A decision support system for the planning of retail facilities: theory, methodology and application
vd Heijden, R.E.C.M.

DOI:
10.6100/IR250639

Published: 01/01/1986

Citation for published version (APA):
A DECISION SUPPORT SYSTEM FOR THE PLANNING OF RETAIL FACILITIES
A DECISION SUPPORT SYSTEM FOR THE PLANNING OF RETAIL FACILITIES

theory, methodology and application

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Technische Universiteit Eindhoven, op gezag van de rector magnificus, prof. dr. F.N. Hooge, voor een commissie aangewezen door het college van decanen in het openbaar te verdedigen op dinsdag 14 oktober 1986 te 16.00 uur

door

ROBERTUS EMMANUEL CORNELIS MARIA VAN DER HEIJDEN

geboren te Renkum

Druk: Dissertatiedrukkerij Wibro, Helmond.
Dit proefschrift is goedgekeurd door de promotoren:
Prof.drs C.W.W. van Lohuizen
en
Prof.dr. T.M.A. Bemelmans
copromotor:
Prof.dr. H.J.P. Timmermans

Heijden, R.E.C.M. van der, A decision support system for the planning of retail facilities: theory, methodology and application.


Thesis Eindhoven University of Technology, includes references and indexes. 1. Urban and regional planning, 2. Regional sciences.

ISBN 90-9001398-9

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ACKNOWLEDGEMENTS

This book is the result of a research study between the end of 1981 and the beginning of 1986. During that period many persons assisted me in various way in developing the research and preparing the manuscript. It is not possible to thank all of them. Nevertheless I like to express my special gratitude to the following persons.

First I like to mention Prof. Dr. H.J.P. Timmermans. Harry was a constant source of ideas and a critical reader in respect of both the mainlines and the details of the study and the manuscript. His support from the very inception of this book was of great importance to me.

The next person is Prof. Drs. C.W.W. van Lohuizen. Wali advised me on the mainlines of the study and the book, critically reviewed various concepts and accepted willingly my continuous exceeding of deadlines.

Prof. Dr. T.M.A. Bemelmans especially advised me in respect of matters concerning computer-assisted decision making.

All the ladies who (re)typed (parts of) the manuscript should be thanked, in particular Mrs Mia Moonen-van den Donk and Miss Marlyn Aretz.

Miss Thea Thuijls completely read the manuscript in order to improve my use of the English language. Irrespective of her efforts, I may have left several textual errors. Evidently, I am responsible for those.

Finally, my wife Dinka Bosman should be given special thank for her intensive support during several years in many ways. She knows more than anyone what it means to me to finish this book. For her constant support, I dedicate this book to her.

Rob van der Heijden,
Eindhoven, 27 August 1986
INTRODUCTION: CONTEXT, AIM AND DESIGN OF THE STUDY

After the Second World War a strong interest emerged on aspects of organization of urban land use. This is caused by the remarkable dynamics in post-war urban systems operations, characterized by growing mobility, expanding urban areas, deconcentration of commercial and non-commercial services and decentralization of labour. Growing income, changing environmental standards for land use functions like living, labour, recreation, transportation, and, in addition, changing preferences and patterns of spatial behaviour of land use categories, underlay these general dynamics. Corresponding dynamics also strongly occurred within retail systems. Although the retail system has a relatively small claim on land use in terms of floorspace, it generally has a considerable impact on the (changing) operations of the urban system. The retail system has two main components: the physical subsystem (locations, size) and the activity subsystem (consumer behaviour, retailer behaviour). The changes in consumer preferences and shopping behaviour and the changes in business economics during the post-war period have had a considerable impact on the nature of the physical subsystem. This became manifest particularly in the development of wholesale centres, hypermarkets and peripheral shopping centres and the viability problems of traditional retail centres.

In consequence of the post-war developments, the need was increasingly felt during the fifties and sixties for control of the dynamic processes within the urban and regional system. A consistent framework for the development of land use plans, in terms of legal prescriptions and organizations, was elaborated and introduced during the sixties. Initially, the main focus within planning was on the effects of population-, labour-, and mobility growth. Towards the end of the sixties, however, retail planning was adopted as an additional field of urban and regional planning in order to control increasing dynamics within retail systems.

Retail planning aims at formulating integrated frameworks (plans) for public spatial policies which attempt to guide processes within the
retail system in order to deliberately achieve a set of objectives. Hence, retail planning is particularly concerned with the preparation of plans on which public spatial policy programs can be based as far as these concern retail system operations. These plans involve a broad spectrum of aspects. Therefore a wide range of information elements with a highly differentiated character is needed to support planning. Applied retail research is basically concerned with producing the major part of these information elements. The supportive role of applied retail research in respect of retail planning focuses on the production of adequate information related to explorative-, impact-, evaluation- and monitoring questions arising during the retail planning process. Therefore parallel to the development of retail planning as a more or less independent part of urban and regional planning in the Netherlands a tradition of applied retail research has developed. The nature of this type of research is based on progress in basic retail research on various aspects of retail systems operations. Since the mid seventies however, applied retail research practices have been criticized heavily. Several aspects of the applied approaches have been discussed intensively during the past ten years by scientists, practitioners and politicians. The discussion comes down to the problem of the production of adequate information to support retail planning within the limits of reasonable costs: it is felt that the ratio between usability of information resulting from research and the required costs is currently relatively unfavourable.

Basically, the criticisms can be understood on three levels. The first level of criticism refers to the relationship between research and planning/policy, particularly the organization of the research project and the basic intention of research. The second level is the conceptual level referring to the theory on retail system operations that underlies the research approach of a particular planning problem. The third level is the level of the operationalization of the theory in terms of a research apparatus. The discussions during the past ten years about applied retail research have produced considerable insight in various issues related to these three levels of applied retail research. Notwithstanding existing criticisms, a main point, however, that applied retail research is still appreciated as an important source of information for retail planning. However, a need for a
reformulation of (aspects of) the currently applied research approach has been argued. Obviously, alternative approaches should avoid criticisms on all three levels.

This study accepts the challenge to elaborate a research approach that is assumed to better meet the requirements of the retail planning support task than applied retail research currently does. The aim of the present study is to formulate and illustrate the principles of a decision support system (DSS) for the planning of retail facilities. In particular, the system is meant for the support of structural retail planning as a part of structural urban and regional planning. The development of such a system will pursue three goals:

(a) to improve the communicative relationship between the production of information (research) and the utilization of information (planning);
(b) to improve the theory underlying the substantive foci of applied retail research;
(c) to provide a more adequate operational methodology for applied retail research.

These three goals correspond with the three levels of criticism mentioned above.

The retail planning DSS will consist of an integrated set of models and data-handling techniques quantitatively describing and predicting (aspects of) retail system operations in terms of trends as well as under the influence of retail plans. The components of the system will be elaborated in correspondence with the basic information needs of retail planning. A cognitive-behavioural theory about consumer and retailer spatial behaviour will constitute the basis of the substantive elaboration of the models and techniques. The DSS will contain a set of elements which distinguishes it from currently applied approaches. This study will be organized as follows.

In the first chapter an analysis of the problematic relationship between retail planning and applied retail research will be given in order to understand and appreciate the criticisms on the aforementioned three levels of applied retail research approaches. This chapter will give an account of the roles of applied retail research and a state-of-the-art which is necessary to fully appreciate the reasoning behind and the significance of the DSS to be developed.
In chapter two a research framework for understanding research activities in terms of the overall relationship between retail planning and applied retail research will be proposed. More specifically, this means that retail planning will be conceived as a process in which the (preparation of) decisions in a context of group deliberations play(s) a crucial role. Final decisions are assumed to be taken by authorized people. The planner and the researcher play basically different roles in the process. The planner is focused on synthesis and consequently guides the group in elaborating plans, evaluating the consequences of these plans and the definition and implementation of operational planning strategies. The researcher covers the information handling activities from an analytic point of view. The support by means of applied retail research during successive phases of the planning process demands for an interactive communication structure between planning and research. Requirements for the interactive relationship in terms of the organization and the substantive focus of research will be formulated. They define the general rationale behind the DSS.

Arguing that the decision support systems approach provides a framework for the fulfilment of the defined substantive requirements for applied retail research, the way chosen in this study will be continued in chapter three. After discussing the advantages of DSS with regard to the problem of this study and the formulation of additional requirements, it will be emphasized that the development of a retail planning DSS requires an answer to the question about the nature of the supportive task of the researcher in the planning team: support of what and when. Therefore, the retail planning decision making process will be analysed using a theoretical decision process model. The results of this analysis provide the framework for defining the system structure of the DSS. In particular, five different production of information tasks related to retail planning decision making will be distinguished: description, exploration of the margins of planning, impact assessment, ex ante evaluation of retail plans, and ex post evaluation of plan implementation (monitoring).

In chapter four the theory of the retail system operations will be elaborated. It provides the substantive basis that underlies the models in the DSS concerned with the production of information about the retail system. As noted, the theory will be based on a cognitive-
behavioural view on the spatial behaviour of consumers and retailers. The scientific paradigm behind the theory axiomatically states that unique aspects related to objects and regularities for the group of similar objects are distinguishable on different levels of analysis. Hence, regularities and unicities are two ends of a continuum, the various natures of which are empirically identifiable on different levels of analysis. The theory will focus on defining the regularities with regard to the operation of retail systems. The theory defined must be empirically connotated. This implies that on the abstraction level that corresponds with the domain of the theory assumptions and hypotheses are measurable and subsequently judgeable on their validity.

In chapter five the operational side of the retail planning DSS will be presented. The chapter itself is subdivided in an introduction and five sections. Each section will give an elaboration of the models and techniques that are considered adequate and suitable for the information production task of each of the five distinguished functions of the DSS with respect to the retail planning process.

To illustrate some of the possibilities of the proposed DSS, chapter six will provide a case study in the region of Maastricht (Netherlands), applying a part of the proposed DSS. The study will end in chapter seven with a discussion of the findings of the study in relation to the problem underlying this study and the criticisms described in chapter 1. This chapter will deal with issues regarding the limits and potentials of the proposed retail planning DSS. Finally chapter eight presents a summary of the main conclusions of this study.
CHAPTER 1: PROBLEM SETTING

1.1 Introduction
Over the past decades scientific knowledge of retail systems has increased tremendously. For example, central place theories and principles of self-organizing systems have increased our understanding of the locational and functional-hierarchical structure of retail systems as well as their dynamics. Behavioural studies have identified the major determinants and regularities underlying consumer decision making behaviour. In addition, spatial interaction theory and random utility theory have been developed as bases for modelling the functional relationship between consumer spatial choice behaviour and the characteristics of the retail structure. As a result, the research apparatus for the support of retail planning, particularly with a focus on evaluating alternative retail plans, has increased rapidly in terms of size, variety and level of sophistication. In this chapter, the main principles of this apparatus will be discussed.

Notwithstanding these developments, relevant literature suggests that the knowledge and apparatus used in applied retail research in the context of retail planning are dated and (partly) not appropriate. Both scientists and practitioners have criticized existing research approaches to retail planning. This chapter analyses these criticisms in order to enlighten the context of the problem of this study. In particular the following aspects will be discussed; first, the mainlines of the development of the retail planning task will be highlighted (section 1.2); next, current practices of applied retail research will be described (section 1.3), followed by a brief analysis of criticism on applied retail research (section 1.4.). The chapter ends with a summary of the conclusions (section 1.5).

1.2 Post-war development of retail planning
An understanding of the major criticisms of current applied retail research approaches asks for a brief introduction of the developments in retail planning after the second world war. Until the Second World
War retail planning was virtually non-existent. As a consequence, the retail structure of an area was solely the result of economic processes which gradually changed the physical- and functional subsystem. Many retail systems were typically characterized by a concentration of retail facilities in the historic centres of urban areas and a set of dispersed retail outlets in the residential areas. Overall, these configurations appeared to be relatively stable.

This situation has changed rather dramatically during the post-war period. The industrial developments had an enormous impact on welfare, preferences and living standards. It changed the use of the physical environment dramatically. Moreover, population grew rapidly. A strong deconcentration of the population was the cause of a tremendous suburban growth and extension of urban areas. Due to this deconcentration distances between urban functions and mobility increased. At the same time the spatial and economic conditions for an increase of mobility improved. These developments are generally referred to in terms of an increase of urban and regional system complexity; growing intensity of the activity subsystem and growing density of the physical subsystem.

As a consequence, physical planning as a generally accepted means for control over spatial developments according to a set of public objectives became increasingly important. Physical planning aims at the preparation of spatial plans to be used as a policy tool for regulating (the impacts of) processes within the urban and regional systems. In particular the focus is on the regulation of the spatial behaviour of different space demanding functions by means of spatial land use plans and related policy programs. The number of options for spatial planning to influence the physical subsystem is generally larger than the number of options to influence the functional subsystem. Land use plans express the desired future structure of the urban and regional system by focusing on the locational pattern, the physical structure and (aspects of) the functional structure, generally indirectly influencing the activity subsystem.

Retail planning is a sub-field of physical planning and is particularly born from the need for guiding the process of decentralization of retail facilities which became manifest during the late sixties and early seventies as a consequence of the urban growth.
The growing need for and realization of urban retail subcentres increasingly unbalanced the relationship between demand (consumer) side and supply (retailer) side of the retail system (Van Peursen, 1971; Davies, 1976). The disequilibrium in the Netherlands became particularly manifest when wholesale centres, hypermarkets and peripheral shopping centres emerged and conventional retail facilities and formula disappeared. The viability of traditional shopping centres was threatened generally as the impact of the large attractiveness of well-equipped urban retail sub-centres (accessibility, parking facilities, choice range). Moreover, traditional constraints on consumer behaviour such as restricted mobility and limited time- and money budgets lost much of their meaning, thus creating new possibilities to establish various new forms of shopping behaviour. A more instable and spatially more dispersed pattern of consumer shopping behaviour resulted.

The attempt for controlling the impacts of these dynamic processes on the physical and activity subsystems by means of (structural) retail plans implies a focus on the regulation of physical- as well as functional structures. However, these possibilities are constrained by the limited set of options for system manipulation inherent to the nature of land use planning. Basically, the available options are related to the spatial allocation of land use functions, the legal control over the allowance of functions on specific locations and the directions on the physical structure, all in relation with other fields of physical planning, such as housing, transportation and non-commercial services. The retail planning options on a structural planning level are hence basically limited to the following set:

- influencing the spatial distribution of retail facilities over the study area ('where');
- influencing the amount of floorspace at specific locations and the distribution of branches ('how much for what');
- influencing accessibility to retail facilities ('how to reach');
- influencing the distribution of population of the study area ('for whom').

The application of these options in the context of structural retail planning is aimed at pursuing public goals on the retail system. These goals are related to the general task to contribute to the improvement.
of the quality of physical and functional structures, avoiding too strong an influence on retailing economics. Hence, structural retail planning deals with problems on the border of business economics and locational, physical and functional planning in a programmatic way. Therefore it generally deals with diverging interests. It concentrates on the questions where, to what extent and in what composition retail facilities are allowed in order to arrange an optimum equilibrium situation between the interests of (categories of) consumers, pursuing public objectives. By means of retail planning conditions are created for relatively free business developments and a sound competition on the one hand and a sufficient supply-side on the other (definition by Werkgroep Hazelhoff, 1980).

This description of the retail planning task has meaning for past as well as future retail planning problems, although important changes in urban and regional developments and consequently also within retail system operations have emerged. Since the late seventies, the tremendous urban expansion (in terms of demography and land use per capita) has come to an end. The problem of the spatial dispersion of retail facilities consequently has become far less dominant within retail planning problems. This implies that the changes within retail system operations are increasingly of a nature that is determined by the unique aspect of existing retail facilities, like new branch mixtures and extensions or reductions of amounts of floorspace. These processes might be related to changes in accessibility, demographic conditions or economic developments. Such processes can be understood as changes in the qualitative and quantitative dimensions of the physical and activity subsystem. Moreover, planning for urban renewal and reconstruction will increasingly be inevitable (readers are referred to Van der Heijden and Westerveld (1982) and Van der Heijden and Van Lohuizen (1983) for a detailed exploration of this issue in the context of retail planning). Hence, changes in terms of the physical- and functional features of retail systems and consumer shopping behaviour also occur during periods of urban growth stabilization when physical planning is focused to a minimum on problems of expansion of urban areas. Retail planning is therefore not losing its meaning, certainly not at a structural planning level. It remains important to formulate and update structural plans in order
to have a framework for deliberations and executive measures in the context of problems on the very local level. Although the substantive problems retail planning is dealing with change, the beforementioned options remain to be the main tools for reaching retail planning goals. Their application is nowadays embedded in planning for stability and in urban management (RARO, 1981).

The past five years have underlined the relevance of some means of retail planning. Literature on retail planning emphasizes that as a result of economic recession during that period a strong tendency of decline of both the functional and the spatial structure of the retail system has become manifest since the late seventies (Luyckx, 1976; Boekema, 1981; Nooteboom, 1982; Van 't Verlaten en Van Teeffelen, 1982). This tendency had negative influences on the quality of the system of retail facilities for a considerable period.

1.3 Mainlines of currently applied retail research
Retail planning has always recognized that the design of retail plans requires a solid body of information on the retail system operations. Consequently, research has always been considered necessary. This led to a tradition of applied retail research starting in the late sixties. In the Netherlands the amount of applied retail research was initially relatively small compared with research in other fields of urban and regional planning, particularly housing and transportation. However, the growing disequilibrium in retail systems, caused by the problem of (peripheral) hypermarkets, gave applied retail research a strong push. Consequently in 1976 applied retail research in the Netherlands was officially added to the existing legal prescriptions for research in the context of urban and regional spatial planning laid down in the by-laws of the 1965 Spatial Planning Act. These prescriptions yield the development of spatial land use plans on the municipal and the provincial level.

Applied retail research in respect of retail planning implies a focus on the production of information about the retail system in order to build an integrated and consistent body of insight, supportive to the process of decision making about plan(s) that can solve particular problems adequately or can pursue particular objectives. Dealing with manipulable variables related to retail plans within the context of a
consistent view of the nature of retail system operations is a pre-requisite to such research. Further, this view must be systematically related to consumer-, retailer- and public interests. Throughout the changes in retail planning problems the need for research that deals with these changes to support retail planning has never been seriously doubted, although some contributions to the discussions on applied research sometimes tend to explicitly stress the necessity of deliberations with various interest groups and reduce the role of research (Heskes, 1982; Van den Akker, 1982; Van 't Verlaat and Van Teeffelen, 1982). It is, however, evident that deliberations should not become a surrogate for research.

A large body of criticism on applied retail research emerged after the legal prescription of it. It is related to the uncertainty about the type of research that should be conducted, given a tendency to reject traditional approaches in applied retail research because of the high costs relative to the limited supportive value of the research results. This unfavourable ratio has turned out to be a major disadvantage of traditional approaches. In order to appreciate these criticisms, current approaches of applied retail research and their relationships with more basic retail research need to be discussed briefly. Beforehand it is noted that this discussion necessarily focuses on the main principles in the stream of studies. This section is therefore subdivided in the following subsections. Subsection 1.3.1 will deal with the role of central place theories, while 1.3.2 will describe that of the behavioural approach. Subsection 1.3.3 will deal with the increasing role of quantitative modelling.

1.3.1 The role of central place theories

Before 1970 little if any research was directly fitted to problems of retail planning. A few studies attempted to identify functional- and spatial hierarchies within the supply-side of retail systems. This emphasis on the supply-side of the retail system can at least partially be explained by the prevailing planning concepts at that time. In particular the concept of functional- and spatial hierarchy, which was based on classical central place theories of Christaller and Lösch, had dominated the planning field since the fifties, as is argued by e.g. Buursink (1973, 1980) and Klooster (1974). Several basic studies
have, more or less successfully, attempted to identify the functional- and spatial hierarchies that are predicted by classical central place theory on the inter-urban as well as intra-urban level (for instance, Smailes and Hartley, 1961; Carruthers, 1962; Clark, 1967; Luyten and Verberk, 1968; Smouth, 1970; Buursink, 1971a,b). Accordingly, the main stream of applied retail studies in the Netherlands on both the intra-urban and inter-urban level referred to classical central place theories and the concept of functional- and spatial hierarchy and focused on aspects of the supply-side (for instance RPD, 1974; OKU, 1974, 1976; PARTNERS, 1974; Rottier and Steffens, 1975; Buursink and Heins, 1974-1977; CINK, 1977; PPD-Zuid Holland, 1978).

However, from the mid sixties until now, the focus on central place theory in applied retail research and retail planning has increasingly been criticized for three main reasons. In the first place it was argued that classical central place theory was logically inconsistent. Secondly, criticism focused on the very rigorous assumptions of central place theory, not only with respect to retailer behaviour but also and perhaps most importantly with respect to spatial consumer behaviour. Thirdly, the whole issue of applying a normative theory based on very rigorous assumptions which bear no obvious (that is empirical) relationship with present real-world processes was seriously questioned in the context of retail planning.

With respect to the first two issues special reference is made to the extensive study on central place theories conducted by Timmermans (1979a). In his study Timmermans critically reviews the classical central place theories of Christaller and Lösch as well as more recent modifications and extensions of these theories in terms of their logical consistency and empirical status. As far as the issue of consistency is concerned he concludes that the theory of Lösch is inconsistent in that no account was taken of inevitably occurring agglomeration effects. Moreover, both Christaller and Lösch, according to Timmermans, did not take account of the inevitable possibility of multi-purpose trips that is related to the widening of the range of lower order goods and services in higher level central places. Moreover, this possibility was not excluded in the premisses of the theory. Timmermans argues that the existence of multi-purpose trips will influence the spatial-geometrical and functional structure of the
resulting pattern of central places. The implicit denial of the multi-purpose trip phenomenon renders the deduction of the concept of functional- and spatial hierarchy invalid.

Secondly the criticism of the basic assumptions of classical central place theories is related to a growing understanding, since the mid sixties, of retailer- as well as consumer (spatial) behaviour, as the result of a broad stream of studies on this theme. The basic behavioural assumptions that are relevant in this context are:
- all consumers have identical needs for goods and services, determined by the price that must be paid for it at the location where it is obtained. That price consists of the price of the good or service plus the costs of bridging the distance. Consequently, since consumer behaviour is characterized by maximizing utility, consumers will have distance-minimizing spatial behaviour;
- consumers as well as retailers are perfectly informed about their environment;
- retailers prefer a location where already other retailers are, but no competitors. Retailers try to maximize the distance to this competition.

This set of assumptions is related to classical theories of economic utility maximizing behaviour. These assumptions are not tested in classical central place theories, but are axiomatically applied. An enormous amount of empirical studies tested the assumptions (see for an overview Timmermans, 1979a, chapter 3). Many empirical studies found the set of assumptions not to describe, explain and predict real-world retail systems operations and choice behaviour patterns adequately (c.q. the rise of hypermarkets and the vanishing of lower level order functions in the higher level central places). The findings suggested that the assumptions have no strong empirical connotation. Together with the growing insight in internal inconsistencies in classical central place theories, these results consequently lead to doubts about the explanatory value of the classical central place theories.

Thirdly, the normative application of the concept of functional and spatial hierarchy, predicted by the theory, in the context of retail planning, was increasingly criticized. This issue is embedded in a more general and permanent discussion about normativity in physical planning. Support can be given to the idea that planning has
particular normative dimensions in order to guide socio-spatial developments according to some public goals or conceptions. However, an approach in which these public goals or conceptions are based on a scientific concept or theory with the intention of giving the planning a quasi-empirical status is questionable. Such a situation is particularly rejectable if the scientific concept lacks a firm empirical basis. Among others Buursink (1980) held a plea for normative applications of central place theories in retail planning. His reasons bear a socio-spatial character. Inherent to his choice, however, is the opinion that spatial behaviour can and must adapt to the physical environment. Buursink accepts this consequence where he states that the real-world must be transformed to the features of the applied concept. This viewpoint that retail planning should have the pretention to build a functional- and/or spatial structure that is able to overrule autonomous processes should, however, be critized. The risk of creating an environment, according to a particular planning concept, that operates on a sub-optimal level and produces tensions is too large. A normative application of the concept of functional- and spatial hierarchy that shows so much disadvantages in terms of the empirical status of the underlying theory, is seemingly rooted in the pretentious belief in human possibilities and rights to 'construct' society basically according to human objectives. This viewpoint has been elaborated previously in Westerveld and Van der Heijden (1980) and Van der Heijden and Westerveld (1984) in respect of physical planning.

The consequence of this viewpoint is that the theoretical concept used in applied retail research and retail planning should be connected as tightly as possible to the real-world nature of the processes and phenomena it describes in order to understand (describe and explain) the retail system operations in 'its own language'. This implies that a careful analytic and inductive theory-building approach is preferred to the deductive, normative application of concepts or metaphors that have no obvious relationship with the object under consideration. The use of metaphors is generally based upon extra metaphysical assumptions of the transferability of the theory or model to another empirical domain. In contrast, a more inductive step-by-step approach can both reduce the role of metaphysical assumptions and enable the users of
the theory and model to understand more systematically which reductions of the real-world variety at every step are possible and accepted in theory-building and modelling processes.

1.3.2 The behavioural approaches

In the field of basic retail research an inductive approach, as mentioned above, has been initiated since the late sixties as a reaction on failures of classical central place theories. The approach is embedded in the behavioural research tradition (for an overview see Timmermans, 1981a). Its focus is on the demand-side of the retail system: the consumers. The behavioural approach in retail research starts from the axiom that consumers are incompletely informed and are maximizing utility within their spatial behaviour not only because of economic reasons. Previously neglected determinants, particularly related to the individual structural position, are assumed to influence consumer shopping behaviour. Initially, hypotheses focused on the relationships between consumer shopping behaviour and environmental, personal socio-economic and cultural factors. During the seventies, in addition to or at variance with the individual structural position approach, increasingly the subjective perception and the personal evaluation of the shopping environment and the formulation of preferences are assumed to be the most determining mechanisms in the context of shopping behaviour. This theoretical emphasis has been labeled as the so-called cognitive-behavioural approach.

