. A minimum overhang of 1,0m is recommended, to offer protection from rain falling at an angle. In certain parts of the country especially near the coast, it might be necessary to provide a longer overhang or side protection, as winds often cause rain to fall at a sharp angle.



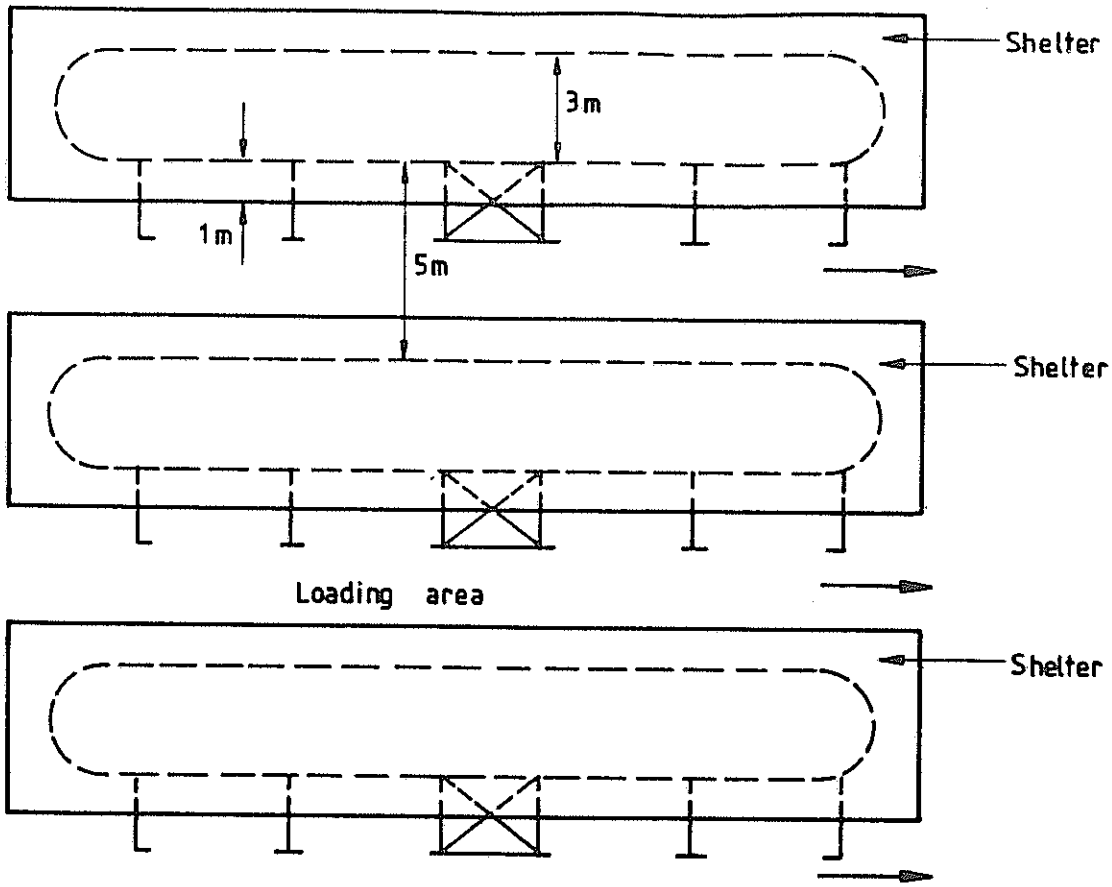
PLAN



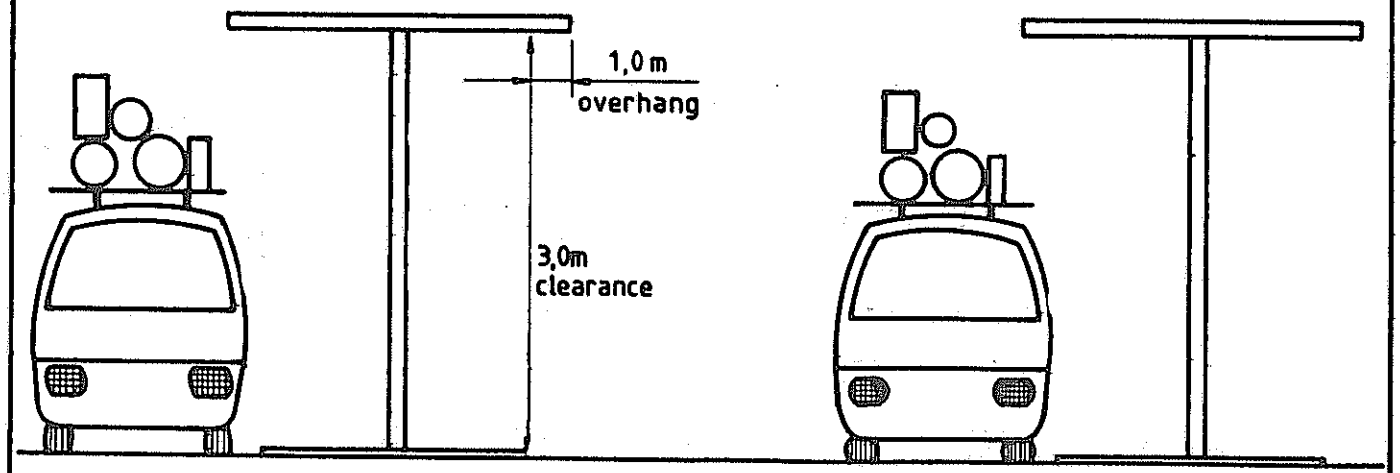
FRONT ELEVATION

SHELTER FOR COMMUTER FACILITIES

Fig. 11.2



PLAN



FRONT ELEVATION

SHELTER FOR LONG DISTANCE FACILITIES

Fig. 11.3

Other areas that need protection from weather within a combi taxi facility are:

the seating, social area
the informal sector area
the off-loading area
the main pedestrian walkways

Alternatively a shelter covering the entire area of the facility can be provided. The deciding factor will be the cost, and the extent of shelter provided will therefore be dependent on the funds available. In the case of fully covering the facility the height clearance should be increased sufficiently for aesthetic and ventilation purposes.

11.4 Signs

Information and directions for passengers are essential to the functioning and operation of a combi taxi facility. Passenger orientation is the principal criterion for the effectiveness of an information system and therefore destination signs should be highly visible. Signs can be mounted on single poles or on the supporting columns for the shelters. Ideally the signs should be located at both the front and rear points of the loading islands. The signs at the front will direct passengers to the correct loading island and the signs at the rear will help drivers to queue in the right loading lane.

11.5 Dustbins

Dustbins must be provided at all combi taxi facilities. They must be large enough, immovable and easy to empty. Various types of dustbins were observed at combi taxi facilities, including a type which suspends from two poles and can be tilted for removal of the contents. This type of dustbin is strong and easy to handle.

In order to keep the facility clean it is essential that enough bins be provided and cleaners appointed to empty them regularly.

11.6 Vehicle washing

Observations showed that water for cleaning and washing of vehicles is important. In many cases water could be obtained from ablution facilities. Where toilets did not exist, drivers had to carry water from nearby water points.