The start of the behavioural approach is characterized by a focus on the patterns of aggregate consumer spatial shopping behaviour. Basic studies focused on explicitly inventoring and describing behaviour primarily to test basic assumptions of classical central place theory. For instance, basic studies focusing on distance behaviour of consumers (e.g. Colledge, Rushton and Clark, 1966; Yuill, 1967; Clark and Rushton, 1970; Day, 1973; Young, 1975) suggested that especially on the intra-urban level consumers do not consistently tend to show distance-minimizing behaviour. The attractiveness of a shopping centre was found to be of considerable influence on spatial shopping behaviour too (Yuill, 1967; Clark, 1968; Timmermans, 1980c). Further, the important influence on shopping patterns of multi-purpose and multi-stop behaviour was described (e.g. O'Kelly, 1983). Moreover, basic
studies pointed out that consumers possess incomplete knowledge of their shopping environment (for instance: Hanson, 1976; Potter, 1977, 1978, 1979; Timmermans, Van der Heijden and Westerveld, 1982a).

In addition to the purely description of aggregate patterns of shopping behaviour a set of basic studies performed correlational analyses attempting to explore the influence of assumed determinants on differences in consumer patronage of shopping centres. Socio-economic and cultural characteristics of consumers were operationalized in variables like car-ownership, family-size, education, income (social class) and the like. The results of empirical studies point out that in well-developed countries there is no clear evidence for the explanatory value of these variables on differences in overt consumer shopping patterns. A second category of assumed determinants, related to the attributes of the supply side, has been operationalized in terms of price, choice, amount of shops and parking facilities, i.e. attractiveness-variables, in a trade-off with the distance between the consumer's dwelling and the patronized shopping facility. There is a firm body of empirical studies suggesting that these variables influence consumer shopping behaviour. Both types of empirical studies, however, are typically focused on getting insight in the associative values between shopping behaviour and their assumed determinants. The types of performed analysis (correlational techniques) do not produce sufficient insight in the explanatory value and the discriminatory effect of the assumed determinants.

In particular this fuzziness about the explanatory power of the assumed determinants with respect to overt differences in consumer spatial shopping patterns gave rise to the cognitive-behavioural approach, which assumes the consumer spatial choice behaviour to be the result of an individual decision making process aimed at deciding where to shop in the context of a particular shopping task. The decision making is based on the subjective perception of retail facilities, the evaluation of these on the basis of subjective criteria with regard to the personal decision problem and other personal characteristics and the formulation of preferences. This cognitive-behavioural approach hence stresses the psychological process of subjective perception and evaluation of the shopping environment that precedes overt shopping behaviour instead of explaining behaviour by
focusing on overt shopping patterns. The individual decision making mechanisms are, as mechanisms, assumed to be independent of the specific nature of the retail system the individual is confronted with. The characteristics of the retail system constitute the input in the perception and evaluation process which results in a particular choice behaviour. There has been a tremendous progress in the last decade in theory-building on this so-called individual spatial decision making process, the measurement of the necessary data and the testing of the assumptions on the nature of this process. The advantage of the cognitive-behavioural approach is that it interprets the effects of (changes in) the shopping environment in terms of the outcome of the individual decision making process. Changes in the environment through perception and subjective evaluation ultimately cause changes in preference and overt behaviour. The cognitive-behavioural theory-building focuses on the definition of these causalities. Because of the obvious disadvantages of classical central place theories one would expect the behavioural insights to be of considerable influence on this type of research. In the Netherlands, however, such influence can only be distinguished remarkably late and the progress within the behavioural approach only gradually became incorporated within the research tradition.

Towards the end of the seventies applied retail research began to combine the traditional attention for the issue of spatial and functional characteristics of the retail system with attention for behavioural aspects of overt consumer spatial shopping behaviour. Examples in this context are studies of Rottier and Steffens (1975), RPD (1978), CIMK (1981). A major problem with this type of applied studies is, however, that the explicit attention to both objective characteristics of supply-side and characteristics of consumer patronage of retail facilities is insufficiently interrelated in terms of an explicit theory. On the one hand the description of the supply-side uses explanatory notions related to classical central place theory and the concept of functional- and spatial hierarchy, although the underlying assumptions are not fully accepted. On the other hand assumed determinants of spatial consumer behaviour are described without relating them to phenomena at the supply-side. Both dimensions are neither theoretically related to each other nor to manipulable
planning variables. The approach lacks a theoretically based assessment of the likely impacts of retail plans on spatial consumer behaviour and the viability of shopping centres without making additional assumptions. The results of this type of analysis are therefore primarily relevant as additional background information. As such, planners are not supported directly and sufficiently. Consequently, given the lack of a feasible alternative, in the context of retail planning the concept of a functional- and spatial hierarchy is still to some degree supported. Retail planners have continued to use it in a normative way by accepting its functional and spatial ordering of retail facilities. Levels of the hierarchy are translated into normative expenditure percentages for the service domain of shopping centres. The resulting expenditures are then translated into amounts of viable floorspace, additionally used as directives for planning (see e.g. Bosman and Van Goor, 1976; Stad en Landschap, 1976, 1978a,b; Lukkes, 1980). Given the gradual incorporation of behavioural insights in aggregate consumer shopping behaviour into applied retail research, it is not really remarkable that the younger cognitive-behavioural approach is even less accepted and applied in the context of applied retail research. On the other hand, much depends on the elaboration of new theoretical insights into an operational research apparatus, applicable in the context of applied retail research. This elaboration has been in development for a few years; this study intends to give a contribution to that elaboration. The main focus of the proposals so far has been the definition of quantitative models for the description and prediction of consumer spatial choice patterns. The next subsection pays special attention to this aspect. This focus is related to the grown relevance of quantitative modelling in the past ten years.

1.3.3 The importance of quantitative modelling

During the seventies planners strongly began to feel the lack of an apparatus to assess the likely impacts of alternative retail plans, particularly as they faced the hypermarket problem. The necessity of a restrictive retail policy concerning these developments had been stressed in the early seventies in several discussions on this problem and particularly by an interdepartmental committee (Werkgroep De Vries, 1973) and the National Physical Planning Agency (RARO, 1973).
The necessity to decide on the requests for permission to start such retail forms caused a need for a research methodology to explain, predict and evaluate the effects of such developments systematically from a spatial policy point of view ('what...if' problems). The use of a quantitative model of consumer spatial choice patterns was proposed as an answer to this need (Werkgroep Rompmodel, 1974). The consumer patronage of retail facilities was argued to be the key to the viability of retail facilities. A quantitative model of consumer choice behaviour should be used to assess the expenditure distribution over an area, enabling the researcher to explore the expenditure shifts caused by new large retail facilities in the area studied. In the Netherlands, an important effort to develop and apply a spatial interaction model was made in the mid seventies (NEI, 1974, 1976). Other similar models were introduced and applied, based on Newton's gravity theory or discrete choice theory. The models were constructed on the notion of a trade-off between distance and attractiveness underlying consumer spatial choice behaviour and assuming single purpose trips and the existence of complete information of shopping opportunities. Both traditional assumptions as well as insights derived from descriptive-behavioural studies were used.

From the mid seventies until now the use of spatial interaction models has increasingly become a regular part of applied retail research. Several variants of the basic equation of the Wilson spatial interaction model and NEI's discrete choice model were suggested and applied. The formulation of these variants was initiated through developments in the area of entropy maximizing and discrete choice theory, although the basic equation remained. Applications in the Netherlands include for instance Gaaff and Van Handenhoven (1980), CIMK (1978, 1981), NEI (1979), Borchert, Doorn and Floor (1984). As a result of the progress in modelling two types of applied retail research can be distinguished: (a) descriptive-analytic studies and (b) studies that use quantitative models of consumer spatial choice behaviour.

The first category of studies is characterized by an analytic description of the retail structure in terms of functional- and spatial hierarchies and aspects of consumer patronage of retail facilities. Sometimes correlational relations between behavioural patterns and
environmental and socio-economic characteristics are computed. As has been stated before, the most important function of such studies is the support planners derive from a general insight in the retail system in the study area particularly for exploring and defining the problems in the operations of that retail system. The lack of a consistent theory on the relationship between consumer choices and the operations of retail facilities makes the approach less suitable for the support of 'what...if' planning problems.

The second category of applied retail research not only describes analytically the main aspects of the retail system (the supply-side and aspects of consumer patronage of retail facilities), but also adds to the descriptive phase the use of a quantitative expenditure distribution model. The model conditionally predicts consumer interaction patterns between retail facilities and residential areas. The models are generally of the spatial interaction type, the entropy maximizing type or the multi-nomial logit type. The use of models not only supports retail planning in terms of exploring planning problems but also in terms of predicting the likely impacts of alternative plans. Predicted interaction patterns associated with a specific planning option are linked to expenditure flows and the resulting turnover in retail centres is a measure of their viability. These figures can give insight in the expected changes in retail system operations caused by the pursued plan implementation.

The descriptive and predictive aspects are summarized in terms of a figure that is considered characteristic for current research approaches (Figure 1). The figure summarizes the main elements in overviews of currently applied retail research approaches by several authors (for instance Borchert, 1979; Gantvoort, 1979; Meerman, 1981; Van de Berg, Hendriks and Van de Meer; 1981; Boekema, 1981; and BRO, 1981). Most applied studies only deviate marginally from this scheme. As argued, some studies do not apply a quantitative expenditure model while other studies do not involve a consumer questionnaire (e.g. Bosman and Van Goor, 1976). Further, some studies pay relatively much attention to the description and explanation of differences in consumer shopping patterns (Rottier and Steffens, 1974; RPD, 1978), while in other studies relatively much attention is paid to the description of the retail structure (e.g. Buit and Nozeman, 1974-1976).
Figure 1: Mainlines of the common approach in currently applied retail research (free to Gantvoort, 1979)
Moreover, studies may vary in terms of the choice of the number and types of variables, the level of sophistication in the analysis of consumer- or retailer behaviour, the operationalization of variables, the type and complexity of expenditure models and so on. The choices that are made in this context depend on the research problem on hand, the theoretical framework, the costs of gathering the necessary data and the nature of information that has to be produced.

1.4 Discussions on currently applied retail research
The relationship between applied retail research, as described in the previous section, and retail planning has often been described as problematic during the past decade (for instance by Jansen, 1977, 1978; Bak and Verberk, 1980; De Nooij, 1980; Van der Linde and Bout, 1981; Van der Heijden and Westerveld, 1982). The dominant feeling is that the information production in applied retail research is not sufficiently tailored to the information needs of the retail planning process. A considerable body of criticism of applied retail research has resulted. In this section the main criticisms will be discussed. This discussion focuses on three distinguishable levels of the applied retail research approaches. These levels of criticism have to be discussed because of two reasons: they can be derived inductively from the body of criticism, and they refer to the three main issues of each type of research: 'philosophy' and organization, theory and (operational) methodology. The levels are the following:

- the first level concerns the criticism of the role of applied retail research with respect to retail planning: what is the position of applied retail research? What are its goals? How is it organized?
- the second level concerns criticism of the theoretical concepts underlying applied retail research. In particular emphasis is laid on whether the concepts are sufficient planning-orientated or not;
- the third level refers to the operational methodology of applied retail research.

These three levels correspond with the main levels of the so-called Concept of Urbanistics suggested by Goudappel (1976, 1980). Within that concept these levels are respectively labeled as the ideos-structural level, the super-structural level and the infra-structural level. Goudappel argues that each object of study can be analysed in
terms of the characteristics of these three levels. The result is a comprehensive analytic picture of the object of study. The approach by means of the three levels might therefore be used successfully not only in an analytic way to overview criticism of applied retail research but also in a synthetic way: to develop an alternative research apparatus by elaborating mutually related frameworks on all three levels. It is remarkable to note that in the Netherlands many contributions to the discussion about applied retail research only pay attention to specific elements on isolated levels. In contrast, criticisms should be mutually related as much as possible. The analysis is presented in three successive subsections according to the above mentioned levels.

1.4.1 The philosophy of applied retail research with respect to retail planning (the ideo-structural level of criticism)

There exists a more or less general opinion in the discussions about applied retail research that this research is in its actual performance too strongly orientated on the problems of research instead of an orientation on problems of retail planning (see e.g. Bak and Verberk, 1980). Critics argue that within retail research insufficient attention is paid to the process of implementation and utilization of research results in the planning process. Too frequently applied retail research tends to proceed retail planning: research stops when planning starts. Researchers often assume that the findings of their activities will sufficiently include the answers to the planning questions that will arise. In other words: the way research is performed often creates a time lag and consequently in many situations also a substantive gap between information production and information needs. In that situation the researcher cannot anticipate all possible information needs arising during the planning process. As a result, the researcher is (implicitly) forced to solve questions that seem to be relevant from his/her point of view with regard to the planning problems. Consequently, applied retail research turns out to be focused too often on solving scientific questions using a standard approach that might not sufficiently be tailored to the planning information needs.

An important cause for these problems could be the fact that a major part of the applied retail research effort is generally performed by a limited number of specialized researchers who have the required
knowledge and technical infrastructure to do this type of research, but who are not directly involved in the planning process. This situation particularly occurs within the context of the application of quantitative expenditure distribution models (the structural planning projects in general). In such situations the actual planning activities like thinking over problems, discussing plans, evaluating available information and so on, often start as soon as the results of the research project have been reported. Hence, the communication between the researcher(s) and planners, politicians and other interest groups is intensified after having finished the data collection and the (first) analyses. It is obvious that the margins for influencing research activities are small under such circumstances.

Fortunately, in the past few years, attention has increasingly been paid to a more interactive organizational setting of the larger applied retail research projects, especially because of the related high costs of the type of research. Increasingly, the research project is embedded in a context of group deliberations in which various parties with different interests (among which the planner, the politician and retailer) participate. The rationale behind this is that regular meetings and permanent communication are a main requirement for a closer connection between information production and information needs arising during the planning process. A project-organization enables the participants to pay more attention to the specific information needs at successive planning process phases in terms of questions and answers. This emphasizes the supportive role of research instead of a preceding and dominating role.

Notwithstanding the increasing attention for a better project-organization, the problem remains that the participants in the team often are not able to express their information needs adequately. Consequently, this may as yet lead to a too strong attention for the problems that seem relevant within the researcher's framework. Among others, Van der Meulen and Heskes (1979) and Bak and Verberk (1980) argue that too little emphasis is laid on the understanding of the information needs at successive phases of the retail planning process, the definition of goals of research and accordingly the differentiation of research activities. On the other hand, it is obvious that the understanding of information needs and definition of research goals
are inevitably embedded in an explicit and adequate understanding of the problems of retail planning and hence the retail system operations. This implies that a real supportive role of research demands for an explicit planning process view of the one hand and a theory on the retail system on the other hand. The way in which the retail system operations are understood (explained and measured) has a direct influence on the kind of information that is generated by applied retail research (what information, how to produce). The process view is the framework that identifies the phases of planning that are candidates for the support through research (what information when). Currently the existence of the gap between information production and information needs is at least partly caused by the lack of these views.

A remaining problem is that of the appreciation of information generated by applied retail research and the use of information by participants of the planning group, provided the information is tailored to the planning information needs. This is however a different question from the one of the focus on information production itself. The researcher and the planner have different attitudes. The researcher primarily deals with the problems analytically, whereas the planner pursues a synthetic translation from analytic information, various (sometimes conflicting) goals and existing limits for problem solving, into retail plans, a future perspective on the retail system and strategies of implementation. The researcher is claimed to support this planning aim and activity, but evidently has other methods, approaches, possibilities and responsibilities. Plan design is not the same as research. These differences can partly be minimized, as far as the extension and nature of the body of information used to support retail planning is concerned. On the other hand differences in attitude must be accepted as far as they are related to the way of dealing with uncertainties and the differences in responsibility. In some situations these last mentioned aspects create the gap between information production and information utilization by the planning group, even if the information is 'objectively' correct and sufficient. Seeking increased utilization in such circumstances is not a problem of developing a new research methodology, but a matter of mutual trust among participants in the planning group (compare Bemelmans, 1979b).
1.4.2 Theory of the retail system (the super-structural level of criticism)

As argued in the previous subsection, a theory of the retail system is needed for effectuating adequate forms of applied retail research. The theory operates as a framework for information production. In general, several types of theory underlie current applied retail research. They have partly been judged in literature to be inadequate, invalid or inconsistent. Criticism on the super-structural level hence refers to the issue of appreciating the adequacy of the theories on the retail system that are applied in research with respect to the nature of retail planning. In this subsection, first three requirements for theory-building will be discussed. In addition currently applied theories are evaluated in respect of these requirements.

Requirement 1 for theory-building

In particular Jansen (1977, 1978, 1982, 1983) has argued that the researcher generally has an invalid view of the multidimensionality of the retail system operations. He doubts whether the retail system can be understood (explained and measured) in terms of patterns and regularities in the same way as the quantitative modelling approach does. Alternatively, Jansen tries to understand the real-world in a phenomenological way in which he stresses the relevance of uniqueness and variety within the behaviour of retailers and consumers. Consequently, he tends to deny the recognizability of dominant patterns and regularities, and he illustrates this viewpoint both for consumer shopping behaviour (Jansen, 1982) and retailer behaviour (Jansen and Koopman, 1983). In his opinion a research approach that is solely focused on aspects of regularities in (spatial) behaviour of consumers and retailers cannot lead to the production of valid nor efficient information. As this is the dominant approach in applied retail research, he has strong doubts about the usability of its outcomes. The approach demands for a strong abstraction and a heavy weight on conventional research quality criteria (like representativeness, causality, generalizability and empirical confirmation) which are, according to Jansen, not suitable for the understanding of retail system performances.

This viewpoint of the theoretical basis of applied retail research
is an exponent of an existing tendency to doubt the usability of quantitative modelling approaches and, in contrast, to emphasize the value of knowledge of the uniqueness of study objects. The doubt is related to a feeling of disappointment about applications of quantitative models in applied retail research in the past, in particular of the unfavourable ratio between usability of resulting information and necessary costs. The viewpoint of the validity and usability of the theoretical approach particularly depends on metaphysical assumptions about the existence of measurable regularities and patterns in retail system operations. The assumptions underlying Jansen's view are not shared here. A too strong emphasis is put on the unique sides of real-world objects in the retail system and a too artificial distinction is made between the regular and unique sides of those objects.

In contrast, in this study the assumption is accepted that the real-world objects in fact combine both unique and regular dimensions of their performance within one continuum (Schuurman, 1972; Nijkamp, 1980b) and that these dimensions are, at least to a certain degree and depending upon the level of analysis, recognizable. The process of recognition of these regularities demands for the application of specific levels of abstraction. Unique sides of a multidimensional object are in that view not denied but generally conceived in statistical terms (error terms; stochastic variables). Moreover, there exists no empirical evidence that the knowledge of patterns and regularities of objects is less reliable than the knowledge of their unique sides. This implies that the criterion of abstraction is not necessarily discriminatory in the discussion of the validity and usability of knowledge. Other criteria for the information production have to be formulated.

In particular the usability of information in the context of retail planning on the structural planning level must be an important criterion, given the supportive task of applied retail research. Additionally, one has to recognize that the nature of structural retail planning demands knowledge of the regularities in the planned system in a particular area. Retail planning is not aimed at regulating the details of the retail system operations but is focused on the mainlines and aggregate levels of retail system operations, leaving a certain
existential freedom for the variety of unique elements in real-world. Hence, a theoretical approach that aims at producing information on the level of regularities in the retail system is more planning supportive than an approach that focuses on unique details of the object under study. Moreover, the latter mentioned approach might lack the power of generalizability and consequently a focus on forecasting, where retail planning is to a considerable degree just in need of predictions of impacts of alternative plans.

In addition, special reference is made to a contribution by Nijkamp (1980a) to the discussion about the theoretical basis of applied retail research. On the one hand he criticizes the tendency to handle multidimensionality too reductively and too abstractly. On the other hand he (implicitly) starts from the assumption of continuity in unique and regular dimensions of the retail planning object. He argues that a more intensive cognitive-behavioural study of consumer shopping behaviour, retailer behaviour and system dynamics is needed to enrich basic insights in retail system operations. In addition, Nijkamp suggests a conceptual framework that is based on the possibilities for identification of the more general mechanisms and he emphasizes the growing importance of methods and models for the systematic analysis of 'soft' data.

The above mentioned metaphysical choice for continuity between uniqueness and complete regularity evidently has consequences for the theory of the retail system operations and its operationalization in terms of a research methodology. Theory-building in this context is aimed at formulating an abstract and generalized representation of the basic elements and their interrelationships of retail system operations in terms of a set of systematically related axioms and testable assumptions in order to provide the researcher with a consistent and comprehensive framework for measurement, analysis and interpretation regarding that object of study. The theory enables him to formulate answers on the questions which variables and data should be addressed in research and how relationships between elements can be measured and understood. More specifically, building a theory of the retail system operations requires the representation of regularities regarding consumer spatial choice behaviour, retailer (spatial) behaviour and their dynamic relationship (action-reaction), within the constraints
of a particular physical structure (Van der Heijden, 1984). The axiom resulting from the discussion above is that these regularities really exist and are measurable.

**Requirement 2 for theory-building**

An additional requirement is that the theory should be retail planning orientated. According to the described nature of retail planning problems and -task (section 1.2.), this implies a focus within the theory on formulating a framework for answering 'what' questions, 'what...if' questions and 'how' questions.

The first type of questions refers to the need for a consistent exploratory analysis of retail systems operations in order to gain insight in current and expected problems, so as to determine what problems might be considered as planning problems and what planning options and margins exist; for example: how is the distribution of floorspace over the study area?; how are facilities patronaged by consumers at the moment?; which trends exist and how will these cause autonomous changes in viability of retail facilities? and so on.

The second category of questions refers to the special attention for the consequences of policy measures based on retail plans, on both the activity and physical subsystems. These 'what...if' questions in particular occur in the context of deciding on plans within the limits of a set of predefined planning objectives. Examples are: which shift in patronage of retail centres will be caused when a new centre with $x$ square metres of floorspace is realized at a particular location and what does this mean for the viability of existing retail centres? What effects does the realization of a set of new routes within the transportation network have on expenditure shifts, accessibility, distributional justice and so on?

The third category of questions refers to the planning and policy context and the instrumental dimensions of policy measures to be taken in the second category. Special reference is made to the conduct in a time perspective of variables that are considered to be manipulable; for instance: is increase of floorspace (hence attractiveness) of a shopping centre preferable in order to strengthen its viability or should reduction of floorspace be considered? How are these measures related to previous measures or to the goals of interest groups? What
are acceptable measures, given public objectives like distributional justice or equality in accessibility as conditions for planning?

Explorative analyses demand for a framework that at least defines variables and related data as a checklist. In this way a 'static' description is possible. A time-'dynamic' description (what is the trend?) and a focus on assessing impacts of plans demand for the additional capacity of the framework to model the relationship between consumer patronage and viability of centres. This implies the requirement that the suggested relationships are understandable in terms of causalities between independent and dependent variables. The impacts to be assessed constitute the fields of dependent variables while the retail plans regard the manipulable independent variables. A focus on the first category of questions requires the incorporation of retailer-, consumer- and public interests in terms of an ex ante evaluation focused approach. Consequently, a theoretical framework usable for assessing impacts of retail planning options can also be used for an analytic-systematic description of the retail systems operations, while reversely this is not necessarily the case. The appreciation of the adequacy of theoretical conceptualizations currently used in applied retail research must at least be based on an evaluation of their power to produce reliable and sufficient insights in the likely (future) impacts of retail plans on consumer-, retailer- and public interests.

Requirement 3 for theory-building
In section 1.3 a choice has been made in favour of an inductive way of theory-building with regard to the retail system operations. The cognitive-behavioural approach was argued to be the currently 'best' known set of theoretical principles. The approach is applicable on the individual level and considers overt behaviour as the result of an individual psychological decision making process. These mechanisms are, at least theoretically, interpretable in terms of causalities. Changes in the physical- and functional structure of the retail system (for instance as a result of planning) might cause changes in the ultimate choice behaviour. Moreover, the model(s) that ultimately describe(s) the individual psychological decision making steps can be defined in terms of equations that are relatively independent of the
characteristics of the physical- or functional subsystems. Planning variables belong to the category of independent variables and are treated in the model(s) in a corresponding way. Therefore, the focus on cognitive-behavioural aspects of the operations of the retail system is considered to be the third requirement to theory-building on behalf of retail research.

Evaluation of the theoretical basis of currently applied retail research

The three requirements to theory-building that have been discussed above, can also be used as criteria for the evaluation of currently used theories in applied retail research. In section 1.3 a distinction was made between descriptive-analytic applied studies and applied studies focused on modelling. The conclusion was drawn that the descriptive-analytic studies generally use theoretical notions deduced from classical central place theories (in particular the notion of a functional- and spatial hierarchy). Further, more recently, also some notions of behavioural theory building have been incorporated in such studies in specific patterns of consumer shopping behaviour with personal characteristics. Typical for the second category of studies is the application of discrete choice models based on deterministic or random utility theory (logistic interaction model). The criticisms of these theoretical bases can be summarized as follows:

Descriptive-analytic studies

a) Applied theoretical principles deduced from classical central place theories are not based upon inductive theory-building. The assumptions of retailer and consumer behaviour tend to have little or no consistent empirical connotation. Moreover, they are not interpretable in terms of cognitive-behavioural decision making processes of individuals. The explanatory value of the theoretical framework must be considered relatively low, which implies an insufficient focus on 'what...if' and 'how' questions.

b) The use of behavioural theoretical notions is aimed at describing and explaining differences in overt patterns of consumer spatial choice behaviour by assumed determinants, related to socio-economic characteristics of consumers (like age, family-size, income and mobility) or spatial variables. The suggested relationships are
based on correlational analyses, the results of which are not necessarily interpretable in terms of causalities. Moreover, the approach is perhaps only partly interpretable in terms of cognitive-behavioural mechanisms of individual decision making.

c) The application of the behavioural notions is generally limited to consumer shopping behaviour. Classical assumptions of retailer behaviour are (implicitly) accepted.

Quantitative modelling studies

a) Applied retail research that is aimed at defining and using quantitative expenditure models generally accept theoretical notions emphasizing some basic relationship between attributes of retail facilities (including the distance to be bridged) or their overall utility and overt spatial shopping behaviour of consumers. Criticisms of the models directly express the criticisms of these underlying theories. These criticisms are for instance summarized by Timmermans (1981b) and Timmermans and Veldhuisen (1981). The models that are used, generally spatial interaction models, entropy maximizing models or logit models, are a priori specified and are not the result of an inductive analytic description of a cognitive-behavioural approach of consumer choice behaviour. The parameters of the model are calibrated on overt choice patterns in order to make the model fit the data. Consequently, the assumptions are not really tested. The models further assume that consumers have perfect information about their shopping environment and that their shopping behaviour consists of single purpose trips.

The calibration of the spatial interaction and entropy maximizing models is based on correlational analysis between observed aggregate consumer spatial choice patterns and attributes of existing retail facilities. In case of the models based on utility theory, overall utilities of retail facilities are derived from observed choice patterns and they are a posteriori explained in terms of attributes of the retail facilities by using correlational techniques. Implicitly the subjective perception and evaluation of the shopping environment are assumed to be linearly related to objective characteristics the shopping environment. Consequently, the parameters of the models are not necessarily interpretable in terms
of individual decision making processes of consumers neither in terms of causalities. The use of correlational analysis implies that the parameters of the model may be influenced by specific characteristics of the physical- and functional structure of the retail system at the moment of calibration. In other words, the parameters partly depend on the specific spatial structure of the area studied. Assessing the likely impacts of retail plans consequently requires an additional set of non empirical assumptions about the change of the parameter values or the generalizability of the model beyond its spatial-empirical domain (e.g. Guy, 1981).

b) Theories underlying the commonly used quantitative models in applied retail research have so far only applied to consumer spatial choice behaviour. Retailer behaviour has not been dealt with until very recently (Timmermans 1986).

The conclusion is that although several quantitative models might be good descriptors of consumer spatial choice patterns, only a limited set of them can meet the specified requirements. This implies a need for improving and extending the theoretical framework that underlies applied retail research.

1.4.3 The operational research approach (the infra-structural level of criticism)

The third level of criticism of applied retail research concerns aspects of the operational research approach. The focus on this level is generally on applied methods and models for measurements, data-gathering and analyses, the number and kind of variables and the kind of required data. Evidently, a considerable part of the criticism regarding the theoretical basis of the research approach also deals with aspects of operationalization. In the literature these criticisms are coloured with a special interest in the trade-off between costs on the one hand and richness, reliability and usability of information on the other hand, since there is a common opinion that applied retail research is in general too expensive in relation to other types of research and to the resulting body of knowledge. The following issues will be discussed in this subsection because of the special attention they receive in the discussion on applied retail research:

- the incorporation of consumer-, retailer- and public interests;
- the data-needs and the related costs.

The first issue refers to the feeling that there is a lack of sufficient and reliable information on relevant retail planning relevant criteria. Planning relevant criteria are related to consumer-, retailer- as well as public interests. These interests are not operationalized in adequate ways and/or inequal importance is attached to these interests in the context of both information production and plan evaluation in current practices. Bak and Verberk (1980) and Verlaat and Van Teeffelen (1982) for instance argue that applied retail research is too strongly focused on producing information aimed at retailer interests by focusing on expenditure flow patterns, turnover, turnover-to-floorspace ratios and viability of retail facilities. Emphasis is put on over- and underexpenditures and consequently the absolute levels of turnover-to-floorspace ratios that are realized for retail facilities, given a priori defined norms. The consequence of this emphasis is that the ultimate retail plan strongly depends on the right calculation of the existing or expected floorspace ratios and the determination of the value of the normative floorspace ratios. Van den Akker (1982) in particular notes that this causes firm negotiations within the planning group about the value of these normative criteria, not in the least because of the problem of defining the correct measurement procedure and interpretation of the data. Consequently, retailers participating in the planning group and generally having a protective attitude have an advantage when they evaluate retail plans, since the criteria related to business economics are often the only evaluation criteria. Under such circumstances retail planning has the image of planning business economics, in which the consumer interest is merely operationalized as the maximum acceptable distance to a politically specified minimum amount of floorspace for daily goods. Public interests (like amount of mobility, need of infrastructure, land use) are generally not dealt with explicitly. There is, therefore, a need for defining a broader and more diverse set of evaluation criteria, not only incorporating aspects of retailer interests in a more varied way, but also (more) aspects of consumer interests and public interests (compare Van de Berg, Hendriks and Van de Meer, 1981; Van der Heijden, Timmermans and Borgers, 1984).

The second issue concerns the need of data in relation to the
applied methodology, particularly because of the costs of research. Currently the afore discussed forms of applied retail research are characterized by means of the collection of relatively large data sets, particularly when quantitative expenditure models are used. As described, these models involve a calibration procedure that is based on observed interaction patterns between what has been defined as origin and destination zones. The procedure aims at increasing the descriptive value of the model in terms of finding the best fit to the collected data. The interaction matrix that is needed to calibrate the model must give a reliable picture of real-world interactions to increase the credibility of the model used in the context of retail planning support. In order to get such a reliable picture a certain refinement in the definition of residential and retail zones is generally required. However there is a positive correlation between the number of zones and the need for data.

Another disadvantage of the currently used models is that the parameter values are in principle not transferable unconditionally to other study areas. Consequently, the application of these models strictly demands for a full data collection for different study areas. In contrast to current approaches the cognitive-behavioural approach primarily demands for measurements of the individual perception, subjective filtering of information and evaluation of retail facilities. These types of measurement have the advantage for data collection that, given the assumption that the nature of several of the psychological mechanisms are independent of the specific real-world context, measurements for the estimation of the model can take place by using experimental designs; the number of respondents can be kept small. This assumption also suggests that the findings of particular measurements in one area might be spatially transferable, which implies an applicability in the context of applied studies in areas with an other spatial structure. Generally, observed interactions serve as a basis for checking the outcomes of the model. Several of these aspects will be addressed in a more detailed way in the remainder of this study. It is however not necessarily true that an approach based on the cognitive-behavioural theoretical principles implies less costs of research than traditional approaches. For instance, the measurements themselves are more complex than current data collection
methods in the context of applied retail research. So far at least no comparative study has been performed. However, theoretically the trade-off between costs and validity, usability and richness of resulting information can be improved when applying a cognitive-behavioural approach.

1.5 Summary and conclusions
The problem of this study has been defined as the reformulation of the applied retail research apparatus. The need for such a reformulation stems from the considerable amount of criticisms of applied retail research. The theoretical and operational aspects of a new research apparatus should on the one hand be linked with the existing research tradition, as far as this is adequate for the aim of the research system in development. On the other hand lacks have to be filled and inadequate aspects of the practices replaced. Therefore, a primary need was felt for an evaluation of current research approaches. This chapter gave an evaluating and appreciating view of current applied retail research. This view has been embedded in a short description of the development of the retail planning task in the Netherlands in the post-war period. Next, the research effort has been discussed in terms of the substantive foci and the type of performed analyses. Finally, criticism of applied retail research has been summarized on three levels: the 'philosophy' and organization, the accepted theories and the operational methodology. The main conclusions are the following.

On an ideo-structural level applied retail research sometimes lacks the right foci and organizational conditions to fulfill its supportive tasks with respect to retail planning adequately. More specifically, an explicit focus on the variety in information needs is necessary. Moreover, the organization should provide conditions for a more intensive communication than is presently the case. As such, a project-organization, enabling the elaboration of the retail plan within a more or less fixed group, is preferred.

On a super-structural level theories underlying applied retail research are insufficiently adequate. Particularly three requirements for theory-building were put forward. The first one states that particular regularities in retail system operations really exist and are measurable. The theory should deal with these regularities. The
second requirement puts a claim on the theory in terms of its planning-orientation. More specifically, this implies a focus on 'what', 'what...if' and 'how' questions. Thirdly, the theory should be based on cognitive-behavioural principles of individual decision making processes, underlying spatial behaviour of the individual. An evaluation of theories, commonly used in currently applied retail research, using these three requirements as criteria points out that none of them sufficiently fulfils these criteria.

Criticism on the infra-structural level of applied retail research refers to aspects of the operational approach and is strongly related to the criticisms on the super-structural level. Two issues got special reference. First, the need for a more explicit focus on and elaboration of the variety of retailer-, consumer- and public interests has been stressed. Secondly, some considerations about the trade-off between the richness and usability value of information produced by applied retail research on the one hand and the costs of research on the other hand were presented. The need of data is particularly considered to be a relevant issue in this respect. A cognitive-behavioural approach of the retail system operations is preferred to other approaches because of the assumed higher level of spatial transferability of (parts of) the related measurements and because of the greater information richness of the approach.

The elaboration of an alternative approach for applied retail research intends to cope with the criticisms expressed in this chapter. The formulation of an integrated operational approach of applied retail research is pursued with frameworks that regard all three levels of analysis. To start with, the next chapter deals with the elaboration of an overall framework for understanding the nature of the relationship between retail planning and applied retail research.
2.1 Introduction
The previous chapter stated that part of the body of criticism of current applied retail research focuses on the ideo-structural relationship between research and retail planning. The main points are the following. First, research is often finished before the actual planning process starts. Second, research tends to solve scientifically interesting problems and, moreover, retail planning tends to be based deterministically on research findings. However, scientific issues do not necessarily correspond to the problems retail planning copes with. Information needs in retail planning often reach beyond the domain of traditional research approaches. Third, the organizational setting of applied retail research does not provide the most adequate conditions for an intensive and effective communication between researchers and planners.

These criticisms, formulated in the past years by several authors, constitute a point of departure, both in this chapter and in chapter three, for suggesting a more effective ideo-structural framework for the relationship between applied retail research and retail planning. This chapter focuses on highlighting the context of the abovementioned problems and, in addition, pays special attention to three issues: a. the aim and focus of applied retail research in relation to structural retail planning; b. the (organizational) position of applied retail research; c. the consequences of (a) and (b) for applied retail research in terms of requirements.

The considerations will result in a plea for applying a so-called decision support system approach to applied retail research. In the next chapter the ideo-structural nature of a retail planning DSS is elaborated.

The discussion on planning, research and their mutual relationships in this chapter do not have the pretention to be comprehensively applicable to all fields of applied planning research. Only when
necessary and illustrative, special reference will be made to these
general developments and views. This chapter is structured as follows:
in section 2.2 the background of the criticism of the ideo-structural
relationship between retail planning and applied retail research will
be highlighted. Next, in section 2.3 attention will be paid to the
decision nature of retail planning. This nature determines the ideo­
structural requirements for applied retail research. These requirements
will be elaborated in section 2.4. The chapter ends in 2.5 with a
summary of the main conclusions.

2.2 Background of the problem
In order to be able to develop an appropriate ideo-structural framework
for applied retail research, at first some more insight should be
given into the background of relevant criticism. In particular three
dimensions play relevant roles in this respect: a. the organization of
applied retail research, b. the substance of applied retail research
and c. the theoretical views on the position of applied retail
research. These dimensions will be discussed in this section in
relation to three successive time periods: the period until the early
seventies, the period from the early seventies to the end of the
seventies/early eighties and the period until today.

During the sixties and the early seventies retail planning in the
Netherlands focused on creating a functional- and spatial hierarchy of
retail facilities, based on notions of classical central place theory.
In that period this focus was hardly criticized since it was firmly
related to the socio-spatial tradition in town planning that favoured
a decentralized, multi-nodal hierarchy of zones for living, working,
distribution and so on, on the intra-urban level and a hierarchy of
central places on the inter-urban level. Various examples of town
planning in the Netherlands from that period are based on that
principle; on the inter-urban level, for example, the geography of the
Noord-Oost Polder; and on the intra-urban level new towns like Lelystad
and Almere. Expansion of existing urban areas was generally also based
on the principle of a functional- and spatial hierarchy. This
influenced the planning of retail facilities substantively (see Bak,
1971; Buursink, 1973; Klooster, 1974). Irrespective of the serious
criticism of the classical central place theory and the manifest
unexplained dynamics of the retail systems, the concept of functional-
and spatial hierarchy remained a basic principle of retail planning
(De Kuyer, 1978; Buursink, 1975, 1980).

During the sixties and early seventies retail planning, consequently, particularly involved the allocation of retail facilities clustered in terms of shopping centres of different size. These allocations resulted in a kind of blue prints for the geography of the retail system. Research focused on calculating the viability of centres in order to support land reservations making assumptions with regard to the development of the size of the population in the study area, the general economic development and the market shares of each shopping centre in terms of proportions of spending power in the primary market area of different shopping centres for various types of goods. In general the relationship between activities of planning and activities of research was rather satisfactory, not in the least because they were organized and performed by the same people. Moreover the construction and exploitation of retail facilities since the early sixties had increasingly become a matter of private investments by larger financiers. They were of course primarily interested in the viability of their investments. Once the final permits were given to these financiers by public agencies the plan execution was mainly considered to be their responsibility. Further, the economic context in the Netherlands until the mid seventies resulted in growth in spending power per capita. In that climate shopping facilities generally flourished well, at least in economic terms. Mistakes in retail planning were rather easily compensated.

Two substantive developments have dramatically changed this situation since the early seventies. First, wholesale centres and peripheral shopping centres arose (Snijder and Van der Velden, 1973; Borchert, 1973; Salmon, Buzzell and Cort, 1974). Secondly, since the mid seventies economic perspectives have substantively changed in combination with a much lower growth of population than in the past decades. Expenditure developments and consumer preferences turned out to be different from the assumptions underlying retail planning. An increasing number of mistakes of retail planning, effectuated in the preceding period, were revealed. As a consequence, several (particularly smaller) shopping centres increasingly operated on a
suboptimal level during the past decade. A relatively high percentage of floorspace for retailing became unused. As noted before, due to these developments the overall nature of retail planning problems has changed since the mid seventies. Retail planning problems have gradually got a more public nature. This implies that the existing problems related to the operation of retail systems increasingly have impacts on the quality of physical- and functional dimensions of urban structures. And reversely, planning measures implemented in existing physical- and functional structures have increasing impacts on the viability of existing shopping centres. The public influence on retail planning gradually grew as planning problems increasingly dealt with public spatial interests. The consequence of this process was that the blue print approach of retail planning increasingly appeared to be ineffective in dealing with problems of operational retail policies. The criticism of retail planning and applied retail research is related to this recognition.

These criticisms are consistent with more general criticisms of traditional blue print approaches in spatial planning practices and theory. Influenced by the growing complexity of urban and regional systems, an increasing public awareness during the seventies and an increasing request for greater public influence on physical planning in that period became manifest. Consequently, planners had to deal more explicitly and consistently with various interest groups and non-professional knowledge input in the planning process. Moreover, it was increasingly recognized that the implicit 'certainties' of the blue print approaches actually had no empirical connotation. In contrast, the role of uncertainties was stressed (Goudappel, 1973, 1981). The consequence of this emphasis is an increased need for a more continuous planning process which carefully deals with aspects of uncertainties in the planning process. Research and planning were increasingly forced to pay more attention to their assumptions, the reductions and abstractions they accept and to the process nature of planned processes. The aim of research in the past decade shifted from producing valid information on observed socio-spatial performances of urban systems (the larger part of applied planning research until the end of the seventies) to the reduction of uncertainties and the production of explicitly conditioned information on what is likely to
happen given particular planning measures (since the end seventies).

In terms of theory-building regarding physical planning these developments were translated into and initiated by an increasing focus on the process of plan preparation and on plan execution and monitoring rather than on the nature of the ultimate plan conform the blueprint tradition. Emphasis was laid on the procedures of planning, the decisions taken and the information used. This had an influence on applied research in terms of an emancipation movement. The result of this emancipation was an increased variety in techniques, methods, models and substantive theories updating research projects. Both in theory and to some degree in planning practice more attention was paid to the definition of goals, the development of alternative plans, the systematic evaluation on impacts of alternative plans and to the monitoring of plan effectuation. In practice this increased focus can be recognized since the second half of the seventies.

The ideo-structural criticism of applied retail research stresses that it has not been sufficiently adjusted to these changes neither substantively nor organizationally. Applied retail research is frequently performed as if the traditional relationship with retail planning is still most effective. This causes a frustrated information exchange. Moreover, applied retail research did not adapt quickly enough to the worsening economic circumstances by means of developing cheaper methods and approaches. An important reason for this late adaptation to changed circumstances might be the separate development and organization of a large part of applied retail research since the mid seventies with respect to retail planning. The problem of wholesale centres and peripheral centres demanded a more sophisticated research approach, resulting in the use of several types of quantitative expenditure distribution models. The specialized nature of these models caused a concentration of know how in specialized research institutes or groups associated with universities. Moreover the existing influence of financiers on retail planning and in general the large investments in retail facilities, also meant a lasting influence on applied research. This has been interpreted in terms of an emphasis in research on viable amounts of floorspace on particular locations. At the same time, the traditional socio-spatial dimension of retail planning has lost relevance mainly because of considerably less urban
expansion and the recognition of mistakes in effectuated planning. These aspects caused a dominance of applied retail research on retail planning. Consequently, retail planning problems tended to be adjusted to the problems that could be solved by means of applied retail research, while research itself increasingly got a more independent position with respect to retail planning.

This situation lasted until the end of the seventies/early eighties. During the seventies serious doubts on planning in general were formulated because of the revealed incapability of providing solutions to problems, resulting from the general economic decline. Economic perspectives were rather bad and in the early eighties the spending power per capita decreased considerably. Economic aspects increasingly dominated the physical planning process. Meanwhile the emphasis on plan preparation resulted in an increased awareness of the deliberation and bargaining character of many planning processes (Van der Cammen, 1982; Veldhuisen, Hacfoort and Timmermans, 1982). The link of both processes caused the recognition of the importance of decision making. On the one hand this implied an emphasis on the political responsibilities of planners and politicians in the planning process. On the other hand this increased the awareness of the personal responsibility of researchers with respect to the planning process. Voogd (1982) for example warns for too close a connection between research and planning in organizations, and the importance of applied research is stressed in counterbalancing the tendency of ignoring research (Van der Meulen and Van der Heijden, 1985). On the other hand the substantive and organizational subdivision of research and planning as is the result of the emancipation of research and the elaboration of planning mainly in terms of procedures and institutes is nowadays generally found not always to be really contributive to more effective and efficient planning.

In this context the influence of the study of Van Lohuizen and Daamen (1976) on these recognitions should be memorized. Their study explored the intension and variety of applied planning research in the Netherlands during the seventies and came to the conclusion that many lacks existed in the variety of studied aspects as well as in the attitudes of many researchers, given the nature of supported planning processes. The report initiated an intensive discussion on the
relationship between planning and research (see e.g. S&V 1978). Additional work by, for instance, Van Lohuizen resulted in the elaboration of problems of applied research and proposals for education, organization and substantive foci (see e.g. Van Lohuizen 1980, 1981, 1983, 1984).

In respect of applied retail research and retail planning elements of deliberations and bargaining were explicitly recognized in recent years (Van den Akker, 1982). For this field, this has led and should lead to more attention for plan preparation and decision making. In order to establish an improved link between applied retail research and structural retail planning both activities are increasingly organized in projects. In the project-organization a mixed group of planners, interest groups and researchers elaborates the retail plan. Each of the participants plays his/her own role and each role is based on individual specialization and responsibility. This implies a basic deviation, in terms of support, from the traditional deterministic and linear utilization scheme, based on the covering of different roles by the same professional. This partly organizational reintegration of applied retail research and retail planning does not necessarily imply the acceptance of research findings as the only body of knowledge for planning. Normative and research external information may of course also be accepted in the planning process. The research problems and approaches are too complex to be completely covered by non-experts. Reversely, planning procedures and methods explicitly recognize the relativity of research findings. Much depends, of course, on the degree in which each of the participants of the team acts on his/her responsibility. Applied retail research can contribute to this by applying supportive methods that appeal to each individual responsibility and the freedom in decision making.

Clearly, applied retail research can only be contributive in such a way when it focuses on the main features of the retail planning process. In relation to this insight it is emphasized that decision making has been mentioned before as the main characteristic of retail planning. In the past decade an important movement within theory-building on planning in general and physical planning in particular has recognized and positively valued the relevance of careful decision
making in planning processes. The question in that context is not whether decisions are taken but how they are taken: what conditions, what information, how explicit, etc. The view on retail planning accepted in this study in order to understand the supportive task of applied retail research is associated with this theoretical movement. It implies that the research apparatus should be linked more explicitly with the decision nature of retail planning. In the next section this nature will be discussed in a more detailed way. After that the requirements for applied retail research will be elaborated as a derivation of the supportive task of research in respect of the decision making process.

2.3 The decision nature of retail planning

In chapter I it has been argued that retail planning deals with the question where, to what extent and in what composition retail facilities should be pursued. The answer to this question is embedded in a careful dealing with the trade-off between retailer-, consumer- and public interests. Structural retail planning focuses on the definition of a program of strategies (a plan) as a fundament underlying political measures with regard to the retail system, and the systematic control of the developments within the retail system. On the one hand this control is meant as a means for problem identification and as a link to policy when and where operational measures have to be taken (feedforward, early warning); on the other hand it is meant as the evaluation of the development of the retail system after the effectuation of a particular plan (monitoring). Such a control may initiate an update of the plan (feedback). Feedforwards and feedbacks may give the plan preparation the required, continuous nature.

Particularly in the traditional blue print approach the plan preparation was seen as a linear-rational process, dominated by experts. It is typical for such a process that each stage is completed before the planners enter the next stage. Moreover, a planning monitor is not explicitly included. The present view on planning deviates from that linear-rational expert view in that it is recognized that the important dimension of plan preparation as well as of the relationship between monitoring and updates of plans is basically the dimension of learning by the participants. Viewpoints gradually develop, insights
gradually increase, information is not systematically provided and partly (mis)used, etcetera. More precisely, planning is considered to be a participative and iterative process in which decisions are taken in interaction with the available imperfect information on the one hand and more or less explicit aims with regard to (a part of) the decision issues on the other hand (principle of bounded rationality, Simon, 1960). These decisions are necessary to link separate and analytic information elements. Hence in the planning process these various information elements are brought together, selected, judged and integratively transferred into the ultimate synthetic plan.

Faludi, who is strongly associated to the decision-oriented view on planning (e.g. Faludi, 1973, 1978, 1983), argues that an operational policy decision is an act of desirability that has to be justified in relation to the relevant (public) interests. This in fact implies that a choice is justified. Making a choice in turn implies a decision about the desirability of at least two alternatives. This decision should take into consideration the pursued aims, the impacts of these alternatives in the perspective of these aims, the costs of implementation, etc. An adequate support of the policy decision maker, therefore, implies that the framework for support must provide argued insights in the nature of the retail policy problems, alternative plans, expected impacts and possibly interdependencies with other policies.

Obviously, irrespective of the possible lack of rationality of the process of planning (rationality in the linear-rational expert model view), the outcome of the planning process is characterized by aspects of consistency, reliability and explicitness with regard to the choices made, the reductions and abstractions applied and the use of available information. This nature of this product is to a high degree featured by the same principles that underlie the nature of products of research activities. In that way, research and planning are not always clearly to be distinguished. The question however is whether this implies the same as Faludi (1983) states: research and planning should not (always) be separated. If this is meant as a plea for considering research and planning synonyms, this might imply that the described characteristics of the planning process will dominate over research activities and/or that planning is forced to accept the scientific rationality of research. The first development would be
undesirable because of the loss of supportive power (as is for example described by Fransen, 1985) as the consequence of less consistency and the possible dominance of policy norms on the foci of research. The second development would imply the revitalization of a type of planning that has been judged negatively in the past. There exists a trade-off between the possibilities to rationalize the planning according to scientific norms and the deliberation-dominated and iterative-participative nature of current planning processes.

With regard to retail planning these considerations imply that it may be understood as a process of sequential micro-level decision making. These decisions are taken iteratively by answering the questions: what are the choice alternatives; what are the consequences of choosing one alternative in this set; what are the relationships with previous decisions; and what are the implications of a particular choice for further decision making? On the aggregate level of the final result of planning this sequence of iteratively made choices results in a systematic overview of the mainlines of decision making from problem identification through plan definition and impact evaluation to ultimate choice and effectuation (this has been argued in detail in Van der Heijden and Van der Meulen, 1983a,b). The quality of the final plan depends on the behaviour of the participants in the group of decision makers: willingness, knowledge, trust, consensus-sensibility and the like. Moreover, each successive decision making step can only be adequately carried out on the basis of information provided to answer the abovementioned questions. This implies the necessity of collecting and analysing relevant data. Applied retail research is supportive to this provision of relevant information in terms of the production of (a part of) that information and in terms of the transfer of the collected information to the group participants, bearing an own scientific responsibility. In the next section attention will be paid to some basic requirements for this supportive task of applied retail research.

2.4 Requirements for the support of retail planning

Afore, it was noted that the supportive task of the researcher in respect of retail planning is nowadays extended to, in principle, all stages of the retail planning process. This task cannot be adequately
fulfilled without meeting requirements that are tailored to such planning-research relationships. These requirements describe conditions for improving the production of adequate information and the improvement of the use of information by decision makers. They can be derived from the so-called 'utilization of knowledge' movement.