Clean vehicles are attractive, enhance the image of the industry and contribute to a high quality service. However, certain by-laws restrict the use of water in public places for health reasons. Sometimes drainage is also a problem. The planner should take into account all the relevant aspects and then decide whether to allow washing on site, preferably in the holding area.

Problems of water usage can be foreseen at on-street facilities and the use thereof should be avoided. At off-street facilities the provision of water will satisfy the operators needs for clean vehicles and could be allowed.

11.7 Lighting

Adequate lighting is essential for a combi taxi facility that is used at night. It was observed that most combi taxi facilities do operate at night. This is particularly true in winter when operation starts at 5h30 - 6h00 in the morning and stops after 18h00 in the evening.

Lighting increases security and reduces the incidence of crime. Special consideration should be given when the facility is fully or partly covered by shelters so that all places are well-lit. Lights must be placed out of reach of vandals and must be economic to operate and easy to maintain.

11.8 Dispatch office

Most combi taxi facilities, with the exception of stops, are controlled by marshals. In some cases two or more marshals were required to control the facility, depending on the number of routes and combi taxis using the facility. The typical duties of a marshal include some of the following:

direct combi taxis to the right lane
direct passengers
ensure that priority of departure is kept
collect fares
give information on routes and destinations.

As the marshal has to be on the scene of the activity all the time, a dispatch office is generally not required. However, the need for a small office/room might arise in cases where a watchman or cleaner is employed. This is likely to happen at long-distance combi taxi facilities where combi taxis are often parked overnight and a watchman is required for security reasons.

11.9 Rest area for drivers

The need for a rest area for drivers is apparent at the long-distance combi taxi facilities. Drivers often arrive at a facility at a late hour and after a long trip and spend the night waiting before starting their return trip in the morning. A rest area would give the drivers the opportunity to rest and start their new trip refreshed, thus increasing safety on the road.