The 'utilization of knowledge' movement is an international movement that focuses on studying various aspects of the discrepancy between research and planning. In particular the applied nature of research with respect to planning and policy is theoretically elaborated and empirically explored. The movement is initiated by social sciences in the USA (compare Burchell and Sternlieb, 1979), whereas the Dutch connection seems to have a relatively stronger focus on the field of physical planning (see the previously mentioned work of Van Lohuizen). Decision making is assumed to be a main dimension of planning processes and it is recognized by representatives of the movement that the availability and utilization of information play a dominant role in decision making. Consequently, the production and the handling of information are not separated within elaborated concepts. The integration of substantive foci of information production and the transfer of information towards decision makers in terms of concepts and operational methods of research are main concerns. This integration aims at improving the quality of decision making within the planning process and ultimately the quality of the planning outcome by organizing a better underlying body of information and increasing the accessibility to this information. A great number of issues is related to this problem. Several of these issues were studied intensively in the past decade. Since an overview of these contributions is not contributive to the aim of this section, the reader is referred to Van Lohuizen (1984) and Hutjes (1984) for an overview. Some thoughts within the 'utilization of knowledge' approach, however, are important in order to clarify the position of applied retail research on an ideo-structural level and will therefore be summarized below. Moreover, they provide the pursued requirements. The following issues will be discussed:

- the identification of the nature and variety of the information needs associated with the planning process;
- the definition and use of a 'planning-orientated theory';
the quality criteria for information production;
- the transfer of information towards the participants in the planning group.

Information needs
A main issue within the 'utilization of knowledge' movement concerns the structuring of research according to the information needs related to the supported planning process. The issue is a reaction on the tendency of researchers to focus their activities primarily on questions of scientific relevance. Such a focus is not necessarily contributive to the process of choices in the planning process. Alternatively, the 'utilization of knowledge' movement typically considers applied research a type of research that is not primarily aimed at the progress of scientific discipline knowledge as such, although scientific goals are not neglected. According to this movement the aim of applied research is to contribute to the solution of practical, real-world planning problems in a particular study area. Consequently much attention should be paid to exploring and defining the information needs of the planning process. Moreover, those needs should be selected that can be answered by means of research.

In the context of a project of applied retail research this requirement implies that the researcher and the other participants in the planning team carefully discuss at every step during decision making what they want to know and what the options are for answering this question by means of research activities. The requirement implies that in this study the basic information needs of structural retail planning processes are identified. In other words, it is necessary in this study to answer the question what information needs these retail planning processes have in common. These needs have to be identified in such a way that it is unlikely that real-world information needs in the context of concrete research or a planning project basically differ from the information needs that underlie the methodology development. Clearly, it is generally impossible to develop a basically new methodology in the context of applied retail research (no time, no money). Hence, the methodology that has to be developed should be specified to such an extent with respect to the mainlines of information needs that it enables the researcher in practice to link
It to the information needs in specific decision making contexts.

**Planning-orientated theory**

In particular Albinski (1984) has argued that the information production by means of applied research, aimed at the support of what he calls the achievement of extra-scientific goals, should be based on a so-called policy-orientated theory. In his contribution 'policy' stands more generally for the supported decision making process. Hence, in order to be consistent with the previously used terms here the term 'planning-orientated' theory will be applied.

The planning-orientated theory integrates and formalizes the substantive foci of the information production activities. It aids the decision makers by providing them with a framework for identifying goals, problems and possible solutions. On the other hand, it helps decision makers to explicate abstractions and reductions in decision making and the limits in availability of data and information. A main requirement for the planning-orientated theory according to Albinski is that it should cover the causal stratum. This implies that the theory includes insights in the planned system as far as they are relevant for the supported planning process and as far as these insights can be described in terms of (causal) relationships. With respect to the theory underlying applied retail research in the previous chapter a similar requirement has been formulated as a derivation of the objectives of retail planning. The causal stratum represents the dynamic operation of the retail system and as such it is related to the empirical nature of the planned objects. A cognitive-behavioural approach of the causal stratum has been evaluated as the most appropriate approach.

A second requirement for the planning-orientated theory is the incorporation of the values and norms stratum, which enables decision makers to evaluate situations they have to decide on. This implies that indicators are needed to quantify the evaluated situation adequately. In the context of retail planning the quantification of these performances should cover the interests the decision makers deal with: consumer-, retailer- and public interests. Consequently the planning-orientated theory underlying applied retail research has to
give the framework for understanding these interests in order to constitute a basis which empirically indicates retail system performances. Therefore, perhaps the term 'interest stratum' is more appropriate. Evidently, the understanding of the dynamics of the retail system in the causal stratum and the quantification of retail system performances are strongly related.

Albinski mentions two more strata to be covered by a planning-orientated theory. The first one is termed the decision stratum and the second one the action stratum. The decision stratum focuses on the willingness of decision makers to change situations which are valued negatively and to maintain (or improve) situations which are valued positively. Further, it covers the options to effectuate this willingness. The action stratum deals with the implementation of the decisions in terms of actions and their monitoring. In contrast to the first two mentioned strata the decision- and action strata do not solely cope with (empirical) aspects of the retail system but also with the value system of planning and policy on the one hand and the processing of information on the retail system on the other hand. As such the decision- and action strata refer to the handling of empirical information on the retail system the causal- and interest stratum focus on, in relation to the value system of decision makers. The object of the planning-orientated theory with regard to these two strata hence concerns the interaction structure between the value system and the quantification of the retail system operations, whereas the object of the two first mentioned strata concerns the empirical nature of the retail system operations. These differences in objects might create fuzziness in elaborating the planning-orientated theory. To avoid this the term planning-orientated theory will be used in this study in association with the first two strata and as such it will be consistent with the previous use of the term theory. In addition it is noted that the two other strata are strongly related to the act of support which in its turn is directly related to the identification of the information needs of the planning process and the way these needs can be answered by means of applied retail research. The consequences of paying attention to the decision- and action stratum in applied retail research will be given thought to in the context of the elaboration of the information needs (chapter 3).
Some contributors to the 'utilization of knowledge' movement argue that in certain situations the relevance of information produced by means of applied research for the supported decision making process is negatively influenced because of a strict acceptance of classical scientific criteria with regard to the information production process: empirical reliability, generalizability, causality and theoretical validity. Examples of studies addressing this issue are studies of Seidel (1981), Cohen (1980) and Weiss and Bucavalas (1980).

There are two types of answers to the question whether classical scientific quality criteria are of negative influence on the utilization value of produced information. The first type of answer confirms the likeliness of this negative influence, given the outcomes of some empirical studies. Therefore representatives of this opinion plea for some trade-off between the scientific quality criteria and aspects of application or utilization. For example, Van der Vall (1980) argues that scientific validity should be matched with both implementation and utilization strategies, since explanatory value alone is no guarantee for impact on decision making. This implies that scientific criteria might be used more critically and perhaps selectively.

Alternatively, one could advocate the use of a cumulative set of quality criteria, in such a way that produced information is not only reliable and valid from a scientific point of view, but also appropriate for the support of decision making without transferring the decision problem and the decision itself into scientific research questions. Although it might be difficult to simultaneously deal with scientific quality criteria and utilization/implementation criteria, this approach has some advantages compared with the above mentioned approach. First one should recognize that the impact of research is extremely difficult to be measured. Consequently, the few studies that have been published on this issue do not permit generalization beyond the domain of these studies. Moreover, one creates a rather fuzzy situation of research if information quality standards are used selectively. There exists very little insight in the isolated impacts of specific criteria on under-, mis- or overutilization of produced information. Therefore it is not obvious what criteria in what context
should be neglected. This might cause subjective selectivity and, therefore, vagueness on the status and application value of produced information (what kind of biases; is application valid beyond the domain of measurement; do reductions and abstractions correspond to real-world processes; what is the validity of a particular set of data?).

It is only possible to solve the question within clear sets of specified conditions. General statements tend to ignore the variety in these conditions for information production and utilization. In that context it is noted that empirical studies on the negative influence of some classical scientific quality criteria generally refer to so-called 'two-community' contexts in which research and planning or policy are basically separated in terms of interests, attitudes, organization, and the like. It is questionable whether the contexts of these studies in fact reflect the Dutch relationship between applied research and physical planning adequately. At least in the context of retail planning on the structural planning level organized in terms of a project group, the two-community model seems to be invalid. This implies that the use of a methodology developed by paying attention to a cumulative set of information quality criteria is not a priori a condition that influences the use of research findings negatively.

The next question is what the additional implementation/utilization criteria in the context of applied retail research are. First, within the present field, it is possible to explicitly link the explanatory variables with manipulable variables. This must be considered crucial for an effective support of retail planning. A second, already noted, criterion concerns the link of the theoretical understanding of the retail system with decision making during each stage of the retail planning process. The planning-orientated theory provides the basis for this link by elaborating the notions for the quantification of retail system performances. Third, the quality of information is influenced by the degree of processing data tailored to the information needs related to the decision problem at hand. For example, a table containing the impact-values of a set of alternative retail plans on a set of evaluation criteria is less contributive to deciding on the preferred plan as compared to this matrix and the additional presentation of the results of the performance of some
conditional multicriteria evaluations on that evaluation matrix. Hence, attention should be paid to the form in which research findings are presented with respect to their relevance for decision making and, reversely, the consequences of specific information needs on data-processing. These criteria suggest that in particular the analysis of the planning process to identify the information needs, the elaboration of a planning-orientated theory and the development of the methodology are of interest for gaining insight in whether or not the cumulative set of quality criteria conflicts with or meets the attempts to improve the support of retail planning.

**Transfer structure**
The issue of the transfer of produced information on to the decision makers mainly refers to an organizational setting. Assuming that in the context of structural retail planning research and planning activities are organized within one project, the question with regard to this issue is: what criteria apply to the communication structure between research and planning activities in such a way that the utilization of available information is improved? The common approach of summarizing research findings in a report may be inadequate since it lacks a quick and intensive interaction between the field of information production and the field of information utilization. Given the described character of the retail planning process (sequential iterative decision making) and the supportive role of research with respect to all stages of decision making, a more interactive and flexible communication structure should be established. Such a structure is an important means for producing and providing understandable and effective information. Clearly, a project-organization is not a sufficient condition but it is a very stimulating condition for creating such a communication structure. Van Lohuizen (1980) suggests that a so-called supplementary research approach might be used for this purpose. One of the characteristics of the supplementary research approach is that the researcher and the other participants in the planning group interact quite frequently and are consequently able to adjust each focus of activity on each other. In a number of situations it is likely that the researcher can answer particular information needs directly on the basis of for instance
experienced knowledge. Or it might be that the researcher's role is nothing more than a systematizing and transferring of available information. Generally, no specific, highly advanced, techniques for that kind of activity are required; nor are they available. However, in a number of decision making situations research has to be performed in which specialized methods and techniques have to be applied. The general idea of the thus pursued relationship/communication structure has been summarized in Figure 2.

2.5 Conclusions
The requirements for applied retail research on an idostructural level in respect of the support of structural retail planning have to be met consistently and integratively when developing an alternative methodology for applied retail research. These requirements are derived from the nature of the retail planning process. An iterative-participating approach of a sequence of limited decision problems is typical for current retail planning processes. These decisions are taken on the basis of imperfect information in respect of present and future retail system performances. Applied retail research is increasingly involved in the support of each stage of decision making. Its primary task is to reduce and explicate uncertainties at every decision making step. This continuous relationship is underlined and
strengthened in the choice for a project-organization and, given the described criticism of applied retail research, is judged positively. The nature of applied retail research in that situation can be outlined normatively by referring to the 'utilization of knowledge' movement. This movement underlines the relevance of the explicit use of (available) information as a basis for decision making. Therefore the importance of an adequate production of information and organization of the accessibility of information on behalf of decision making is stressed.

Four main issues associated with the movement are discussed because of their relevance for the present study. The described relationship between the researcher and the other participants in the planning group can only be effective if it is based on a flexible and efficient communication structure. A flexible and efficient research methodology is needed. To develop such a methodology it is necessary to analyse carefully decision making in retail planning in order to gain insight in the nature of the information needs associated with each decision making step. The nature of applied retail research and, hence, the methodology applied is based on a planning-orientated theory that is formulated on the basis of the insights in the information needs. The planning-orientated theory systematically describes the dynamic operation of the retail system and indicates the way these operations are quantified. Finally it is argued that quality criteria for information production related to the implementation of information in the planning process should be added to classical scientific quality criteria.
CHAPTER 3: PRINCIPLES OF THE RETAIL PLANNING DECISION SUPPORT SYSTEM

3.1 Introduction
An important conclusion from the previous chapter is that basically the methodology of applied retail research should be derived from the process of decision making in retail planning. More specifically, the methodology needs to be adequate for answering the information needs associated with that decision making process. It is therefore necessary first to analyse these information needs.

This chapter starts with this particular aspect of the methodology development. In section 3.2 first considerations with regard to the procedure for identifying these information needs will be given. This implies the choice for some decision process model. Given the fact that in chapter 2 a focus on the mainlines has been argued for, the model is used to identify the common elements of structural retail planning processes. Next, in section 3.3 decision making in the retail planning process will be analysed according to the chosen decision process model. This results in insights in the mainlines of decision making steps and the supportive role of applied retail research in respect of these decisions.

The next step is to organize the research activities in a consistent and flexible framework. The so called decision support system approach provides a usable framework for simultaneously fulfilling all the previously defined requirements for applied retail research. A DSS explicitly integrates information production and information handling in a computer based system meant to support decision makers in a quick, efficient and interactive way. Because many readers will not be particularly familiar with the ideas behind decision support systems, the main components of these ideas will be summarized in section 3.4. Next, the consequences of this choice for the further development of the methodology for applied retail research will be discussed in section 3.5. This chapter ends in a summary of the main conclusions in section 3.6.
3.2 Considerations for the identification of information needs

The nature of the retail planning process indicated in chapter 2 typically refers to an ill-structured decision process. This implies (Bemelmans, 1979a, 1984) that the objectives, the decision problems, the required information and the solutions are not a priori fixed. Further, uncertainties exist with regard to future developments and impacts of plan effectuation. Moreover, the reliability and validity of a part of the utilized information are subject to doubts. Finally, decisions are taken by more decision makers with diverging interests and these decisions mutually influence each other in a dynamic way.

The ill-structuredness of retail planning makes it difficult to analyse the associated information needs. In order to explore the mainlines it is necessary to apply some type of abstraction and reduction. In principle two approaches are possible. The first one is the analytic description of a number of structural retail planning projects to be interpreted in terms of some decision process model. This necessarily implies a focus on the mainlines. In addition these mainlines may be encoded in terms of a sequence of structured decision making moments. Each of these moments may then be analysed in terms of the required information and options for support by means of applied retail research. Unlike the first option the second option does not start with an inductive definition of a decision process model, but rather accepts some general decision process model. Both options have advantages and disadvantages.

The main advantage of the inductive approach is that it might result in a good (empirically based) insight in the nature of retail planning processes. However, the purpose of the analysis is to suggest options for the development of a basic methodology for applied retail research. Consequently, such empirical descriptions require a rationalization afterwards. This means a search for similarities between various studied processes and/or the a posteriori interpretation of these similarities in terms of mainlines of decision making. A serious problem in that respect is that particular deficiencies of planning practice might be included in the outcomes of the analysis. In other words, (new) possibilities to enrich the decision making and to improve its quality that are no common practice might remain hidden and might beforehand be excluded from the inductive decision process.
model. Consequently, such a model might bear a conservative nature and, moreover, it would lack a particular degree of normatism. The main advantage of a general decision process model is that in theory it can be comprehensive and might perform a stimulating role with respect to retail planning practices. The main disadvantage is, however, that such a model might not correspond sufficiently to real-world practices by including decision stages that have no meaning for retail planning. Therefore, the decision what approach is most appropriate in this study is primarily based on pragmatic reasoning. It is extremely time-demanding to systematically analyse a number of retail planning processes in such a way that biases related to specific elements in processes are reduced in an acceptable way so as to enable valid generalizations. Such analyses are not available. Secondly, an important consideration is that the methodology in development is assumed to be an alternative for current practice and to have a stimulating (normative) influence on the relationship between retail planning and applied retail research. Given these two reasons a general decision process model will be used in this study to analyse decision making in retail planning processes on a structural planning level.

The choice for an appropriate model is facilitated by the fact that several models suggested in the literature show great mutual resemblances. Basically, they refer to the rationale behind the model suggested by Simon (1960) interpreting decision making in terms of: intelligence (analysis of the problem and definition of the decision aims and evaluation criteria), design (design of decision options and synthesis into policy strategies) and choice (choice for a strategy, translation of the chosen strategy in operational measurements to effectuate the strategy and ex post evaluation). Hoogerwerf (1984), for example, describes a policy design process in abstract, normative terms. The basic elements are: a. the analysis of policy elements, b. the definition of policy goals, c. the definition of optional means to reach the goals. Other examples can be mentioned. Discussing the selection of DSS's in organizations, Vari and Vecsenyi (1984) start from a decision making model structured on three general stages: planning (activities preparing the choice), choice and implementation. Nijkamp (1983) speaks about the sequence: exploration, definition, design, generation of alternatives, evaluation and selection, whereas
Van Doorn and Van Vught (1978) present a model that incorporates the stages: preparation (analysis, anticipation and design), choice, implementation (action) and ex post evaluation. Further, the findings of a study of Mintzberg, Raisinghani and Theoret (1976), based on the analysis of twenty-five strategic decision processes, suggest that these processes are characterized by an identification phase (involving recognition and diagnoses), a development phase (involving research, design, analysis, evaluation and bargaining) and a selection phase (involving authorization). Masser (1983) notices that although these findings are primarily based on decision making within business organizations, they show obvious parallels with public planning processes. Finally, a study of Boekholt (1984) points out that the design process is a process dealing with ill-structured problems, based on an elementary operations cycle. This cycle contains the following operations: the formulation of problem and objectives, the formulation of points of departure, the generation of variants, the evaluation of variants and a choice. These operations are, as Boekholt states, the common process stages in a great number of different design processes.

The essences of these models have recently been summarized cumulatively in the model suggested by Bahl and Hunt (1984a) (see Figure 3). "The figure pictures decision making within an environmental frame and is dynamic. It recognizes prospects of learning and model definition" (p.13). The figure "provides a reasonable if abstract picture of the essential 'event structure' of human choice. Whatever decision making is, in other words, it includes something like the subprocesses depicted in the figure. Just how and in precisely what ways it includes them remains for research and theory to further specify". (Bahl and Hunt, 1984a, p.13). The use of such a decision process model to understand the supported retail planning process does not imply that everyday decision making takes place according to the suggested process. Such an assumption is invalid. As Andriole (1979, p.23) puts it: "Obviously, decision makers seldom -if ever- make decisions on the basis of such a rigid rule structure". However, these structures "...are proffered not as representations of reality, but as tools through which we might gain insight into the decision process. At the same time, the distinctions to which the model alert us enables
Figure 3: A general decision model (Bahl and Hunt, 1984a)

PROBLEM IDENTIFICATION & DEFINITION

FORMULATION & REDUCTION OF SELECTED ALTERNATIVES

PREDICTION & EVALUATION OF OUTCOMES

EVALUATION OF ALTERNATIVES

ALTERNATIVE ACCEPTABLE?

CHOOSING DECISION CRITERIA

CONFIRMATION OR VALIDATION?

ANNOUNCE AND EXECUTION

LEARNING FROM THE DECISION PROCESS OUTCOMES

POLITICAL, PSYCHOLOGICAL & SOCIAL FACTORS
us to understand the processes which invariably – yet implicitly or unconsciously – occur during every day decision situations... Decision process models enable us to lend order to and examine the process with a minimal amount of unknown distortion”.

The model of Bahl and Hunt puts forward a set of more or less well defined decision making steps, each of which is more structured than the overall decision making process. This means mainly that on the level of each stage, the decision problems as well as the strategies for solving the problems are reasonably clearly to be identified. The question is of course whether the Bahl and Hunt model basically encompasses the main dimensions of retail planning processes in practice, or whether additional important aspects need to be put forward. The study of several Dutch retail planning projects suggests that in general retail planning decision making processes do not deviate from the Bahl and Hunt model in that they focus on analysis, the discussion of plans and the suggestion of 'best solutions' (Van der Heijden and Westerveld, 1980; Van der Heijden et al, 1986). In fact the approach in those studies is highly standardized and rather limited (compare Bak and Verberk, 1980), as will be clarified in the next section. The consequence of the choice made above for the present study is that the (normative) decision process model of Bahl and Hunt can be used to analyse the specific nature of the stages of decision making in retail planning. Thus insights can be gained in (a) the information needs, (b) the role of applied retail research and (c) the nature of the relevant part of the methodology. Note that as a consequence of the choice for the Bahl and Hunt model, the analysis has a normative meaning with respect to the lacks in current retail planning practices. This analysis is presented in the next subsection.

3.3 Nature of the retail planning process

The first stage in the model of Bahl and Hunt concerns the problem identification and definition. This stage can imply two things: (a) whether a practical problem is experienced or (b) whether there exists what might be called an opportunity.

The experience of a problem or opportunity can be the result of activities of monitoring processes in the retail system and/or activities of early warning by the planning agency, for example in the
context of preparing general land use plans. In this context, the use of findings of some research activities is obvious. The decision makers are in principle confronted with the description of some past developments or expected developments. The researcher describes these developments as adequately as possible in terms of the economic operation of the retail system, the use of retail facilities by consumers and perhaps the consequences for some public interests. These descriptions might vary considerably and are very dependent upon the conditions and the availability of data. Descriptions of future developments require some prediction of dynamics in the retail system requiring the use of some predictive model. The recognition of opportunities by planning agencies might of course also be the result of planning operations in other fields of the urban system. For example, urban extension might need new retail facilities, or, a new infrastructure might increase the accessibility to a particular shopping centre, or, urban renewal programs might initiate the reallocation of particular shopping facilities, etcetera.

The experience of a problem or an opportunity can also be associated with interest groups that operate external to the formal planning agencies. These recognitions are followed up with deliberations with the authorized agencies in order to discuss experienced problems or the possibilities to effectuate the opportunities. For example: the more than average loss of turnover in a shopping centre caused through changes in accessibility might be a problem of retailers located in that shopping centre. In contrast, the request for a permit for starting a wholesale centre might be seen as an opportunity for one retailer and as a problem for other retailers and public planning agencies.

Each identification of a problem requires a consistent description in order to evaluate whether it is a problem to act on by means of some new or updated structural plan, or, whether it is a problem that can be solved on the basis of an existing structural plan, or, whether the problem can be solved by means of non-intervention. This implies that it is defined in terms of a locational- and functional problem. The scale of the problem is of relevance in particular for the evaluation. Problems/opportunities that occur on the level of one shop within a shopping centre may be solved by taking some simple measure in direct
deliberation with the involved interest parties. However, problems that occur on the level of a shopping centre might cause the need for a planning approach on the level of a region.

The information needs of the decision maker in the context of this evaluation mainly focus on getting insights in the scale of the shifts in dynamics in the retail system. The experienced knowledge of the researcher in this context might be explored to get an indication. This knowledge is based on past practices initiated by means of the legal prescriptions regarding applied retail research in the context of the development of land use plans and the directives suggested by the Hazelhoff committee (Werkgroep Hazelhoff, 1980). It leads to a detailed idea about the scale of the changes and the sense of developing (or updating) a structural retail plan. Alternatively, the beforehand expected scale of shifts in operations of the retail system, based for instance on simulations in the context of monitoring and early warning systems, may lead to the situation that a particular development is put on the planning agenda.

It is obvious that the first stage of the Bahl and Hunt model with regard to retail planning refers to a great variety of motives, conditions and substantive considerations. The definition of the problem in planning terms implies that the original richness of aspects is filtered in the perspective of a planning-orientated understanding of the dynamics in the retail system. This is related to theoretical views on the impacts of the manipulation of certain planning variables on the performance of the retail system. Hence, the reduction of the problem variety of planning-orientated variables and planning sensitive mechanisms requires a reflective role of the researcher who is supposed to have the necessary insights in those variables and mechanisms. This participation in the discussion is aimed at clarifying, explicating, insights. The researcher particularly discusses general theoretical (or experienced) insights and, when available, specific knowledge on details of the problem on hand.

The next step in the decision process model of Bahl and Hunt concerns the formulation and elimination of alternative courses of action, which demands for an insight in the margins of retail planning: what can retail planning do to influence the planning problem? As noted previously a limited set of options for manipulating
the considered system exists:
- influencing the spatial distribution of retail facilities;
- influencing the amount of floorspace and, indirectly, turnover-to-floorspace ratios and branch distribution;
- influencing accessibility to retail facilities;
- influencing the distribution of population of the study area.

The definition of plan alternatives is based upon the (combination of) these manipulable variables. Clearly, the discussion in the planning group will be substantively more structured given this limited set of planning options. The researcher can play a stimulating and reflecting role with respect to this discussion. The participants are assumed to be primarily interested in the identification of a limited set of alternative courses of action to tackle the planning problem. Most likely, this identification is in fact a process of growing awareness of the relationship between alternative retail plans and their impacts. This process of growing awareness is at least partly based on an iterative communication with empirical knowledge of the retail system operations. Information needs that refer to these specific operations can be answered by the researcher, once the required data have been collected and made accessible. Systematic operations on these data require a specific operational approach. The data concern the patronage of shopping facilities by consumers and the nature of the retail facilities in the planning area. The analyses are indicative and explorative. The research activities in this context have to be embedded in an explicitly explained and accepted retail planning-orientated theory.

Parallel to the definition of plan alternatives a set of criteria has to be developed for evaluating these alternatives. The Bahl and Hunt model uses the term 'decision criteria'. These criteria constitute the \textit{ex ante} evaluation framework. The role of the researcher in this context is reflective in particular. He explains what type of criteria can be used, if data are available, on the one hand and the goals of retail planning on the other hand. The number and types of criteria are consequently defined within the framework of the trade-off between the costs of required data and the resulting insights. As has been argued previously, these criteria generally refer to aspects of retailer-, consumer- and public interests. The definition of criteria
not only necessarily implies the definition of variables that serve as indicators for retail system performances but also implies the definition of normative values for these variables from a policy point of view. In fact the definition of the criteria concerns the definition of indicators of the retail system performance understood in terms of the supply-demand dynamics and as such concerns the central information needs of the decision makers associated with the 'what..if' questions.

The following step in the Bahl and Hunt model concerns the prediction of effects of alternative plans on the operations of the planned system and the evaluation of the outcomes of these predictions. Given the alternative plans and the decision criteria, the prediction involves the performance of conditional analyses of future impacts of these plans. This necessarily implies the application of some predictive model. Insights have to be gained in the conditional shifts in consumer patronage of shopping centres and the conditional effects on attributes of the supply-side. What information needs of decision makers can be answered depends on the availability of data and the capacity of the model to predict and quantify the impacts on retailer, consumer and public interests. Most likely, part of the information needs of decision makers in practice adjusts to the responsiveness of the applied methods of prediction. This adjustment process takes place in a trade-off between the costs of more extended predictions (data-requirements) and the priorities in information needs. The evaluation of the separate outcomes of the predictions can cause a feedback to previous decisions about data collection, chosen criteria, plan definitions or even the formulation of the retail planning problem.

Once a corporate body of information is generated on the likely effects of alternative plans, these plans are evaluated by means of multicriteria evaluation to arrive at a final ordering of them with respect to the expressed preferences (criteria values and weights) of the participants in the planning group. In this phase the researcher may also play an important role in forcing the participants to explicate their preferences and in addition in applying multicriteria methods. These methods aim at generating rank ordered lists of alternatives within various condition sets. The outcomes of these methods are used in the deliberations to arrive at a final choice. If particular results are not acceptable for the group this may lead to
other criteria, normative values etcetera. The process continues until a final decision has been made. This implies that one or perhaps a few plans are considered to be acceptable to all participants.

By means of operational policy measures a particular strategy can be effectuated in real-world processes. The plan effectuation, according to Bahl and Hunt, brings about some process of learning and feedback. In terms of research this might require some planning monitor and the feedback to decision makers or feedforward in the context of early warning. These research activities can give rise to the perception of new problems or the identification of opportunities by the planning agencies. In principle, this might cause a rewind of the process and it may start again. In the context of monitoring the focus is on collecting easy measurable data on variables that are considered to be good indicators of retail system performance; for example: the amount of floorspace, the number of functional changes in retail facilities in a time period, the type of changes. The collected data have to be linked to some method of analysis that matches the real-world developments with the political value system.

The abovementioned, partly normative, nature of the retail planning process gives a sufficient idea of the type of information needs associated with the successive decision making. The nature of the support by the researcher is varying over time. He may perform the role of 'the reflectioner' at one moment, 'the initiator' at another moment and may deal with enlightenment tasks at still other moments. These roles are dependent upon the nature of the information that is needed or required. The variety in information elements is extensively discussed by Van Lohuizen (1984). Distinctions should be made between categorized data, knowledge, insights, judgements and norms. The enlightenment function is associated with producing new information (up to the level of insights) (Weiss, 1980) about the operations of the retail system. That information is highly based on analyses of empirical data. Moreover, these analyses are based on a set of special analysis techniques and methods. This is not, at least in a far less degree, the case in the context of the performance of the other mentioned roles. The methodology to be developed for applied retail research should focus on the support that has an enlightenment nature, because the analyses in that context are reasonably identifiable,
structured and related to a consistent and explicit planning-orientated theory. Given the previous analysis of the retail planning process, this in particular implies a focus on the support with respect to the aforementioned stages of:
- diagnosing problems and opportunities;
- exploring the margins for retail planning;
- assessment of impacts of alternative plans;
- multicriteria evaluation of alternative plans; and
- monitoring and early warning.

In order to enable an effective support of these stages, the researcher should use a methodology that is adequately taking into consideration the type of required information. The elaboration of this methodology will be embedded in a decision support system approach. The implication of this choice will be elaborated in the remainder of this chapter.

3.4 Decision Support Systems

3.4.1 Introduction

The explicit use of the term decision support systems (DSS) in the context of physical planning is of recent date. The existing fuzziness about the notions that underlie DSS and the fact that many readers may not be particularly familiar with the developments caught in this label, demands for an introduction. This section is, however, not aimed at presenting an extensive overview. Readers are referred to the literature for such overviews. In particular the following issues will be discussed:
- DSS and physical planning (3.4.2);
- issues in DSS building (3.4.3).

3.4.2 DSS and physical planning

The notion of Decision Support Systems refers to a recent stage in a historical process of building computerized data-processing systems helpful to several kinds of management operations in organizations. The result of the historical dimension of building data-processing systems is the current existence of various types of such systems. Bemelmans (1984) for example distinguishes between Transaction Processing Systems (TPS's), Structured Decision Systems (SDS's) and
Decision Support Systems (DSS's). TPS's are systems that are typically focused on the registration of (administrative) data. The design problem in that context is completely structured, which implies that the variables and their relationships are exactly known. SDS's are systems that are focused on producing information on behalf of the support of routine operational management operations. The processing of data is based on completely structured and formalized procedures, which is possible because of the fact that the decision problem is exactly structured. The information is not generally descriptive (like in case of TPS's) but is focused on specific tasks. (Sometimes, these systems are labeled as information systems. This label might be confusing, however, because others use this label as an overall term for data-processing systems.) Next, DSS's are systems typically used to support semi-structured decision making on strategic and tactical management levels. The system does not decide but the decision maker. The procedures of data-processing are not beforehand exactly known. DSS's and part of the SDS's can be summarized largely in what is called Management Information Systems (MIS's). The systems within this category of MIS's might considerably vary in terms of the domain of support, procedures of data-processing, hardware, etcetera.

In the seventies an important effort focused on building MIS's, based upon corporate models of the operations of a firm (Bosman, 1981). Sol (1983) however notes that he has been found it to be very difficult to construct total management information systems, for (a) the corporate modelling approach generally results in an organizational view that is too abstract and (b) the resulting information systems are not able to deal with relatively unstructured management decision tasks. The systems generally do not provide the opportunity for real communication with decision makers. In this context, Crescenzi and Gulden (1983, p.92) state: "As more and more data have been captured in the computer, managers have wondered, with increasing frustration, why it seems so difficult to access that data in a timely way to support managerial decision making. The first attempts to satisfy this need were the MIS's of the seventies. MIS often failed to satisfy the need because the MIS was often based on providing volumes of data that provided management with a 'damage assessment of the operations' instead of information that would help him prevent the damage. The
management information was a by-product, constrained by data which came out of the structured clerical tasks that has been automated". The answer to this problem has been sought in developing DSS's that add an extra dimension to the MIS aims of the seventies. The additional dimension in DSS's is according to Thierauf (1982, p. 6) "that of the decision maker whereby the individual retains control over the computerized decision making process and brings in his or her judgment, expertise, and the like, to bear the whole process of problem solving". Hence, DSS's are data-processing systems that focus on supporting non-routine decision making by enabling decision makers to directly influence data-processing. DSS's thus "incorporate features found in management information systems and in mathematical models of operations research. They emphasize direct support for managers in order to enhance the professional judgement required in making decisions, especially when the problem structure tends to be semi-structured and unstructured..... Emphasis is placed on helping the manager make decisions rather than on an actually making decisions for the manager. This interplay results in a total effort that is greater than the manager or computer operating independently (as in classical MIS), thereby providing synergistic decision making. Also, presentation of information is in a form that is useful versus presenting all information that might be useful" (Thierauf, 1982, pp. 7-8).

The label decision support systems for data-processing systems for the support of not completely structured decision problems has been accepted in the context of physical planning in recent years (Voogd, 1983b; Van der Heijden and Van der Meulen, 1985). This is initiated with the recognition that the conditions of decision making in firms and in (public) physical planning often show great resemblances. For instance Nijkamp (1983) emphasizes the complexity and uncertainty in decision making and the imperfection and relevance of available information, which causes decision making to be non-routine. Moreover, as Nijkamp states, an enormous increase in statistical, technical and econometric modelling has led to a clear need for and opportunities for more adequate (quick and flexible) data-processing and information monitoring. Nijkamp summarizes the underlying reasons for the increased interest in physical planning in building data-processing systems for the support of semi-structured decision making, where he states that
the "provision of reliable, manageable and up-to-date information -structured in a logical way on the basis of a sound methodology- is essential for understanding and actively influencing technological, socio-economic, spatial and environmental processes in a rational and systematic way" (p. 284).

Several types of data-processing systems might be applied to support various forms of limited decision making processes for subfields of physical planning, provided that the information needs of those processes are understood adequately. In particular the data-processing systems that bear a DSS character can be linked to the traditional task of many types of research on behalf of physical planning (for a detailed discussion see Van der Heijden and Van der Meulen, 1983a,b, 1985; Van der Meulen and Van der Heijden, 1986). DSS provides an adequate framework for understanding the role of research as a source of information and for the reduction of the uncertainties of decision making in physical planning. Besides covering of what is going on in some specific fields of modelling, the DSS idea could be applied in a more normative way, i.e. as a guideline for developing new research methodologies and refining the ongoing research developments.

Summarizing, DSS is a type of a computer based data-processing system developed and used to improve the effectiveness and efficiency of decision makers in performing semi-structured tasks. 'Judgement' is one typical ingredient of such tasks (Negoita, 1983). Moreover, decision problems may be differently defined and alternative solution methods and not necessarily equivalent solutions may exist (Bonzcek, Holsapple and Whinston, 1979). An effective support by means of DSS, therefore, implies that a certain interaction between the system and the decision maker(s) is facilitated. The support itself is focused on providing the required information in the right form and at the right time. Moreover, DSS use is aimed at bringing some order in the decision making process. This is stressed by Ginzberg and Stohr (1982), where they state (p. 20): "Structure should be brought to bear on any phase of the process where it is appropriate -i.e. definable and acceptable to the decision maker". Basically this implies the same as the earlier discussed task of reduction of uncertainty in decision making.

Negoita's (1984, p. 29) words are characteristic in this respect: "In
essence the job of decision support systems is to provide information so that the decision maker may have more orderly decision making".

3.4.3. Issues in DSS-building

The building of a DSS first demands for the formulation of some points of departure. According to the literature on DSS three issues are of particular relevance: (a) the system-structure of DSS, (b) the contents of DSS and (c) the use pattern of DSS. Shortly, basic considerations with regard to these issues will be summarized.

The DSS system-structure

Among others, Bahl and Hunt (1984a,b) stress that when specific information is required on specific questions related to the decision making task, then it is necessary to organize the system in accordance with the nature of the supported decision process. Hence, the system structure should strongly be influenced by the structure of the decision making process respectively the pattern of information needs. This view refers to two components of 'structure': (a) the process of decision making in terms of the procedure, the sequence of decision steps, and (b) the substantive nature of information needed, produced and used. Both components are of course related to each other, but specifically the first one has strong implications for the system organization while the second one is of specific interest for internal modelling.

With respect to the first component of the DSS-structure, Bonczek, Holsapple and Whinston (1979, p. 269) use the term decision process model for the scheme describing the successive stages of decision making. In other words, designing a DSS demands for the definition of an adequate decision process model. Because DSS's are meant to support semi- or ill-structured decision processes, Kosaka and Hiouchi (1982) plea for subdividing the ill-structured decision problem into a set of related structured and solvable subproblems. The more or less artificial order that is inherent to this set can be conceived as the order of the applicable decision process model. Of course, this approach implies a relatively high degree of simplification of the real-world decision making process. However, simplification can be considered inherent to every day decision making. Moreover, in relation
to the aim of DSS's, such process models clarify (parts of) these everyday simplifications and clarify repetitive as well as unique elements among decisions on the one hand while they can actually bring about a higher degree of order and openness to the decision making on the other hand. Considerations with regard to the second component of the DSS structure are discussed next.

Contents of DSS
Substantively, the design of a DSS implies that an answer must be given to the question what information has to be produced and whether this is possible given theoretical, methodological and measurement constraints. It implies that the information needs of the (future) user(s) should be revealed. It is however an invalid assumption to think that a decision maker can define exactly what information he/she needs. Hence, several problems in respect of the need of information are to be solved by the information analyst in interaction with the decision maker(s). Generally in the DSS literature, this problem is labeled the development of an information model or conceptual model in the decision making field. As argued in section 3.2 such a model should be sufficiently abstract to be descriptive of a large variety of decision situations. But it should also have concrete implications for the design of a decision support system. Van Griethuijsen and Jardine (1984) consider the specification of an 'information model' in a formal and clear way essential for the development of each data-processing system. The specification has to be independent of technical implementation, has to provide opportunities to change the operational system, must indicate what data are required and has to be understandable for non-experts. In the words of Orman (1984) "The conceptual model contains a single description of the system with emphasis on semantics, completeness and consistency. At this level the data sets are uniquely named, a comprehensive data dictionary is built, name conflicts are resolved and the algebraic deviation rules are compared to ensure consistency and to eliminate redundancy" (p. 6).

DSS use
The issue of DSS use refers to the interaction between the system and the decision maker(s). The nature of interaction (man-machine-
communication) is of relevance for identifying requirements for the organization and technical elaboration of the computer system.

Reflecting on the problem of interaction between man and machine, Alter (1977) notes that "It is a common believe that the direct use of decision support systems by decision makers should be encouraged" (p. 111). This belief is a consequence of the idea that direct interactive problem solving is the best strategy for unstructured problems. He points out that several views on interaction exist, but in most cases 'give answers' and 'ask for answers' are the best labels to characterize man-DSS communication in existing systems. According to him, this implies that no really interactive systems exist. Alter argues, however, that it is perhaps more important to create 'responsiveness' rather than 'interactiveness'. Responsiveness is a combination of power (the degree to which the system can answer the questions), accessibility (the degree to which the system can provide the answers in a timely and consistent manner) and flexibility (the degree to which the system can adapt to changing needs and situations). According to Alter, DSS design implies a series of design decisions with the overall objective of attaining a cost-effective degree of responsiveness.

Direct interactiveness is of interest particularly in the context of a personal DSS. In physical planning on a structural level, however, decision making is mainly a group activity. Moreover, it is a low frequency decision making problem. The researcher as a participant in the planning group is claimed to support the process of group decision making. He provides various types of information during the sequence of decision making stages; only in some crucial stages the DSS is used. This role has been labeled as an enlightenment-function. There are basically two options for using the DSS. The first option is to enable each member of the group or the group as whole to directly communicate with the DSS, for example in sessions guided by the researcher. The second option is to accept the researcher as an intermediate between the DSS and the planning group.

Evidently the first option puts considerably higher claims on the organization of interaction in terms of DSS-building than the second option. It has consequences for the nature of the software, the software-managing models and the use of computer-facilities (hardware).
Van Hee (1985) and Kochen and Barr (1984), for example, give a good overview of the kind of problems to be solved in developing more sophisticated data-processing systems which pursue direct interactiveness. A system that enables direct interaction puts additional claims on the speed of the communication and the flexibility of the system towards the users. This flexibility must be anticipated since changing software during interactively processed runs is not possible. In particular the need for speed might put a limit to the set of optional models incorporated in the DSS, and hence the type of analysis performed, because of computational time. The suggested types of analysis, however, generally require considerable computation time implying that feedbacks to users are delayed. The use of computer mainframes might improve this situation but on the other hand could put a limit to the flexibility in choice of hardware. Another option is to choose for other types of analysis, but that might conflict with the substantive requirements for the research models related to the nature of the retail planning-orientated theory. Hence, in pursuing direct interactiveness the trade-off between substantive analyses, communication flexibility and -speed and use of hardware needs to be carefully studied. What is gained in one dimension might be lost in others.

At variance with direct interactiveness, the second option interprets interactive communication with regard to the DSS in terms of a sequence of sessions in which the necessary input data are collected by the researcher and outcomes of DSS-use presented, explained and discussed in the planning group. The role of the researcher is probably heavier compared with the first option but, on the other hand, DSS-use is more efficient and effective. The researcher and not the system explains the participants the nature of the optional analyses and discusses with them the kind of questions to be answered before the DSS can produce required knowledge ("chauffeured computer use"). This procedure might prove to be more effective for the group of participants than direct interaction is since there are more options to make the decision makers understand the meaning and manipulability of the DSS. Moreover, decision makers are not forced to react instantaneously without having had the opportunity to think the process over from a new perspective, using additional knowledge, and so on.
According to Hart (1984), who describes a management information approach for semi-structured decision tasks, such a gradual decision making approach enabling informal contacts, discussions and time to think things over, is preferred for reaching a consensus. Further, less high claims apply to the technical elaboration of the DSS compared with the first option. It might even be sufficient to develop a number of subsystems for several types of analyses organized in terms of a software package realizing input-output flows, linking analyses with a central data-bank and mutually linking different types of analysis. The approach has the advantage of not locking, either actually or seemingly, the decision making process in the a priori specified framework of the DSS. Specific information requirements put forward during the group sessions can be answered by changing the software before running. In contrast, a system that enables direct interaction has strictly speaking to anticipate such additional information needs or it alternatively fails to feedback and forces the decision makers to follow anticipated routes.

General principles of the management of information flows in terms of the organization of interaction are hardly to be formulated. Many options for technical elaboration in fact exist. It is extremely important that the organization of the system fits in with the specific features of the planning process. In that respect, direct interactivity is generally of less relevance than responsiveness. Moreover, each view needs to be updated regularly and transferred into changes of the DSS, given the developments in computer facilities and the changes in the willingness to accept computer supported decision making. In this context, the definition of DSS users by Ginzberg and Stohr (1982, p. 19) is quite illustrative: users are "people who need to understand the implications of decision alternatives". Therefore, they consider a functional role definition of users (i.e. key decision influencers) more appropriate than a formal (organizational) role definition. Instead of direct interactiveness, Ginzberg and Stohr stress the so called 'two-way communication', which means that the user can react to intermediate processing results by studying them and influencing the continuation of the process according to his intermediate conclusions. "The two-way communication can take place during a single session at a terminal, over multiple sessions spread
out in time, or even with a batch system" (p. 22)

3.5 DSS and applied retail research

The introduction to the nature of the DSS approach in the previous section illustrates that the previously elaborated aims of applied retail research and the requirements for the methodology in development can be met very well within the framework of a DSS approach, given several common elements. These common elements, given the aim to support of group decision making, can be summarized in terms of the key ingredients:

- support of semi-structured decision making by a planning group, which causes an extra relevance of interaction between research and planning;
- DSS users and participants in the retail planning group are interested in the quick and flexible availability of reliable and valid information that reduces uncertainties in decision making;
- the information needs of decision makers are crucial for the nature of the organization and substance (the architecture) of the support;
- the identification of the sequence of decision making is based on the use of an abstract decision process model. This model explicates and normatively influences the process of decision making by encoding the semi-structured process in a set of limited, more structured decision tasks;
- the substance of information needs associated with the supported decision process is determined by analysing the separate decision steps identified in the decision process model;
- the information needs have to be translated into methods and techniques of information production. The use of an information model (conceptual model, planning-orientated theory) basically underlies such a translation;
- the researcher plays the role of first DSS user or information producer and handler with respect to the group decision making ("reflectioner and chauffeured enlightenment");
- applied retail research and DSS focus on solving interactively decision problems by describing situations, providing a context for plan development, producing insights in the effects of alternative plans, the evaluation of these plans and monitoring.

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Given these common elements, the appropriateness of the DSS approach as a framework for the elaboration of the methodology for applied retail research is quite plausible. The acceptance of such a framework is the more likely given the fact that the major part of the information needs of applied retail research refers to the processing of quantifiable data, as has been illustrated in section 3.2. Clearly, such data are generally most easy subject for computerization. This choice, however, has also some consequences for the further elaboration of the methodology for applied retail research. Given the typical focus on the use of computerized systems the attention should in principle be focussed on those aspects of information production that can be subjected to some systematic computerization. This implies that no further attention will be paid to simple activities of information provision applied by the researcher based on the dealings with experienced knowledge, on the categorization of available information, etcetera, that do not need specialized methods and techniques. Of course, experienced knowledge as meant here might also be computerized. However, the application of such knowledge is too ad hoc and moreover, the type of research activities is so basical (e.g. classification), that it has no use generalizing these activities in terms of models in a DSS. Hence the DSS methodology typically deals with the mainlines of information production. Given the analysis on the basis of the Bahl and Hunt model of the information needs associated with the retail planning process five stages are particularly considered candidates for support by DSS:

- the production of an initial descriptive-explorative view on the current performance of the retail system;
- the exploration of the margins of retail planning;
- the assessment of likely impacts of alternative plans on future retail system performances;
- the systematic evaluation of the alternative plans, given the assessed likely impacts and the interests of decision makers;
- the monitoring and early warning.

Although the attention for different information production activities will be focused on describing these activities in separate modelling and measurement steps on the assumption of enabling an optional module based computerization, the consequence of the prime attention for
responsiveness implies that no specific attention will be paid to the technical elaboration in the sense of the user friendliness of the DSS. Van Hee (1985) gives a good overview of the main aspects to be dealt with in the context of the technical elaboration of the data-processing systems. Minimal (technical) elements in the building of the data-production systems are: (a) the data bank, implying the stock of registered data, and (b) the model bank, the set of available (quantitative) models of various types used to perform systematic operations on the data. These models describe aspects of the retail system dynamics and data handling activities. In Figure 4 both elements are related to the five tasks of the retail planning DSS. The design of the system is, according to Van Hee, a piecemeal approach that focuses on a module-based elaboration and refinement of elements of software. The main concern is now to indicate the contents of these elements. This problem, which constitutes the centre of this thesis, will be elaborated in the next two chapters.

3.6 Conclusions
This chapter focused on identifying the information needs associated with the decision making in the context of retail planning and the identification of the nature of the separate support tasks of applied retail research. In order to identify the information needs a general decision process model was chosen that encodes the planning process into a number of more structured decision steps. As such the
development of the methodology for applied retail research is linked with the assumed (and to a certain degree normative) mainlines of the retail planning process. In addition these separate decision steps are described in order to find out what the position of the researcher is. The researcher plays various roles. In a number of situations the enlightenment function implies that specialized methods and techniques have to be applied in order to produce (empirical) information up to the level of insights. On the basis of the analysis of the retail planning decision making process five stages were identified the support of which requires a specialized methodology: problem diagnosing, exploration of the margins of retail planning, impact assessments, multicriteria evaluation and monitoring. The methodology is organized from the perspective of decision support system approaches. The nature of DSS was described and, in addition, the main issues in DSS building discussed. Finally the implications for this study were discussed. In particular, it was concluded that attention has to be paid to the elaboration of the responsiveness of the methodology, while no special attention will be paid to the interactiveness of the retail planning DSS. The elaboration of responsiveness means that attention should be paid to the nature of the data bank and the model bank associated with the DSS. As argued in the previous chapter, this first requires an explicit planning-orientated theory. The next chapter presents that theory.
CHAPTER 4: RETAIL PLANNING-ORIENTATED THEORY

4.1 Introduction

It has been argued in the previous chapter that, basically, the information needs related to the five stages of decision making that are of interest for DSS refers to the empirical performance of the retail system. Consequently, the central point of information production in the DSS involves the simulation of demand-supply dynamics in the retail system. This simulation requires the application of a quantitative model incorporating aspects of consumer spatial choices and retailer behaviour. In addition, the information production requires the quantification of the retail system performance in terms of indicators relevant for retail planning. The operational elaboration of these tools for information production needs to be based on an adequate retail planning orientated theory. This chapter presents the required theoretical framework in two parts. First, a theory is presented for the understanding of the operations of the retail system, focusing on two main aspects: (a) consumer spatial choice behaviour in relation to shopping centres (section 4.2) and (b) retailer spatial reactive behaviour in relation to changes in their 'business context' (section 4.3). Evidently, this theory has to meet the requirements for theory-building, specified in chapter 1:

- the theory assumes that the operations of the retail system are interpretable in terms of measurable regularities;
- the theory bears an inductive-empirical nature based on a cognitive-behavioural approach of individual choice behaviour and decision making;
- the theory is planning-orientated, implying a capacity for answering 'what' as well as 'what... if' questions.

The second part of the theoretical framework underlies the quantification of the operations of the retail system in terms of indicators. The focus is on describing the three fields of interest considered relevant for retail planning: consumer-, retailer- and public interests. Indicators of the retail system performance need to
quantify these interests. The theoretical notions that underlie the elaboration of such indicators are presented in section 4.4. Figure 5 summarizes the substantive focus of this chapter. The chapter ends with a summary of the main conclusions in section 4.5.

4.2 Consumer spatial choice behaviour

4.2.1 Background of the theory
A cognitive behavioural approach to the understanding of consumer spatial choices in the context of the understanding of the development and application of expenditure distribution models focuses on the understanding of consumer spatial choice as the final outcome of an individual cognitive-psychological decision making process. This approach is linked to an important progress in the field of geography and regional science, with as a special feature a shift in interest from the prediction of macro-level spatial choice patterns to the micro-level explanation of spatial choice. Since the end of the 1970's this spatial choice paradigm has become a promising approach in the field of the studies of orientation patterns. The emphasis was put on disaggregate behavioural probabilistic modelling based on the understanding of the relationships between the spatial structure, the individual decision making processes and overt behaviour (e.g. Louviere, 1976, 1979; Schuler, 1979; Timmermans, 1979b, 1980b,c, 1982). In this context individual spatial choice behaviour is assumed to be conditional upon decision making among multiattribute choice alternatives, which means that individuals evaluate these alternatives with regard to relevant attributes and integrate their separate evaluations according to some algebraic rule. The focus in the modelling approach is, ultimately, on establishing the functional relationships between the postulated elements of the decision making process.