11.10 Commercial activities

The provision of formal commercial activities within a combi taxi facility is a matter related to management policy and as such falls out of the scope of this report. The benefits of providing shops, restaurants and petrol facilities are an added convenience for both passengers and operators, income from rents of shops and the attractiveness of the facility. On the other hand, commercial activities require additional space and could generate other traffic which interferes with the traffic flow within a facility.

11.11 Informal sector

The term informal sector is a widely used term that describes a growing number of people working in mini-business ventures of their own that are normally not reflected in socio-economic statistics. The informal sector is sometimes known as the Underground or Unrecorded economy. Recent estimates bring the total number of people involved in the informal sector in South Africa to no less than 625 000. Out of them there are approximately 150 000 hawkers who are unrecorded, unlisenced and often do not appear in official statistics.

In all the combi taxi facilities visited, the informal sector was present either inside or near the facility. In every case it was obvious that hawkers were satisfying an actual need and providing a service to passengers.

The number of hawkers observed varied in different parts of the country according to the type of facility and to the proximity of other shops. The main product offered was fruit and vegetables. Other products included cooked food, clothes, shoes, leather goods, hats, paintings, curios, etc. The services offered were dry cleaning, shoe repairs, barber shops and many others.

In some facilities an area was demarcated for hawkers, thus limiting their numbers. In some cases stands with shelters were provided as part of the facility for use by the informal sector. This resulted in a better control of the informal sector with obvious benefits on littering and general hygiene aspects.

It is recommended that this sector should be allowed a place in off-street combi taxi facilities, while at on-street facilities the lack of space will in most cases restrict the number of hawkers.

However, some method of controlling this activity is necessary to ensure hygienic conditions and to protect public health. It is therefore recommended that an area should be set aside for the informal sector with certain basic facilities such as stands with shelters. The provision of such facilities sets a limit to the number of hawkers and facilitates their control. A built-in counter of desk height or lower will ensure that goods displayed are kept above ground level but not above eye level of the seller. A seating space/chair in correct relation to the counter and a shelter against sun and rain will make the area attractive.

Because hawkers depend on the passing trade, siting of the hawking area should concide with the main pedestrian flow. There are many examples of bad siting of hawking areas never been used at combi taxi facilities. The informal sector must be placed adjacent to the main stream flow of passengers but it should not obstruct their free movement.

Consideration should also be given to the adjacent land use. Shopkeepers in the vicinity of combi taxi facilities do not want hawkers because they see them as unfair competition.

In any case, the matter of planning for the informal sector in a combi taxi facility should be discussed with representatives of all groups affected and especially with hawkers and nearby shopkeepers, in order to get their co-operation and acceptance of the site chosen and avoid possible friction.

11.12 Other facilities

A number of other secondary facilities may be needed at a combi taxi facility depending on local conditions.

Telephones: The provision of public telephones at combi taxi facilities is desirable. However, they are susceptible to vandalism and require regular maintenance to operate.

Oil-wastebins: It was observed that in some facilities, combi taxis would drain their oil and dispose it either in the dustbins or in the stormwater drain. Neither is acceptable and if there is a need for oil changes some provision for disposal of oil should be made.

Fences: Security reasons call that combi taxi facilities should not be fenced or walled-in. The combi taxi facility design must provide for passenger protection from harassment and violence by offering open areas with direct view of passengers and operators. Open areas provide an environment in which crime is discouraged and combi taxi facilities should comply to this requirement.

Street furniture: The quality of the environment at a combi taxi facility is an important design objective. Street furniture can enhance the quality and aesthetics of a facility but the provision of equipment depends on the funds available. Items that may be included in a combi taxi facility are, bicycle racks, fountains, planters, street clocks, picnic tables, baggage lockers, etc. It is essential that street furniture does not obstruct pedestrian movements.

In the colder areas of the country providing facilities to light up fires in the social area, should be considered. It has been observed that during the cold months of the year combi taxi passengers start fires in order to warm themselves. Providing for this will result in the control of the fires and will avoid damage to other street furniture in the facility.

11.13 Procedure to determine ancillary infrastructure requirements

Following the discussion on the ancillary infrastructure that may be part of a combi taxi facility, the following procedure is recommended to identify what should be provided.

i) Consider the type of facility (terminal, rank, stop, on or off-street)

ii) Consider the operation (commuter or long-distance)

iii) Establish the size of facility and number of passengers

iv) Examine adjacent land use activities and availability of ancillary facilities close by (toilets, shops, telephones, etc)

v) Discuss with operators and passengers and identify their specific needs as far as ancillary infrastructure is concerned.