There is a variety of modelling approaches for the choice process. The retail planning orientated theory will be linked to the so-called (de)compositional multiattribute preference modelling approach based on data collected in experimental utility measurement designs. Recently, Timmermans (1982) integrated the most important elements of the contributions to the cognitive-behavioural understanding of
Figure 5: Structure of the retail planning-orientated theory

CONSUMERS

SOCIO-ECONOMIC CHARACTERISTICS, MOBILITY, TIME AND FINANCIAL CONSTRAINTS

PERCEPTION, EVALUATION

PREFERENCES, ATTITUDE

SPATIAL EXPENDITURE DISTRIBUTION

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individual decision making among multiattribute choice alternatives into a consistent theory for consumer spatial choice behaviour. This framework is adopted in this study and extended to retailer behaviour. In the following subsections the approach of consumer choice behaviour will be discussed both in qualitative and mathematical terms.

4.2.2 Qualitative description of the theory

The adopted conceptual framework is presented in Figure 6. Applied to consumer shopping behaviour, consumer choices are considered to be the outcome of the individual's act of choosing one particular shopping destination from among the set of potential destinations in his or her environment. This choice is related to a decision process based on the subjective perception and evaluation of the levels of the attributes of the shopping destinations. The cognitive-behavioural approach of that decision process emphasizes that consumers do not take their decision on the basis of the objective reality, but on the basis of the image they have of that reality. The image is personal and subjective and is first of all the result of the perception of the objective 'choice space'. Perception as such is based on 'search and learning', a process of receiving information about the real world situations. Inherent to this process is the subjective filtering of real world stimuli with three dimensions particularly relevant for understanding shopping behaviour. The first is that the individual is not familiar with all the alternative destinations in his/her environment. The second is that each alternative destination is perceived in terms of a limited set of attributes of that destination. The third is that consumers' perception of real-world objective characteristics is not necessarily error-free or a linear function of these characteristics.

The first dimension is the existence of a personal awareness space: the spatial field that contains the alternatives the individual is familiar with. In addition, the so-called activity space denotes the spatial field the individual actually uses in the context of his/her spatial conduct (Horton and Reynolds, 1971). Potter has introduced analogous notions referring to the retail system (Potter, 1977, 1979). He defines the information field of a consumer as the zone that includes all the shopping centres the consumer possesses knowledge
about, irrespective of whether they are used or are not used in the conduct of his/her shopping. The usage field of a consumer is defined as the zone which includes all the retail centres which he/she patronizes in the course of his/her shopping activities. Evidently, the usage field is a subset of the information field; both fields are the result of search and learning processes.

The second aspect of the aforementioned filtering process concerns the fact that each destination may be characterized by means of the levels of a bundle of attributes. The set of attributes is large but finite and contains attributes of a quantitative as well as a qualitative nature. Partly these attributes relate to the destination itself and partly they relate to the effort involved in patronizing the destination. The consumer filters the amount of stimuli he/she receives from each destination belonging to his/her information field. Only information concerning a subset of attributes passes the individual's 'filter'. The result is a cognitive space with which information is transformed into cognitive concepts relevant for the
individual in understanding his/her environment. They constitute the basis on which the individual acts.

Moreover, the cognitive-behavioural view stresses the fact that for each objective value of any influential attribute of the alternative destinations there exists a corresponding subjective evaluation value. This value can be interpreted as the utility related to a particular attribute of a particular destination with respect to a certain individual choice problem. Hence the information stored in the cognitive space is evaluated and transferred into a set of part-worth evaluation values assumed to be systematically related to the objective levels of these attributes in the context of that choice problem. In addition, these part-worth utilities are integrated by the individual into a (weighted) overall evaluation of each destination according to a certain combination rule. A set of overall evaluations related to the set of alternative destinations the individual is familiar with results in an ordering of the alternatives according to the degree to which each of the alternatives contributes to the fulfilling of the individual's shopping needs and choice criteria. The ordering reflects the individual preference structure. The final decision where to shop then depends upon the decision rule the individual applies. In general, the probability that a particular destination will be chosen is greater when that destination has a higher position on the rank ordering of the total set of alternative destinations the individual is familiar with.

4.2.3 Formalization

The prediction of the probability that a consumer will select a particular shopping centre, given the levels of attributes of the shopping centre, requires the specification of a mathematical model. In the context of structural retail planning shopping centres constitute the choice alternatives referred to in the previously outlined theory. The requested model may be constructed on the following set of axioms and assumptions, previously outlined in Timmermans, Van der Heijden and Westerveld (1984a).

Assume an area with a finite set (S) of M* mutually exclusive shopping centres. Each shopping centre is conceived of as a bundle of attributes. Let R* denote the set of all attributes of the shopping
alternatives. Each shopping centre \( j \) may then be described by a vector 
\[ X = [X_{j1}, X_{j2}, \ldots, X_{jR*}] \]
where \( X_{jr} \) is the level or value for shopping centre \( j \) on attribute \( r \) \((j=1, \ldots, M*; r=1, \ldots, R*)\).

Axiom 1: For any type of shopping behaviour there exists a subset of shopping alternatives from among which a choice will be made. This axiom refers to the definition of the individual spatial information field. The consumer \( i \) will consider a subset \( A_i \) of alternatives \((A_i \subseteq S)\). Let \( M_i \) denote the total number of shopping alternatives in the choice set of individual \( i \). It is assumed that the definition of the choice set \( A_i \) is influenced by means of a set of spatial and personal characteristics and further that once the levels of the variables that represent these characteristics for an individual can be measured it is possible to predict the probability \( i_p \) that a particular shopping centre \( j \) will be known by \( i \). Hence:

\[ i_p(j \in A_i) = f_1(X_{jr}, Y_i) \quad (4.1) \]

with:

\[ X_{jr} : \text{the value of environmental attribute } r \text{ of shopping centre } j; \]
\[ Y_i : \text{a set of personal characteristics of individual } i. \]

Axiom 2: For any type of shopping behaviour there exists a subset of independent attributes of shopping centres used by an individual to discriminate among known shopping centres.

This axiom refers to the notion that consumers do not discriminate between shopping centres on the basis of all possible attributes \((R^*)\) but rather on the basis of only a limited number \((R_i)\) of relevant attributes. Consequently, each known shopping centre may be described by means of the vector of relevant attributes \( X = [X_{jr}] \) with \((r=1,2, \ldots, R_i; R_i < R^*)\). It is assumed that the set of relevant attributes can be uncovered.

Axiom 3: For any influential attribute of the shopping alternatives there exists a corresponding perceived or psychological value.

This axiom is related to the notion that choice behaviour is dependent upon an individual's subjective evaluation of the alternatives on the
basis of the limited set of $R_i$ influential attributes. Let $x_{ijr}$ denote the psychological value for an individual $i$ of the $r$-th attribute of shopping alternative $j$ ($j=1, 2, \ldots, M_i$). Then $x_{ijr}$ can be thought of as the individual's $i$ part-worth utility of attribute $r$ for alternative $j$. A further assumption is that the psychological values or subjective evaluations of attributes are systematically related to objective levels of the attributes of the choice alternatives:

$$x_{ijr} = f_{2ir}(X_{jr}); \quad (r=1, 2, \ldots, R_i) \quad (4.2)$$

with:

- $x_{ijr}$ : subjective evaluation value of the $r$-th attribute of choice alternative $j$ for individual $i$;
- $X_{jr}$ : objective value of the $r$-th attribute of choice alternative $j$.

Several mathematical functions may be used for $f_{2ir}$.

**Axiom 4**: For any set of part-worth utilities associated with some set of attributes there exists an algebraic rule by means of which the individual integrates these part-worth utilities into an overall utility for attribute combinations. The equation for this axiom is:

$$U_{ij} = f_{3i}(x_{ij1}, x_{ij2}, \ldots, x_{ijR_i}) \quad (4.3)$$

where $U_{ij}$ is an individual's overall utility of choice alternative $j$. Again, several mathematical functions might be used to represent the nature of the combination rule denoted by $f_{3i}$. So far, the only forms that have seen serious applications or appear to be estimable by means of tractable procedures are related to the general multilinear form (assume $R_i=3$ and deleting the subscript for the individual):

$$U_j = c_0 + c_1x_1 + c_2x_2 + c_3x_3 + c_4x_1x_2 + c_5x_1x_3 + c_6x_2x_3 + c_7x_1x_2x_3 + \varepsilon_j \quad (4.4)$$

where $\varepsilon_j$ is an error term and the $c$'s are scaling constants. The multiplicative combination rule:

$$U_j = c_0 + c_1x_1c_2x_2c_3x_3 + \varepsilon_j \quad (4.5)$$
and the additive combination rule

\[ U_j = c_0 + c_1 x_1 + c_2 x_2 + c_3 x_3 + \varepsilon_j \]  (4.6)

are the most simple and commonly used functional forms that can be derived from the general multilinear form. The typical feature of the latter and most frequently used rule is that a low utility for one attribute can at least partly be compensated by a high utility for one or more other attributes. Some authors have argued the use of non-compensatory combination rules (Burnett, 1980; Hendriks, 1983). These rules (for an overview see Timmermans, 1984c) state that individuals arrive at a choice by screening alternatives on an attribute-by-attribute basis. However, empirical evidence accumulated so far (Timmermans, 1983a; Timmermans, Van der Heijden and Borgers, 1984) suggests that the predictive ability of noncompensatory combination rules is, at least in a consumer choice context, lower than that associated with compensatory decision rules.

It is assumed that the nature of the compensatory combination rule may be uncovered in experimental settings. That implies that the mathematical function that describes the integration of part-worth utility measures into overall utility measures in an experimental context can also be used to explain the integration of part-worth utilities \((x_{ij1}, x_{ij2}, \ldots, x_{ijR_i})\) into the overall utility \(U_{ij}\) for individual \(i\) for a particular real-world choice alternative \(j\). Shopping centres may be ordered on an individual's preference structure or function according to their overall utility scores.

Axiom 5: Overt spatial choice behaviour is systematically related to the individuals' overall evaluations of shopping centres.

It is assumed that a particular decision rule relates the ordering of the choice alternatives to the probability that a particular alternative will be chosen:

\[ p(j \mid j \in A_i) = f_{4i}(U_{ij}) \]  (4.7)

Alternative mathematical functions may be used for \(f_{4i}\). The simplest option is to use the deterministic decision rule, which states that the
alternative with the highest score will invariably be chosen. Probabilistic rules assume that an individual's overall utility is composed of a fixed component \( \bar{U}_{ij} \) and a random component \( \varepsilon_j \):

\[
U_{ij} = \bar{U}_{ij} + \varepsilon_j
\]  

(4.8)

Depending upon the assumptions regarding the distribution of the error term, various functional forms arise. An alternative interpretation in this context, particularly for model specifications on the aggregate level, is that \( U_{ij} \) equals the average overall utility of the \( j \)-th choice alternative calculated among a number of individuals. \( \varepsilon_j \) then represents the heterogeneity among individuals.

4.3 Retailer reactive behaviour

4.3.1 Background of the theory

So far, the description of the theory has been focused on the subsystem of consumer spatial choice behaviour. There exists, however, a strong need to extend the theory to the (spatial) behaviour of retailers. When such an extension is realized, a more sophisticated approach of the demand-supply dynamics within the retail system will be possible. Currently, conceptualizations in applied retail research do not or hardly pay attention to the accommodation of the dynamic interaction between consumer choice behaviour and retailer behaviour in modelling retail system operations. Operational models lack an explicit link between changes in consumer shopping behaviour and changes in the attributes of shopping centres. Such a link, however, can improve the reliability of the assessments of the likely impacts of retail plans and, in addition, the quality of the retail planning decisions.

One of the few approaches that attempt to develop a dynamic model of consumer-retailer interactions is Wilson's approach aimed at understanding basic principles underlying retail systems dynamics on the basis of the application of modified traditional spatial interaction (gravity) models (Coelho and Wilson, 1976; Harris and Wilson, 1978; Wilson, 1981; Clarke and Wilson, 1983) and catastrophe theory (e.g. Wilson and Oulton, 1983) and bifurcation theory. The problem with this approach is that they are based on rigorous, untested
and restrictive assumptions regarding retailer behaviour. A reliance on the heavily criticized spatial interaction model intensifies the problem. Finally, a point of discussion is whether the inherent focus on equilibrium is valid for real-world contexts and processes or not.

Another approach to the study of retailer decision making in the context of the choice of retail locations, firm size and intensity of capital use has been suggested by Miller and Lerman (1979, 1981) and Lerman and Liu (1984). They suggest micro-level random-utility models of retailer decision making. Although the foundation of these models on the utility theory is an important step forward, the main problem is that the calibration remains based on correlational analysis. This causes difficulties in the interpretation of the parameters in terms of cognitive-behavioural causalities in individual decision making.

The changes of interest for structural retail planning generally concern observable changes in the different levels of the attributes of shopping centres. These changes are the results of three types of retailer behaviour. The first one is the reaction of retailers to local changes in conditions of retailing (quantified in terms of changes in turnover). The reallocation of shops can be considered as one type of reactive behaviour. The second type of behaviour is not necessarily dependent upon changes in the business conditions, but tries to initiate changes (initiating behaviour). Like reactive behaviour, its consequences can to a certain degree be measured in terms of changes in the levels of attributes of the shopping centre. The third type of behaviour is locational behaviour of starting retailers. In case reallocation of other retailers preceeds this act, no considerable changes in the planning of relevant attributes of the shopping centre occur. It is also possible that a locational choice is linked with an extension of floorspace at a particular location. In that case the choice is more or less dependent upon some planning measure.

One has to deal with these types of retailer behaviour in the context of theory-building and modelling in various ways. The third type of behaviour can be captured in terms of deliberately pursued changes in retail facilities by means of retail planning. For the present problem reactive and initiating behaviour are of greater interest since the related changes bear a more autonomous or indirect
character. Reactive behaviour depends by definition upon changes in conditions of retailing, quantified in terms of turnover levels. In terms of theory and models this can be captured in variables in so far as these changes are related to changes in consumer patronage of retail facilities and/or retail planning measures. This is not entirely the case with initiating behaviour, which may have various underlying reasons. This autonomous change is not necessarily dependent upon system variables manipulable by way of planning. Consequently, this type of behaviour is difficult to deal with in the present theory-building process in which a clear link with consumer behaviour is pursued. For that reason, the extension of the theoretical framework will focus on the understanding of relevant autonomous retail planning changes in attributes of shopping centres as far as these are the result of retailer reactive behaviour. Since the same requirements for the conceptualization of consumer spatial choice behaviour also apply to the understanding of retailer behaviour (one consistent theoretical framework is pursued), the use of cognitive-behavioural notions in order to understand the decision making process of retailers is preferred.

This implies that the autonomous changes are understood as the outcome of a decision making process of individual retailers under particular conditions. As Timmermans (1986) argues, the overwhelming amount of empirical results of cognitive-behavioural analyses of individual spatial choice behaviour in various contexts suggests that there is no reason to believe that the related assumptions cannot be met in the study of choice behaviour of retailers as well. In addition, Timmermans describes an application of the approach in the context of retailer locational decision making and concludes that it provides a promising framework of analysis. The consequence for the extension of the theoretical framework will be elaborated in the next subsections.

4.3.2 Qualitative introduction to the theory
The decision making process of retailers has to be understood in terms of the mechanisms and variables that serve the aims of information production by applied retail research. This means in particular that the elaboration of retailer behaviour in the context of this study will focus on decision making with regard to the problem of the choice for
an adequate type of reaction on developments influencing the conditions of retailing businesses, the causes of which are external to the retailer. Hence it concerns reactions on trend developments or retail planning initiated developments in the conditions of retailing. Both types of developments are described/predicted in applied retail research on the level of clusters of shops, the objects of structural retail planning. The focus is on the question of retailer reactions to a worsening in the retailing conditions or on the question when the retailers intend to profit from a considerable improvement in the retailing conditions. A number of options is available in both situations; for example, establishing changes in branch mix, service-level, amount of floorspace, opening/closing a shop, and so on. Retail planning is of course particularly interested in those types of reaction that have spatial consequences. The decision making process is in respect of the choice among these options conditional upon a set of cognitive-psychological mechanisms.

However, there are differences compared with the consumer choice task. Consumers find themselves in situations that they necessarily have to go out shopping. This means that the choice problem is a fact, although the choice of the destination itself is considered to be an act of freedom and willingness. The retailer on the other hand finds himself in the position that he is free to decide whether or not he will react to the developments in retailing conditions. A confirmative answer creates the additional abovementioned choice problem: what is the most adequate and feasible type of reaction? These two choice problems can be linked to one choice problem by interpreting non-reaction as one object of the choice set of the retailer. The overt reaction performed by a particular retailer (including non-reaction) is the result of a decision making process based on the subjective perception and evaluation of the advantages and disadvantages associated with each possible action with respect to the objectives of reaction. These objectives are, at least partly, related to the economic operation of the shop, interpretable in terms of the ratio between turnover and cost. Considerable changes in the turnover level initiate a decision making process aimed at deciding how to react to these changes. It is assumed that retailers perceive their retailing context as a bundle of conditional variables that can, at least
partly, be influenced by means of some reaction for arriving at a preferred retailing context.

The retailing context can be defined in terms of spatial-functional environmental attributes (shop-external) (dispersion of shops, size of the shopping centre, parking facilities, road infrastructure, physical lay out of the shopping centre, types of shops, competition, etc.) and attributes related to the operation of the individual shop (shop-internal). Both categories of attributes might be qualitative as well as quantitative. The retailer decision making process and the resulting reaction are not primarily based upon the evaluation of the objective effects of changes in the levels of the attributes of the retailing context associated to some reaction, but are merely based on the individual perception and evaluation of the expected effects of this reaction on the retailing context. It may therefore be assumed that each retailer has some subjective evaluation value for the specific retailing context he/she is confronted with. Moreover, reactive behaviour is assumed to be based upon the expectations about the effects of changes in the level of particular attributes of this retailing context. Over time, a series of overall evaluation values for the retailing context results, describing some function in time. This will be elucidated by means of Figure 7.

Figure 7a illustrates that the turnover in a particular shop decreases during the period $t_0-t_2$, when a constant slight increase is expected. Assume that the expected development also denotes the required development given a particular cost level. The actual decrease might be the result of, for instance, decreased accessibility or the gradual development of other shopping centres. A retail planning measure at $t_2$ stops the decrease, but an under-expenditure remains. A retail planning measure at $t_3$ brings about a recovery of the expenditures up to the 'acceptable level'. It even causes over-expenditure. In Figure 7b the development in the ratio between the actual turnover and the fixed costs for the retailer is expressed. The development in turnover in the period $t_0-t_2$ causes a decrease in the ratio, when a balanced situation demands for a constant level. Hence retailing economics is increasingly unbalanced. Accordingly, the retailer's overall evaluation decreases as the degree of unbalance increases. At $t_1$ the personal lower-threshold of evaluation values
related to non-reaction is exceeded, the consequence of which is that
the retailer decides to react by taking some measures with the aim to
lower the fixed costs. Suppose he chooses to dismiss some of his
employees, then the fixed cost level decreases and the ratio is moved
up to a more balanced situation. However, since the turnover continues
to decrease, the ratio does too. Suppose that at \( t_2 \) the overall
evaluation has not exceeded the lower-threshold, then the growth in
turnover between \( t_2 \) and \( t_3 \) causes a constant (suboptimal) level of the
ratio turnover and fixed costs and a constant (suboptimal) overall
evaluation of the retailing context within the evaluation margins of
non-reaction.

The impacts of the retail planning measure at \( t_3 \) on the turnover,
the ratio between turnover and costs and the overall evaluation, are
obvious. In the period \( t_3-t_4 \) the value of the overall evaluation
increases and even exceeds the upper-threshold. Suppose the retailer
decides to profit from this development in terms of increasing his
floorspace and at the same time engaging an extra employee, then,
although this reaction may bring about a higher fixed cost level and
hence a sudden decrease in the ratio turnover and fixed costs, the
retailer will keep his overall evaluation level. However, it is likely
that the optimal turnover/cost ratio, the optimal subjective evaluation
level and both the upper and lower threshold values of non-reaction
will be adapted to the new retailing context.

Figure 7 assumes that particular margins to the overall evaluation
level related to the optimal cost-turnover level determine a 'zone of
indifference', causing non-reaction. As long as this overall evaluation
does not exceed the threshold related to this zone of indifference, the
retailer is not inclined to react to a development but will wait for
future developments. Of course, these margins will differ among
retailers. This implies that, given a particular change in turnover,
some retailers appear to react and change levels of particular
attributes within their retailing context, while others do not.
Consequently, on the individual level, the choice problem related to a
change in turnover is assumed to be dependent upon the difference
between the preferred overall evaluation value and its margins on the
one hand and the actual overall evaluation level on the other hand.
The actual choice of a reaction from among the set of reactions is
Figure 7: Hypothetical relationship between turnover, costs and retailer subjective evaluation

A
Hypothetical development in actual turnover (F) compared to the hypothetical development in turnover according to the general trend (G). A and B are retail planning measures.

B
Hypothetical development in the ratio of turnover-to-floorspace ratio and fixed costs of retailing
G': according to the trend
H': actual, with intervention by retailer (X: compensating reaction, Y: profiting reaction)
H'': actual, without intervention by the retailer

C
Hypothetical development in retailer's overall evaluation of the retailing context
G'': according to the trend
E': according to development H' in Figure 7b
dependent upon the subjective evaluation of the advantages and disadvantages of the choice alternatives in the perspective of the difference in evaluation values.

There are some problems that complicate the understanding of this decision making process and the modelling process. **First**, unlike consumer spatial choice behaviour, it is very difficult to define the complete, objective choice set properly. This has at least two reasons. Firstly, the choice alternatives are formulated in terms of retailing business variables, which may be difficult to identify. Secondly, retailers might decide to choose for reacting simultaneously in two or more different ways (for instance: a new branch mix and dismissing employees). Those mixed, integrated choice alternatives are even less identifiable than the separate, independent types of reactions they are composed of. The number of combinations is theoretically not limited.

**Secondly**, the choice conditions of the individual retailer are considerably more complex than the choice conditions in the context of consumer spatial choice behaviour. Since the consequences of the retailer's choice in terms of financial investments and changes in the image of his retailing activities might be dramatic and generally non-reversible without (financial) losses (both aspects do not apply to consumer spatial choice), the retailer might have to take into account relatively more context variables. Part of these variables might be of a social nature. Sets of relevant variables might differ considerably among different retailers in the same shopping centre.

A **third** problem is for a retailer that the utilities associated to particular reactions might be differently directed under various conditions. For example, the extension of floorspace can under certain circumstances imply a higher level of turnover. When the cost level is increased less, this implies an improvement of the ratio between costs and turnover. However, the situation may also occur that an extension of floorspace causes an increase in cost level (for example more employees are required) so that it cannot be compensated enough in terms of a higher level of turnover. In that case the net effect is a less favourable turnover/cost ratio.

These three problems indicate at least two things. First, classical assumptions of retailer behaviour and in dynamic modelling approaches...
approaches as discussed before, hardly reckon with this complexity of problems. Secondly, there is a need for a considerable amount of basic empirical research in order to analyse the choice problem in terms of cognitive-behavioural mechanisms, in order to face and possibly reduce the measurement and modelling complexity and the related need for large data sets. The state-of-the-art of understanding retailer reactive behaviour in a cognitive-behavioural way requires applied retail research to collect many data that might prove to be not very usable afterwards. This is very cost-demanding, which contrasts with the objectives of the development of the alternative applied retail planning research methodology. Notwithstanding these problems the need remains for systematically approaching retailer reactive behaviour in the context of applied retail research. This means that the theory on retailer reactive behaviour should adjust be defined in a way that enables a rather simple measurement and modelling approach to be effective and that nevertheless includes cognitive-behavioural dimensions of that behaviour. In the next subsection, the qualitative considerations in the present subsection will be elaborated in terms of such a formal theory.

4.3.3 Formalization

Assume a group of H retailers in a spatially clearly identifiable shopping centre j and assume that for each of these retailers a multi-dimensional context for retailing (the 'retailing context') h exists (h=1,...,H), characterized by Rh attributes.

Axiom 1: Each retailer has a subjective evaluation of his/her retailing context.

This axiom is based on the assumption that retailers subjectively and continuously perceive and evaluate their retailing context. Indirectly, this implies that the levels of the attributes of their retailing context are evaluated. Let $O_{ht}$ denote the evaluation of retailing context h at time t. On behalf of modelling, the following assumptions may be made.

One might assume that the conditions of retailing are completely represented by the level of the turnover in context h and the level of costs of retailing. In that case,
where $V_{ht}$ denotes the level of turnover, $C_{ht}$ the level of costs in retailing context $h$ at time $t$ and $g_1$ some functional relationship between turnover and costs on the one hand and the subjective evaluation of the retailing context on the other hand.

Alternatively, it may be assumed that the conditions of retailing are not completely represented by $V_{ht}$ and $C_{ht}$. For example, personal objectives and characteristics may be of relevance too. In that case, the levels of additional attributes may also influence $O_{ht}$, which can be described by the following equation:

$$O_{ht} = g_2(V_{ht}, C_{ht}, X_{rht}); \quad (h=1, \ldots, H; r=1, \ldots, R_h) \quad (4.10)$$

where $X_{rht}$ denotes the level of attribute $r$ of retailing context $h$ at time $t$.

Next, the assumption might be made that retailers arrive at a subjective overall evaluation of their retailing context on the basis of some compensatory combination rule. Alternatively, however, some non-compensatory combination rule may be assumed which implies that a low evaluation score for one attribute level influences the overall evaluation strongly.

Further, the assumption might be made that retailers evaluate their retailing context with respect to some preferred (minimum) score of subjective evaluation, denoted by $Q_h^*$, given particular conditions of retailing. $Q_h^*$ can be thought of as some ideal point given these conditions. The acceptance of equation 4.9 means that $Q_h^*$ is related to the level of costs and thus represents a minimum level of turnover. The acceptance of equation 4.10, alternatively, means that $Q_h^*$ is related to other attributes of the retailing context as well.

The consequence of this axiom is that changes in the level of turnover for retailing context $h$ brought about by the trend and/or planning initiated developments with regard to relevant conditions of retailing, bring about a change in the retailer's subjective evaluation of his/her retailing context. The assumption is that these changes become manifest (and can be measured) within some time period $\Delta t$. Let $\Delta Q_{ht}, \Delta t$ denote this change in subjective evaluation.
Axiom 2: The probability that reaction $q$ by a retailer will be chosen is dependent upon the degree of change in evaluation value $O_h$ on the one hand and the subjectively expected effects of reaction $q$ within retailing context $h$ on the other hand. This axiom may be formalized as:

$$ p(q) = g_3(\Delta O_h, \Delta t, \Delta \hat{O}_h, q) $$

(4.11)

where,

$\Delta O_h, \Delta t$ denotes the actual change in evaluation value related to retailing context $h$ in time period $\Delta t$;

$\Delta \hat{O}_h, q$ denotes the expected change in evaluation value related to retailing context $h$ brought about by reaction $q$.

Reaction $q$, except for non-reaction, deliberately manipulates the levels of particular attributes of retailing context $h$. This results in an improved attractiveness (and hence turnover) and/or a decreased cost level. It is assumed that the relationships between changes in subjective evaluation and the choice of a reaction can be measured in a hypothetical measurement context. A further assumption is that, in case the difference between the actual evaluation score and the ideal evaluation score is small, no reaction will be initiated that actually has consequences for the levels of particular attributes of the retailing context. In this context 'small' can be understood in terms of not exceeding some upper evaluation value $O'_h$ or some lower evaluation value $O''_h$ both related to the value of $O_h^*$ given a particular nature of retailing context $h$.

4.4 The quantification of retail system performance

4.4.1 Background of the theory

An adequate support for the retail planning process requires the specification of a framework for the quantified description of the retail system performance. A planning-relevant quantification of this performance is necessary for a balanced evaluation of the retail system and is assumed to contribute to good decision making. The overview in chapter 1 of currently applied retail research showed that part of the criticisms on applied retail research focus on the way the retail
system performance is evaluated. A framework for the systematic quantification is lacking. Moreover, predictions emphasize economic variables and, in many descriptive-analytic studies, descriptive variables are used that bear no obvious relationship to demand-supply dynamics of the retail system. Before an alternative theoretical framework for evaluation will be elaborated, first both types of criticism will be further elucidated.

Descriptive nature of current approaches

A way of elucidating the first type of criticism is to describe the mainlines of the comprehensive ex ante evaluation framework that has been suggested by Rogers (1979). Although Rogers focuses especially on the impact of new shopping developments on existing retailing and travel patterns, his framework can very well serve the purpose of describing the mainlines of common practices. Rogers motivates his efforts by arguing that so far the study of impacts has hardly provided a methodology for comprehensively evaluating the impacts of new shopping developments. He notices that methods employed to predict the impacts of new retail facilities almost completely focus on business impacts: the effects on turnover. Instead "the interrelation of changes in consumer behaviour, travel, patterns, and store sales demand that an effective analysis be comprehensive in scope and allow for trade-offs between impacts" (p. 396). Rogers argues that there are six major issues of impacts, each of which can be subdivided in operational variables. These issues are:

- Characteristics of the proposed shopping development:
  - design and environmental effects;
  - accessibility;
  - retail attributes (size, product range, store types, tenant mix, store operating).

These aspects highly influence the types and numbers of customers attracted and the pattern of competitive impact. It is therefore relevant to get a good picture of these aspects.

- Characteristics of the existing retail structure.

Naturally, the changes in travel behaviour and the patterns of competitive impacts from new retail developments highly depend on the shopping habits consumers have before the introduction of the
new facilities and the degree of satisfaction with the existing facilities. Therefore, a thorough analysis of these habits and the existing retail structure is needed. Assessments on choice patterns have to be made.

- Shopping capacity and demand relationships.
This parameter concerns the relationship between available expenditure potential (demand) and retail floorspace (supply). The calculations need a thorough knowledge of retail economics and the dynamics of the store trading area.

- Population density and distribution.
Present and future distribution of population with respect to the location of the proposed developments are of crucial significance for its economic success and it influences the likely impacts of new developments on traffic patterns and competing facilities.

- Trade area population characteristics.
The population characteristics influence shopping habits and are hence of influence on the viability of new retail facilities and the impacts on the existing retail structure.

- Distance and road patterns.
Critical factors are the interrelated effects of distance and the patterns and quality of road infrastructure.

What is to be learned from the evaluation framework Rogers proposes with respect to the aim of the theoretical framework? This evaluation framework is not linked to a theory on the operations of the retail system. The understanding of these operations and the produced information is consequently somewhat selective. Moreover it is highly qualitative-descriptive and primarily bears the character of a checklist with items that should be dealt with in applied retail research. This is at the same time also the value of the framework: it emphasizes the need for dealing with various aspects related to retail planning. However, the framework is too undirected and fuzzy to constitute a basis for the development of clear indicators for retail system performance in the context of DSS. Consequently, the framework by Rogers is a necessary though not sufficient basis for developing the retail planning DSS.
Critics on current retail planning state that:

- retail planning is very much dominated by a focus on retail economics;
- the planning of retail facilities in land use terms heavily depends on the use of normative turnover-to-floorspace ratio;
- this translation of expected viability into future land use is selective because of doubts about the reliability and usability of data underlying normative turnover-to-floorspace ratios and consequently subject to bargaining and deliberations in the planning team.

Indirectly, these criticisms also apply to the information production for retail planning. The biased nature is related to the natural tension between the interests of retailing economics and the objectives of retail planning. The attempts to avoid considerable constraints on retailing economics by means of public planning are inherent to our societal, public objectives. Therefore, retailer interests are generally well organized and dealt with in decision making. Consequently, retail planning commonly provides retail facilities with optimal spatial-social conditions and special attention is paid to the problem of the economic viability of retail facilities.

The attention for the economic viability of retail facilities bears the character of calculating turnover-to-floorspace ratios, given an empirically based (use of a model) or normative (use of particular calculation rules) assessments of turnover, assuming a particular size and spatial distribution of population. The expected turnover-to-floorspace ratios are then compared to normative turnover-to-floorspace ratios that generally serve as a measure for deciding whether or not floorspace might be increased or should be reduced at a particular location. These calculations bear generally a very aggregate and absolute character.

With respect to the third aforementioned point particular reference should be made to the amount of criticism on the reliability of the data underlying the normative turnover-to-floorspace ratios values and consequently the much too dominating use of this criterion in retail planning (see e.g. Berkhuijsen, 1974). The approach hardly accounts for existing multidimensional variety and gradual changes in the
operation of the retail system. One consequence is that the evaluation of the performances of the retail system often becomes a matter of bargaining and negotiation. Another consequence is that retail plans might be suboptimal from the viewpoint of affected interests not involved in the planning process as strongly as the retailer interests are.

Therefore, an extension of the attention in retail planning to other aspects of the multidimensionality of the retail system is needed. Moreover, not only normative values should be used as criteria for indicators. In case the performance of a retail system is quantified for one particular moment, the values of the indicators bear an absolute, static character. The way of dealing with these values in the context of retail planning could be a comparison of them with absolute norm values for these indicators or with the values of the same indicators in comparable study areas or with the values of a dynamic range of past and/or future trend performances of the retail system. Particularly in the context of the prediction of future system performances under various conditions an effective way of dealing with the values of indicators is a comparison of them with the range of values of indicators of the hypothetical future trend development of the system. This comparison with the trend is considered to be a worthwhile approach, given the indicated problematic (political) nature of defining absolute norm values.

4.4.2 Theoretical framework for performance indicators.
As has been argued in chapter 1, structural retail planning focuses on the locational- and functional regulation of the distribution of retail facilities in a planning area: where, how much for what, how to reach and for whom? The general objective has been described as contributing to the management of the quality of the physical and functional urban and regional systems, while at the same time avoiding too strong influences on the development of retailing economics. Therefore, retail planning ultimately deals with the question where, to which extent and in which composition retail facilities are allowed in order to arrange an optimum equilibrium situation between the interests of (categories of) consumers and (categories of) retailers, who pursue public objectives. Retail planning provides the locational- and
functional conditions for a reasonably undisturbed development of retailing business and a sound competition on the one hand and a sufficient (from the user's point of view) supply-side on the other hand. The retail planning objectives should determine the framework for the quantification of retail system performances. In particular three fields of interest were distinguished: retailer interests, the interests of consumers and some public interests. The essence of the interests of retailers is the guarantee of income and continuity of the retailing business activity in terms of sufficient turnover. The essence of the interests of consumers is the establishment and/or maintenance of sufficient choice possibilities within a reasonable distance. Finally, the essence of the public interests is that 'land' or 'space' are dealt with as scarce economic sources and equity is pursued among the conditions of shopping and retailing. These notions have to be elaborated in more detail.

Retailer interests

The central point of this category of interests has been indicated by means of the notions of sufficient income and continuity. These notions refer in a global way to the notion of efficiency. In the literature some authors have explicitly paid attention to the issue of efficiency (for instance Gaile, 1977; Rich, 1979; McAllister, 1980, Aziz, Butterfield and Kubursi, 1983; Moas, 1983). The measures of efficiency suggested in these studies are generally variants on the calculation of the per capita consumption of goods and/or services in the study area. The measure is often used in the context of finding the most efficient (hypothetical) configuration of size and space of the production structure. The most efficient retail structure from the retailer's point of view is assumed to be the configuration that maximizes consumption of goods by consumers living in the study area. The problem with this point of view is that the measures apply to the overall nature of the retail system. Consequently, they fail to give insights in the specific context and features of an individual shopping centre. Moreover, the basis of evaluating the actual performance of the system is the value of the index for a hypothetical consumption-maximizing situation. The underlying assumption that a retail system deterministically develops in such a direction does not necessarily
have to be valid. At least one should recognize that this development in real-world practices of retail planning can hardly be identified. Moreover, specific local circumstances make it unlikely to enable a retail system to arrive at such an ideal situation. Hence, the hypothetical maximum consumption level has little meaning and consequently a comparison of real-world performances based on it has too. An adjusted, retail planning orientated, interpretation of the notion of efficiency is necessary. Two mutually supplementary points of view will be suggested.

In the context of structural retail planning it is necessary to interpret the notion of efficiency on the level of each shopping centre which constitutes the basic business environment for retailers. The first interpretation of efficiency could be the ratio between the service production capacity of the shopping centre and the total service consumption. Evidently, such a ratio can only be determined when both aspects are expressed in comparable terms and, additionally, evaluation requires some anchor-points. The use of normative turnover on the one hand and expenditures on the other hand satisfy the first part of the requirement. The second part of the requirement is satisfied when a maximum value of 1.0 for efficiency for the ratio between normative turnover and expenditures is assumed. A value higher than 1.0 implies a loss of efficiency. As noted before, this evaluation basis is quite common in currently applied retail research. The practical problem is the identification of the normative turnover level. A minimum requirement in that context is the fact that this normative value should be made centre-specific. In that way, it gives some, though limited, insight in the efficiency level in a particular shopping centre.

A second interpretation of efficiency stems from the fact that the first interpretation hardly takes into consideration the local relationships between the benefits of the production of services (the turnover) and the costs of the production. In section 4.3 it has been assumed that on the individual level there exists a balance between costs and benefits, the level of which describes a continuous function. It is important to note that this balance is based on the individual evaluation of efficiency. When the evaluation of the business context exceeds a margin of indifference, the retailer seeks to change the
efficiency level by performing a particular type of reaction. Hence, retailers pursue efficiency that is adapted to an individual context. This view of efficiency stresses the dependency of the efficiency level upon specific local circumstances, in other words, efficiency in a relative perspective. The problem of this view with regard to retail planning is its interpretation on the level of the shopping centre and, additionally, the development of indicators. However, as noted before, retailer reactions are related to disturbances in their balanced situation, particularly when these are caused by external influences. One could interpret any discrepancy on the level of the shopping centre between the actual level of turnover and the level of turnover under the conditions of non-intervention as a disturbance of efficiency. Such a centre-specific interpretation takes into consideration the relativity of efficiency: the dependency of the efficiency level and its development upon local factors are included in that way. The translation of this view and the first mentioned view into indicators will give a basic insight into aspects of relevance for retailers. Nevertheless, it is recognized that further research is required so as to refine and extend these views on behalf of the development of retail planning relevant indicators.

Consumer interests
The essence of the second category of interests, those of the consumers, has been described as the establishment and/or maintenance of sufficient choice possibilities within a reasonable distance. Each consumer has a particular knowledge of the shopping opportunities in his/her environment. The individual is interested in keeping up this level of knowledge, since this level in a certain way represents the choice space of the individual. Two aspects are relevant in this context: the objective choice space and the subjective choice space. The first aspect refers to the availability of shopping opportunities. Availability simply expresses the objective number of opportunities within the individual's environment. The second aspect refers to the information fields: the shopping opportunities the consumer subjectively possesses knowledge of. Changes in the spatial structure might cause changes in the information field and, consequently, the subjective choice space. The reverse is less clear: information fields
might be changed without changes in availability, for instance as the result of changes in the individual's structural position. What is generally termed the accessibility to shopping opportunities is important for both the choice space and the actual behaviour of the consumer. There exists a variety in meaning and contents attached to the notion of accessibility, which is the result of the fact that accessibility is a widely discussed topic in geography and regional science. Portugali (1980) interprets in an overview accessibility as the individual's (subjective) evaluation of the relative quality of a location. The relative quality of a location (in the context of structural retail planning: shopping centres) can be interpreted as the trade-off between the advantages of these centres and the costs of bridging the distance between the individual's home and these centres. Where availability simply expresses the objective choice space of the consumer residing at a particular location, accessibility expresses the trade-off between the attractiveness of available opportunities and the cost of use. Geographical distance or travel time might be used as simple surrogate variables for transportation costs. Alternatively, some distance-cost function can be used. Furthermore, quality might be expressed objectively, or in terms of subjective evaluations. Variables used to quantify the individuals' evaluation of the quality are for instance the subjective evaluation of the size of the shopping centres, the actual individual choice probabilities or the actual expense at particular moments. The present definition of accessibility has the advantage of being easily linked to the domain of variables and data described by means of the theory on consumer-retailer interaction. Moreover, specific notions put forward in the discussion on accessibility are variants of the described interpretation. For example Koenig (1980) uses the term 'consumer surplus' to indicate that the difference in net profit resulting from the (in the definition) mentioned trade-off can be interpreted as different parts of individuals' income. From a similar perspective, Askew (1983) and Kirby (1983) uses travel time to indicate the real income effect of bridging the distance.

Public interests
Sensibly dealing with space as a scarce economic source and pursuing
equity among the conditions of shopping and retailing has been mentioned the essence of this third category of interests. The first notion refers to the generally accepted view that urban and regional planning cope with 'land' as an economic product. With respect to the present study, there are particularly two aspects of the operations of the retail system to be concentrated on: the occupation of land by consumers and the occupation of land by retailers. The first aspect refers to the interaction between residential areas and shopping facilities (mobility). The second aspect refers to the amount of land use capacity.

The second notion mentioned above is related to what might be called the social objectives of urban and regional planning. Planners are affecting the interrelation between the 'social structure' and 'spatial forms'. It is necessary to make a distinction between equity and equality in this context. According to McAllister (1980, p. 48), "equity is indicated by the degree of equality in the distribution of services among the population". It is used to indicate an end state in which services are fairly distributed (distributional justice). Rich (1979) notes that the idea of equity stems from the formulation of the service-location problem by the government of western societies, namely "to offset the burdens imposed on some groups by the operation of the market economy so that a greater equality of 'life changes' is achieved. An equitable arrangement is then one which promotes greater equality of condition. Services are equally distributed when everyone gets the same services. They are equitably distributed when citizens are in a more nearly equal life circumstance after receiving the services than before" (p. 152). The provision of equal service outputs to groups of consumers who are in highly unequal circumstances may produce inequitable outcomes. Hence, the relation between the services provided and the services citizens desire (preferences) is crucial. Still in other words: equal outputs may produce unequal outcomes for the residents of different neighbourhoods. The differences between equity and equality corresponds with the differences between effectiveness and efficiency. A spatial pattern of services may be efficient when it merely produces a certain optimum of services/goods. Effectiveness, however, "is a matter of outcomes, effects, produced by the relationship between community needs and available public service"
The consequences of this view for the development of performance indicators in the context of a retail planning DSS are the following. By means of retail planning, equity is pursued in opportunities of retailing as well as the opportunities for the use of retail facilities. This is a public objective bearing a social character. According to the literature, an important condition for reaching equity is the realization of more equality in particular conditions for different measurement units (in the retail planning field: retailers, retail zones, consumers, residential areas). Therefore, the DSS should focus on providing information about the degree of equality in variables considered as indicators of these conditions. For the consumers the indices of availability, information level and accessibility on the level of residential areas can be used. For the retailers indices related to turnover-to-floorspace ratios on the level of the retail zones can serve the pursued measurement.

4.5 Conclusions
In this chapter the theoretical framework has been elaborated, the need of which was stressed in the overview of the criticism on applied retail research and, additionally, in the context of the definition of requirements for the developments of a retail planning DSS. One main focus has been laid on consumer spatial choice behaviour and the reactive behaviour of retailers on changes in this retail context, because the dynamic interaction is the central characteristics of the operations of the retail system in the planning area. The obvious influence of consumer spatial choice on the retail system performance and hence retailer reactive behaviour has been elaborated on qualitatively as well as in a formal way. The theoretical relationships have been understood in terms of the cognitive-behavioural approach of the choice problems consumers or retailers are confronted with.

The present approach of consumer spatial choice behaviour provides a more basic framework than is currently used in applied retail research. The focus on the individual psychological mechanisms such as to willingly, perceiving, weighting and choosing, provides an approach that can incorporate individual constraints in a more valid way than currently used conceptualizations do both methodologically and
theoretically. As such, this dealing with the individual decision making processes in the provided theory is aimed at increasing the flexibility of modelling these processes on disaggregate levels. Moreover the nature of the theory implies that the specification of models used for predicting the likely effects of alternative retail plans can be relatively independent of specific spatial characteristics of the study area the models are applied to, thus attempting to avoid the important criticism on current expenditure distribution models.

With respect to the domain of the retailer behaviour it must be noted that the extension of the theory as such and moreover the understanding of that behaviour in notions also used to understand consumer behaviour might be considered as an important progress relative to theories in currently applied retail research. Currently, retailer interests are dominantly operationalized in applied retail research by calculating turnover-to-floorspace ratios and retailer income while retailer behaviour receives no special attention. An exception is the more explicit dealing with features of the supply-side in the development of dynamic equilibrium models. However, such models have not yet been proved to be applicable in the context of supporting retail planning. Moreover, other criticisms on a theoretical level apply to these models, such as that they have not been built on the principles of the cognitive-behavioural view of individual decision making processes and, consequently, lack the advantages this view has in terms of understanding and coping with the operations of the retail system.

The second main point in the theoretical framework is the elaboration of a framework that might be used for the quantification of retail planning relevant information about the performance of the retail system. The framework encompasses three domains: retailer-, consumer- and public interests. Retailer interests focus on aspects of efficiency, interpreted in terms of the changes in the economic operation of the retail facilities. With regard to consumer interests aspects of accessibility and availability are emphasized. Finally, public interests stress aspects of land use and public costs and the creation of equal conditions for shopping and retailing. In the context of the exploration of the performance of the retail system at one particular moment, the quantification of these notions refers to
absolute norms. In the context of predictions under various conditions, the quantification includes a comparison with the expected trend-development. Although the suggested framework in this respect should be subject to further developments, it is a more comprehensive and retail planning relevant approach, provided that appropriate operational indicators are elaborated on. Part of the next chapter deals with that problem.
CHAPTER 5: THE RETAIL PLANNING DECISION SUPPORT SYSTEM

5.1 INTRODUCTION
The aim of this chapter is to present the retail planning DSS. There are two points of departure. The first one is the analysis of the decision process in chapter 3, aimed at the recognition of DSS-candidate stages of the planning process. The second one is the theory of the retail system elaborated in the previous chapter, given the information needs related to the identified decision making stages. As mentioned before, these stages are:

a. description and diagnosis of retail planning problems;
b. exploration of the margins of retail planning;
c. impact assessment for alternative retail plans;
d. ex ante multicriteria evaluation of alternative retail plans;
e. monitoring and early warning.

The relationships between these stages, the theory of the retail system and the DSS are summarized in Figure 8.

For each of the five stages a version of the DSS will be presented in this chapter. Since the typical feature of DSS-building is the module-based approach, whereby each module will focus on a particular type of analysis, it is not necessary to follow the abovementioned sequence of stages. In particular, the methodology for the exploration of planning margins and the monitoring include the use of models and data defined with respect to other stages. Therefore, these two stages will be discussed at the end of this chapter. First, in section 5.2, the research methodology for identifying retail planning problems is presented. The analysis of future trend developments in that context requires the elaboration of a model for the prediction of retail system dynamics. Next, in section 5.3, the approach of assessing impacts of alternative plans is discussed. The model specified in section 5.2 is used for these assessments. Special attention is paid to the quantification of retail system performances relative to the expected trend development. A number of indicators will be proposed. Section 5.4 discusses some way of ex ante multicriteria evaluation of
Figure 8: Basic relationship between DSS, the retail planning process and the retail planning-orientated theory

RETAIL SYSTEM DYNAMICS

INDICATORS

CONSUMER INTERESTS
PUBLIC INTERESTS
RETAILER INTERESTS

MODELS AND TECHNIQUES FOR THE MEASUREMENT AND PROCESSING OF DATA

INFORMATION

EXPLORATION, PROBLEM IDENTIFICATION
PLAN EXPLORATION AND DEFINITION
IMPACT ASSESSMENT FOR ALTERNATIVE PLANS
MULTI-CRITERIA EVALUATION
MONITORING AND EARLY WARNING

DSS - EXTERNAL INFORMATION
alternative retail plans. In section 5.5 the exploration of margins of retail planning is elaborated and in section 5.6 an approach of monitoring and early warning will be outlined.

5.2 IDENTIFICATION OF RETAIL PLANNING PROBLEMS

5.2.1 Introduction
The main aim of the first stage of the retail planning process is to get general insights in the retail system and to determine possible retail planning problems. In principle, the theory elaborated in chapter 4 serves as the framework for the production and understanding of the required information. There are two categories of analyses (a) the descriptions of the current situation, and (b) the prediction of future supply-demand dynamics of the retail system. In the context of the first type of information production the framework serves as a checklist, indicating the main fields and foci of analyses. The variety in analyses is not principally limited. In the context of the second category of analyses, the variety in analyses is limited, since a predictive model should be used. For the elaboration of the DSS methodology it is most efficient to start with the limited, but necessary types of analyses related to model specification and, in addition, suggest remaining types of analyses. Options for descriptive analyses are partly related to the data necessary for the specification of the predictive model. Therefore, the structure of the model specification will first be discussed in this section. Attention will be paid to the specification of an expenditure distribution model (5.2.2), the relationship of the suggested model with currently more accepted discrete choice models in applied retail research (5.2.3), the retailer reactive behaviour model (5.2.4), the use of models for description and prediction (5.2.5) and some additional options for descriptive analyses (5.2.6).

5.2.2 Expenditure distribution model
The specification of an expenditure distribution model involves the following steps:

I. specification of a model for predicting consumer information fields;
II. specification of a multiattribute preference model for predicting consumer spatial choices;

III. translation of consumer spatial choices into expenditure distribution of spending power over the study area.

I. Information fields

For the measurement of information fields of consumers some alternative approaches might be used. Potter (1977, 1979) uses a graphical method, implying that respondents are asked to indicate on a map all the shopping centres of which they have knowledge. The success of the method partly depends on the graphical abilities of respondents. No insight is gained in the degree to which consumers are familiar with shopping centres. Alternatively, respondents might be asked to indicate their degree of familiarity by responding to a prespecified list of shopping alternatives on a rating scale varying from not known to perfectly known (Smith, 1976; Hanson, 1976; Timmermans, Van der Heijden and Westerveld, 1982a). This measurement requires a careful identification of shopping alternatives and a meaningful labelling of these alternatives. Several descriptive analyses of data on information fields are possible. Timmermans, Van der Heijden and Westerveld (1982a) suggested the following descriptive statistics. Let $f_{ij}$ denote the dichotomised familiarity score of individual $i$ for shopping centre $j$. A value of 0 implies that the respondent is not familiar with the centre, whereas a value of 1 is used to indicate that he/she knows the shopping centre. Then $M_i$ denotes the 'information total' for individual $i$. The average information total across $I$ individuals (for instance living in one residential zone) is calculated by:

$$
\bar{TF} = \frac{1}{I} \sum_{i=1}^{I} M_i
$$

(5.2.1)

Next, the mean distance from the respondent's home to the shopping centres he/she is familiar with can be calculated as:

$$
\bar{d}_i = \frac{\sum_{j=1}^{M_i} d_{ij} \cdot f_{ij}}{M_i}
$$

(5.2.2)
with \(d_{ij}\) denoting the distance between the respondent's residence and shopping centre \(j\). The measure gives an indication of distance bias: the degree to which consumers possess more information about nearby shopping centres than about more distant shopping centres.