APPENDIX A

ACTIVITIES IN THE VICINITY OF COMBI TAXI FACILITIES

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Table A1: Activities in the vicinity of combi taxi facilities:

Café - Tea Room	Hospital
Food - Take Aways	Hotel
Fast Foods	Video Shop
Butchery	Black hair salon
Supermarket	Hardware Store
Furnishers	Dry Cleaner
Clothing shop	Vdeo games
Wholesalers	Exhaust centre
Restaurant	Railway station
Bottle store	Bus station
Fruit and Vegetable shop	Post Office
Shoe store	Stationary
Cycle shop	OK Bazaars
Chemist	Pick & Pay
Radio shop	Light Industry
Garage - petrol station	Church
Motor spares	City Hall

APPENDIX B

COMBI TAXI FACILITIES OBSERVED

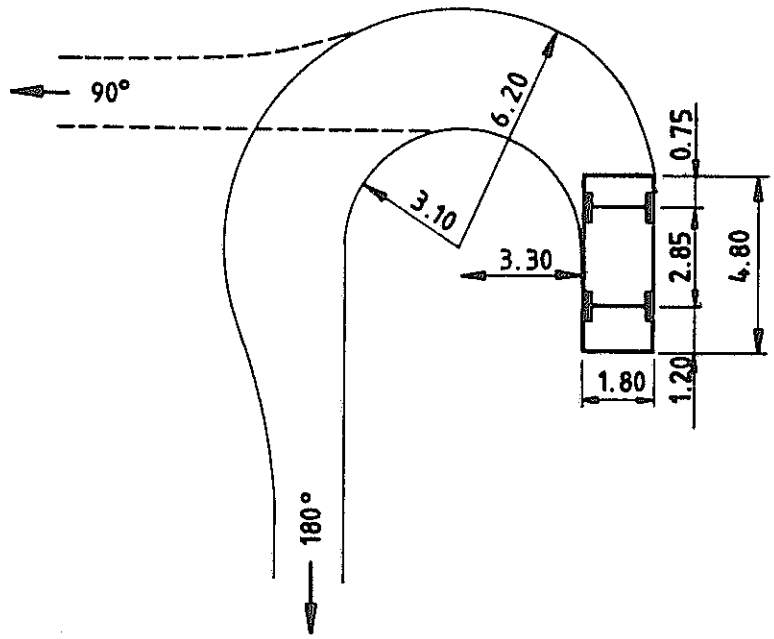
TABLE B1 : COMBI TAXI FACILITIES OBSERVED

CAPE TOWN METROPOLITAN AREA	Bellville terminal Claremont rank Elsiesrivier rank Grand Parade rank Hanover Park rank Mowbray terminal Retreat terminal Wynberg terminal
PORT ELIZABETH METROPOLITAN AREA	Griffin Street terminal Windvogel terminal
CAPE PROVINCE	East London terminal George terminal Grahamstown terminal Kimberley CBD rank Kimberley terminal King William's Town terminal
DURBAN METROPOLITAN AREA	Centenary Road terminal Pinetown terminal
PIETERMARITZBURG METROPOLITAN AREA	Pietermaritzburg terminal
NATAL	Estcourt terminal Ladysmith terminal Newcastle terminal
BLOEMFONTEIN METROPOLITAN AREA	Bloemfontein terminal
ORANGE FREE STATE	Kroonstad terminal Welkom terminal Welkom bus & taxi terminal

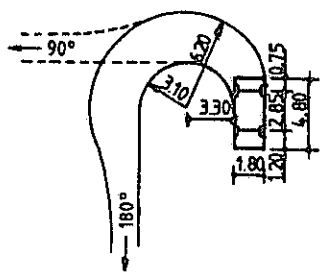
JOHANNESBURG METROPOLITAN AREA	Baragwanath terminal Bree Street terminal City & Suburban holding area Faraday Street terminal Mary Fitzgerald holding area New Doornfontein rank/holding area North Street rank Sandton terminal
PRETORIA METROPOLITAN AREA	Belle Ombre terminal Bloed Street terminal Denneboom terminal
EAST RAND METROPOLITAN AREA	Boksburg terminal Brakpan terminal Nigel terminal Springs transfer station
TRANSVAAL	Heidelberg terminal Klerksdorp terminal Pietersburg Indian Centre terminal Pietersburg Pick and Pay terminal Potchefstroom terminal Standerton terminal Vanderbijlpark terminal Vereeniging terminal

APPENDIX C

TURNING TEMPLATES



Scale 1 : 200



Scale 1:500

TURNING PATH FOR DESIGN VEHICLE AT CRAWL SPEED Fig. C1