Brown and Holmes (1971) presented an approach to measure distance bias in another way. It involves the rotation and translation of the vectors linking the consumer's place of residence to the city centre until it coincides with a common axis emanating from the city centre and the occupation of a common point on this axis. The shopping centres in the respondent's information field are rotated and translated to the same degree and the same direction as the consumer's place of residence (see Figure 9a). Hence, the original spatial distribution remains. Individual information fields are now comparable. Brown and Holmes suggest the identification of the spatial properties of each distribution by identifying the elliptical function that best fits the points distribution, using standard ellipse techniques. The measure of standard radius \(SR\) is then used as a measure of distance bias. \(SR\) describes the average dispersion of the distribution from its mean centre. In terms of Figure 9b the standard radius is defined as:

\[
SR = \sqrt{\frac{1}{2} (aa')^2 + \frac{1}{2} (bb')^2}
\]  

The lower the standard radius the greater the distance bias. Brown and Holmes also discuss the so-called directional bias and sectorial bias. Directional bias describes the degree to which the information fields are orientated towards a particular direction such as the city centre. Sectorial bias describes the degree to which the information field is structured along a single axis (Figure 9c). Sectorial bias can be measured by means of the coefficient of circularity \(CC\), defined as:

\[
CC = \frac{bb'}{aa'}
\]  

Hence, \(CC\) equals the ratio of the length of the minor axis of the ellipse to that of the major axis. A ratio of zero denotes a perfect sectorial bias and a ratio of one represents absence of sectorial bias. Finally, the Angle of Rotation can be considered as an indicator of the directional bias relative to the city centre.
Figure 9: Analysis of information fields according to the Brown and Holmes (1971) procedure

a)

b)

c)  example of sectorial bias

example of directional bias
These measures give insight in the spatial properties of information fields. They can be linked to consumer characteristics or spatial characteristics of the study area so as to identify associative relationships by means of correlational analyses. Apart from the performance of such descriptive analyses, a model should be defined for the prediction of future information fields. The aim of the submodel is to determine structural zero-cells in the expenditure distribution matrix. The following aggregate logistic model, suggested by Van der Heijden and Timmermans (1984), can be used to predict the familiarity of a consumer \( i \) with shopping centre \( j \). The model is based on \( R \) attributes of shopping centres, considered equally of influence for all consumers:

\[
\frac{\exp (\alpha + \sum_{r=1}^{R} \beta_r \cdot X_{ijr})}{1 + \exp (\alpha + \sum_{r=1}^{R} \beta_r \cdot X_{ijr})} = P_{ij}
\]

(5.2.5)

where,

- \( P_{ij} \) denotes the probability that an individual \( i \) is familiar with shopping centre \( j \);
- \( r \) denotes the index for influential variables \( (r=1, \ldots, R) \);
- \( X_{ijr} \) denotes the value of variable \( r \) with regard to individual \( i \) and shopping centre \( j \);
- \( \alpha, \beta \) are parameters.

The parameters in this model can be estimated on the aggregate level by applying (weighted) least squares analysis, stepwise regression analysis or maximum likelihood estimation.

II (De)compositional multiattribute preference models

The specification of a (de)compositional multiattribute preference model for predicting consumer spatial choices implies that attention should be paid to the following issues:

- the identification of attributes that dominate the consumer evaluation and the choice of shopping alternatives;
- the measurement of part-worth utilities of levels of these attributes and the identification of the combination rule by way of which consumers integrate part-worth utilities into an overall utility for shopping alternatives;
- the decision rule that links preferences to overt choices.

**The identification of relevant attributes**

A first approach for identifying the factors underlying consumer evaluation- and choice-behaviour is that of multidimensional scaling (e.g. Dobson and Kehoe, 1974; Nicolaidis, 1977). The approach typically involves that respondents are requested to express the degree of similarity between pairs of choice alternatives. MDS attempts to find a multidimensional space of a dimension as low as possible in which the interpoint distances are as monotone as possible with the similarity measures. The influential factors are then identified on an a posteriori basis, by inspection of the derived scaling configuration or by correlating the scales to a set of independent variables denoting the attributes of the alternatives.

A second approach involves the use of rating scales or semantic differential scales so as to measure the relative importance of a set of a priori defined factors (e.g. Michaels, 1974; Thomas, 1976). Average ratings are then calculated to elicit the factors that dominate choice behaviour. Alternatively, multidimensional scaling or factor analysis can be used to reduce the semantic scores to a smaller number of independent underlying perceptual dimensions.

A third approach is that of factor listing (e.g. Louviere, Wilson and Piccolo, 1977; Timmermans, Van der Heijden and Westerveld, 1982b). This approach involves respondents being invited to specify the reasons for choosing a particular destination and not choosing an alternative. The most frequently mentioned reasons are considered to be the most important attributes influencing choice behaviour.

A fourth approach is the so called repertory grid methodology (e.g. Hudson, 1974; Urselman, 1978; Timmermans, Van der Heijden and Westerveld, 1982b,c). The basis of the methodology is the personal construct theory, developed by Kelly (1955). The theory is built on the postulate that an individual uses personal constructs to give meaning to the world around him/her. The ramifications of this postulate are elaborated through eleven corollaries defining how individuals develop their personal constructs of reality. In order to elicit these personal constructs, the repertory grid methodology has been suggested. Commonly, a respondent is asked to name a number of
meaningful elements (e.g. shopping alternatives). Next, the individual is presented sets of triads of elements and asked to specify some way in which two elements are alike and thereby different from the third element. This process is repeated with different triads until, after several consecutive trials, the individual is unable to provide additional constructs. The individual is then requested to rate each element on the basis of each provided construct. The resulting repertory grid of constructs and grid scores may then be subjected to some form of multivariate analysis to eliminate the redundancy in the grid matrix. Moreover, individuals may be asked to rate the constructs in terms of their importance in influencing individual behaviour.

The final suggested approach is the protocol analysis (Park and Lutz, 1982; Lundberg, 1984). The fact that individuals are requested to mention relevant attributes and order these according to the weights they attach to them in the context of their behaviour is typical for this approach. Additionally, they are asked to indicate under which conditions, defined in terms of the level of the elicited attributes, the choice alternative will no longer be chosen. This approach has also the advantage of enabling the individual to answer to these questions in semantically meaningful terms. Attributes important to the respondent are not excluded and unimportant attributes not included. Moreover, the respondent is asked to evaluate the levels of the attributes simultaneously, which implies that a reliable insight in the relevance of each attribute and the willingness to accept configurations of various levels of these attributes is gained. The answers are embedded in a 'think-aloud' approach.

The advantage of the multidimensional scaling approach is that the attributes are not pre-specified. Relevant attributes are not excluded beforehand. On the other hand, the approach assumes that the dimensions are independent. If this assumption is incorrect, then the interpretation of the dimensions may be meaningless. Moreover attributes that are really independent in the mind of the individual may load on a single dimension. These attributes are evaluated in the same way, which in fact implies that the conclusion is wrong. Another serious problem is that the approach applied usually discards eliciting the semantic labels of the attributes. The identification of the factors therefore relies upon a subjective a posteriori interpretation.
of the dimensions by the researcher, at the risk of superimposing his/her own perceptions. The main disadvantage of the use of rating or semantic differential scales is the pre-specification of attributes with the risk of forcing respondents to respond to attributes totally unimportant to them. Moreover, relevant attributes might be excluded or some attributes might be semantically meaningless to the individual or subject to varied interpretations. The factor listing approach has the advantage of being direct, but on the other hand the approach assumes that individuals are able to specify instantaneously the attributes they use to discriminate among choice alternatives. Moreover, respondents might ex-post rationalize about their behaviour, which could cause an artificially close correspondence between attributes and behaviour. The advantage of the repertory grid approach is that it relies upon the individual's own subjective and meaningful understanding of reality. There is no need to pre-specify attributes and problems of ambiguity in semantic meaning of attributes are avoided. Meaningless attributes are not included and meaningful attributes are not excluded. However, the practical problem is that the approach implies a time-demanding measurement procedure. This precludes it from being applied in large-scale surveys. Another problem is that when the researcher chooses for a smaller number of respondents providing relatively reliable data, special care should be taken with regard to the selection of respondents, given the ultimate aim of generalizability of the results. The protocol analysis approach has generally the same (dis)advantages as the repertory grid methodology. Interviews are relatively time-consuming and it is difficult to generalize. The choice for a particular method ultimately depends on the context of the research project. The combination of one of the sophisticated approaches together with for example factor listing will generally give sufficient insights. Nevertheless, whatever method is applied, one has to consider that a model based on identified factors might be meaningless for retail planning when these factors are not related to manipulable, policy-sensitive attributes of shopping centres. Therefore, a certain degree of pragmatism might be necessary. On the other hand, there exists sufficient empirical evidence that in the context of shopping behaviour, influential factors correspond to a high degree with policy-sensitive attributes of shopping centres.
The next step in the modelling of consumer spatial choices is to measure part-worth utilities people attach to levels of the elicited attributes and to measure the way these part-worth utilities are combined into an overall utility for choice alternatives.

**Part-worth utilities and combination rules**

Axiom 3 of the theory of consumer spatial choices is based on the notion that the individual's subjective evaluation process of shopping centres determines actual choice behaviour. It states that for any influential attribute of the shopping centres there exists a corresponding psychological value or part-worth utility. In addition, axiom 4 states that these part-worth utilities regarding the levels of different attributes are integrated/combined into an overall utility by way of some algebraic rule. Evidently, the operationalization problem focuses on the measuring of part-worth utility functions and the identification of the combination rule. The first option is to use a compositional approach. The second option is a decompositional approach.

A compositional approach typically involves the estimation of overall utilities for shopping centres derived from evaluative data for each individual attribute of these shopping centres and possible data about subjective importance weights. In general, the following procedure is followed. First, respondents are asked to express their subjective evaluation of the levels of the set of elicited attributes of shopping centres according to some rating scale representing a continuum between 'very bad' and 'excellent'. Evidently, to avoid biases in respondent's answers, because of the fact that respondents might not share the same set of centres they are familiar with, it is necessary to ask respondents to only evaluate the shopping centres they are familiar with. Subsequently, these part-worth utilities are combined into an overall utility for each multiattribute shopping centre the respondent is familiar with by way of some algebraic rule. As noted in chapter 4, the so-called additive and multiplicative combination rules are found to be most promising in this context. Four combination rules can be derived (deleting the subscript for $i$):
a. the unweighted additive combination rule:
\[ R \sum_{r=1}^{R} x_{jr} \]
\[(5.2.6)\]

b. the unweighted multiplicative combination rule:
\[ R \prod_{r=1}^{R} x_{jr} \]
\[(5.2.7)\]
c. the weighted additive combination rule:
\[ R \sum_{r=1}^{R} w_r x_{jr} \]
\[(5.2.8)\]
d. the weighted multiplicative combination rule:
\[ R \prod_{r=1}^{R} x_{jr}^{w_r} \]
\[(5.2.9)\]

where \( w_r \) denotes the weight attached to attribute \( r \) and \( x_{jr} \) the evaluation of attribute \( r \) of shopping centre \( j \). Evidently, rules c and d require some measure of relative weight individuals attach to the elicited attributes. Both the multiplicative and the additive combination rule assume some degree of compensation among evaluation scores: low values on one attribute of a shopping centre can to a certain degree be compensated with high values on another attribute. Substantively this means that individuals weigh various attribute levels in their decision making. Clearly, the additive combination rule bears a more compensating nature than the multiplicative rule. The last one assumes that if any of the separate evaluations of the attributes is close to zero the overall evaluation of that particular shopping centre is also very low. As such the multiplicative combination rule is an approximation of some non-compensatory rules.

The choice between an additive and a multiplicative rule is not the outcome of a clear preference. In terms of empirical analyses, for example, Timmermans (1980a) found that both rules basically generated the same proportion of correctly predicted spatial choices of consumers. In another study, Timmermans, Van der Heijden and Westerveld (1983) found that either an additive or a multiplicative combination rule can be used successfully to portray the way in which individuals combine part-worth utilities defined on attribute levels of multiattribute shopping alternatives in order to arrive at an overall preference measure. However, in other studies (e.g. Louviere, 1981; Timmermans, Van der Heijden and Westerveld, 1984b) it was found that the multiplicative rule performed better, though slightly, than
the additive rule. A disadvantage of the additive combination rule is
that the relative contribution of a separate evaluation of one of the
attributes is dependent upon the number of separate evaluations
included. This puts a special claim on the construct-validity of the
multiattribute choice model. Multiplicative rules do not have this dis­
advantage. Moreover, the relationship between the dependent and
independent variables can be given a more clear interpretation in the
context of the multiplicative rule than in the context of the additive
rule. Further, it is noted that the additive rule is robust as long as
the independent variables are related monotone to the dependent
variable. In the context of consumer choices of shopping centres, this
condition is generally satisfied. A final consideration is that in many
cases an additive rule can be estimated more easily than a multi­
plicative combination rule.

The actual identification of the combination rule can be based on
a predictive validating approach or direct measurements. Options are:
- an additional measurement of overall evaluations of shopping
alternatives by consumers and the use of these as a check on the
outcomes of predictions of overall evaluations by using various
combination rules;
- linking predicted overall evaluations for shopping alternatives to
overt choices and using these choices as a check on the explanatory
value of various combination rules. Clearly, also some decision rule
have to be implemented (see under c in this section for alternative
decision rules);
- identifying the nature of the combination rule by using experimental
conjoint or functional measurements (see the considerations
concerning decompositional approaches).

For the specification of a predictive model to be used in the
context of applied retail research it is necessary to link the
subjective evaluations of levels of attributes to their objective
counterparts. This requires the identification of the functional
relationships between the objective levels of the attributes and the
corresponding subjective evaluations. In general the following
functional forms can be used and have been applied (deleting the
subscript for the individual):
\[ x_{jr} = a_1 r + a_2 r x_{jr} x_{jr}^{3r} \]  
(5.2.10)
\[ x_{jr} = a_1 r + a_2 r x_{jr} + a_3 r x_{jr} + a_4 r x_{jr} \]  
(5.2.11)
\[ x_{jr} = a_1 r + a_2 r e^{(a_3 r + a_4 r x_{jr})} \]  
(5.2.12)

where,
\( x_{jr} \) denotes the part-worth utility for attribute \( r \) (\( r=1,\ldots,R \)) of shopping centre \( j \);
\( x_{jr} \) denotes the objective level of attribute \( r \) of shopping centre
\( a_r \)'s are parameters.

Hence, the assumed relationships are not necessarily linear. The estimation of these functional relationships can be performed on the individual level as well as on the aggregate level. In the last case, individual responses are averaged across respondents to yield average ratings, under the assumption that these responses constitute an interval scale. The iterative use of least-squares algorithms enables the parameters of the presumed functional form to be estimated (see for example Timmermans, 1982).

The basic assumption of compositional approaches is that individuals are able to provide valid and accurate evaluations of levels of separate attributes of shopping centres, irrespective of the context of the stimuli. If this assumption is not valid, the measurement of part-worth utilities most likely yields biased results. Moreover, the functional relationships between subjective evaluations and their objective counterparts might be dependent upon the real-world experiences of individuals. Hence, the estimation at the individual level might be strongly biased because of these experiences and the specific structure of the retail system. This also implies that, in principle, the relationships estimated might not be validly applicable beyond the domain of measurement. Particularly in the context of retail planning, when for instance a new shopping centre is constructed or the amount of floorspace in the largest shopping centre is considerably increased, this is a disadvantage of the compositional approach.

As noted before, an alternative way of estimating a multiattribute preference model of consumer spatial choices involves a
The identification of utility-functions and the combination rule in the context of a decompositional approach at first typically involves the measurement of an individual's preferences for a set of hypothetical choice alternatives in terms of rank ordering. These alternatives are defined in terms of a combination of levels of the elicited attributes. Next, the overall rank ordering is decomposed into the separate contributions of the levels of the attributes (part-worth utilities) to the overall preference ordering. A number of problems related to this decompositional multiattribute preference approach is discussed by Timmermans (1984b).

The measurement problem is commonly known as the 'conjoint measurement problem'. It is based on the assumption that it is possible to measure the relative contributions of two or more attributes to the overall utility measure, even though their individual effects may not be properly measurable in any direct fashion. The approach is concerned with simultaneously scaling the independent variables (the levels of the attributes in terms of which the choice alternatives are defined) and the dependent variable (the measured preference ordering of the choice alternatives) in such a way that a particular combination rule preserves the manifest preference order relationship as closely as possible (Luce and Tukey, 1964; Krantz, 1964). The various approaches to this problem differ in terms of the specification of the measurement model, the research design and the scaling/estimation methods. Initially, much effort has been spent on identifying the conditions for applying various combination rules (e.g. Krantz and Tversky, 1971; Emery and Barron, 1979). More recently, the focus has shifted to deriving the part-worth utility scales for the attributes of the multiattribute choice alternatives, assuming that an a priori hypothesized combination rule applies to the specific evaluation task. The emphasis is on the application of various data collection procedures, estimation procedures etc. Green and Srinivasan (1978) suggested the term 'conjoint analysis' in order to cover this development. The following issues have to be described in the context of conjoint analysis:

- the specification of the measurement model (a);
- the data collection (b);
- the choice of an estimation/scaling procedure (c).
In the following equations the subscript \( j \) will refer to hypothetical choice alternatives and the subscript for the individual will be ignored.

**Specification of the measurement model**

The first question is how separate utilities are combined into an overall utility. Previously, the choice between additive and multiplicative combination rules has been discussed. Assume that an additive rule is chosen. Three general types of models have been suggested by Green and Srinivasan (1978). The first one is the part-worth model:

\[
U_j = \sum_{r=1}^{R} f_r (X_{jr})
\]  

(5.2.13)

where,

- \( X_{jr} \) is the level of attribute \( r \) of choice alternative \( j \);
- \( f_r \) is the part-worth evaluation function of attribute \( r \) (\( r=1,..,R \));
- \( U_j \) is the overall evaluation of choice alternative \( j \).

In case \( f_r \) reflects a linear function, the simple vector model results:

\[
U_j = \sum_{r=1}^{R} W_r X_{jr}
\]  

(5.2.14)

If \( W_r \) is positive, the utility function increases with the increasing levels of attribute \( r \). Reversely, if \( W_r \) is negative, the utility function decreases with the increasing levels of attribute \( r \). The estimation of the part-worth model requires the estimation of \( \sum_r (n_r-1) \) parameters, where \( n_r \) denotes the number of levels defined for attribute \( r \). The vector model involves the estimation of \( R \) parameters. The estimation of a larger number of parameters implies that the parameters estimated are less reliable. On the other hand, the part-worth model is the most flexible model.

**Data collection procedures**

The first step in the procedure involves the eliciting of the attributes. Previously, methods for identifying relevant factors influencing consumer's perception, evaluation and choice of shopping centres have been discussed. The selection of attributes
to be included in the decompositional multiattribute models is on the one hand determined by their relevance for explaining (differences in) shopping behaviour and the manipulability in the context of retail planning. On the other hand, however, the number of attributes elicited should also depend upon the number of parameters that needs to be estimated. That is to say, the ratio of the number of choice alternatives and the number of parameters estimated should be as large as possible so as to increase the reliability of the parameter estimates. The fact that a larger number of attributes implies that a more difficult evaluation task for the respondent results, possibly causing less reliable answers, should also be stressed.

The second step in the data collection procedure, given the set of attributes elicited, is to decide upon the specification of the attribute levels. This specification is important because of its influence on the outcomes of the analysis. The choice ultimately depends upon the aim of the study. In the context of applied retail research the impacts of new retail facilities might be assessed, the multiattribute nature of which might go beyond the domain of the experience of the respondents. Hence, this implies that it is necessary to specify attribute levels that go beyond that domain without making them unbelievable. Further, the levels specified should express meaningful differences with respect to the consumers' perception of shopping centres.

The third step concerns the combination of the attribute levels into a set of hypothetical choice alternatives. The two main alternative methods for combination are the full-profile approach and the trade-off approach. In the context of the full profile approach respondents are requested to rank order the set of alternatives all defined in terms of levels of all attributes (so-called factorial design). Evidently, too many attributes would represent an unreasonable ranking task for a respondent. For example, the use of 3 attributes with 3 levels each implies a set of $3^3 (= 27)$ choice alternatives, whereas the use of 4 attributes implies a set of $3^4 (= 81)$ preference judgements. Therefore,
especially if more than three attributes are included, a trade-off approach might be more suitable. In that context, respondents are asked to provide preference measures for choice alternatives defined in terms of the levels of pairs of attributes. The evaluation task is sequentially performed with regard to different pairs of attributes. The main disadvantage of the trade-off approach is that the evaluation task is less realistic than in the case of a full-profile approach. Individuals may be uncertain as to what should be assumed about the attributes excluded from the specific pair of attributes in terms of which the choice alternatives are defined. Moreover, the way in which the attribute combinations are presented might influence the respondent's answers. This might for example cause a tendency to patternize responses to sequential pairs of attributes. Although there are still some more options for measurement, it should be emphasized that in the context of applied retail research the number of important influential attributes can be limited to 3 to 5 without losing much explanatory power (compare e.g. Timmermans, Van der Heijden and Westerveld, 1982 b,c). This implies that generally a full-profile approach (in case of \( \leq 3 \) attributes) or a trade-off approach (otherwise) can be used.

The fourth step concerning the exact design to select the set of hypothetical choice alternatives for which preference judgements are obtained is directly related. A trade-off approach involves
\[
\frac{1}{2} \sum_{r} (n_r, n_{r'}) (r \neq r')
\]
judgements. A full-profile approach involving a full factorial design implies that respondents have to provide
\[
\prod_{r} n_r
\]
preference judgements. Evidently, in the context of both approaches the number of judgements depends on the number of attributes and/or the number of levels for each attribute. When the combination of both is large, the number of preference judgements might become too large to be handled by the respondent. Therefore, Green (1974) and Green, Carroll and Carmore (1978) have suggested various kinds of fractional factorial designs. These designs imply that a small number of hypothetical choice alternatives is selected. The consequence is that all possible interaction effects no longer can be measured. Usually, all main
effects and two-attribute interaction effects can be measured, while all higher interaction effects are ignored. However, for applied retail research there would be no use in defining each attribute in terms of more than 3 levels, because that would violate the discriminatory value of the subdivision in respect of consumer's perception and would complicate the measurement unnecessarily. A trade-off approach which uses 5 attributes, each defined in terms of 3 levels would imply \( \frac{5}{2} \times 4 = 10 \) trade-offs for pairs of attributes, while each trade-off contains 3x3 choice alternatives and, hence, 9 preference judgements. This has not been found to be too demanding for respondents. Evidently, each trade-off approach or full-profile approach which uses less attributes (respectively 4 and 3), each defined in terms of 3 levels, implies an easier judgement task.

The fifth step in the data collection procedure is to choose a suitable way to present the choice alternatives to respondents. In the context of applied retail research verbal description can be quite accurate since individuals generally comprehend these verbal descriptions of choice alternatives very easily. So far, it has been assumed that respondents express their preference judgements in terms of (non-metric) ranking of choice alternatives. It is quite obvious that this approach is less demanding in terms of the individual's task to express his/her preferences, as compared to the use of some rating scale procedure. Such a procedure implies that respondents are requested to express their degree of preference for the choice alternatives, for instance indicated on a 1-100 mm scale. Such an approach is known as the functional measurement approach (Anderson, 1974). To increase the reliability of this measurement the respondent is, generally, first asked to choose the most preferred alternative and assign a value 100 to it. In addition the other alternatives are rated in terms of overall preference. To improve the interval scale properties, more extremely defined alternatives can be used as anchor points. Nevertheless, the assumption of interval scale properties of such preference judgements might still be questionable in some cases. The reliability of the measurement might be tested on the level of
the individual respondent by using various measurement techniques in one session. Moreover, replications with a time lag might be used to test the stability and reliability of the measurements. It is obvious, however, that in the context of applied retail research the choice of a particular preference measurement should not only be determined by questions of reliability, but also by some pragmatic considerations. This implies that tests on reliability of answers and the extension of the measurements at the level of the individuals should be limited, because they might be too time consuming and, consequently, imply too high costs for data collection. On the other hand, more time for interviewing individuals might be (partly) compensated by the fact that more diverse and more reliable information will be collected and by the fact that a smaller number of respondents might be sufficient.

(c) Estimation procedures.

The estimation of the parameters of the decompositional measurement model depends upon the type of model, the scale level of the dependent variable and the method of data collection. Timmermans (1984b) discusses the most important estimation procedures in detail. Assuming an ordinally scaled dependent variable, it is sufficient to discuss two approaches.

The first estimation procedure is that of monotone regression. This technique utilizes search techniques which derive interval scales by iteratively adjusting trial scale values for each attribute. The aim is to minimize departures from the order relationship in the preference measurements that are observed while maintaining monotonicity with the dependent variable. Generally, the badness-of-fit measure termed 'stress', is minimized. For three attributes stress is defined as:

\[
S = \sqrt{\frac{\sum \sum (\sum (z_{r_1r_2r_3} - \bar{z}_{r_1r_2r_3})^2)}{\sum \sum n_{r_1r_2r_3} (z_{r_1r_2r_3} - \bar{z})^2}}
\]

(5.2.15)

where,
\[ \hat{Z}_{r_1r_2r_3} \] is the monotonic regression value which best predicts \( Z_{r_1r_2r_3} \) from the rank orders;
\[ Z_{r_1r_2r_3} \] is the corresponding value derived from the specified measurement model;
\[ n_{r_1r_2r_3} \] is the number of observations for combination \( r_1, r_2, r_3 \);

and

\[
\bar{Z} = \frac{\sum_{r_1} \sum_{r_2} \sum_{r_3} n_{r_1r_2r_3} \cdot Z_{r_1r_2r_3}}{\sum_{r_1} \sum_{r_2} \sum_{r_3} n_{r_1r_2r_3}} \tag{5.2.16}
\]

Roskam's (1974) UNICON algorithm can, for example, be used to derive the part-worth utilities for various combination rules in the part-worth type of model from evaluation data. Alternatively, PREFMAP can be used for the vector model. Srinivasan and Shocker (1973) suggested linear programming techniques to estimate parameter values: LINMAP is suited for both types of measurement model.

The second main estimation technique is used for data directly resulting from a paired comparison design. The procedure applicable in this context is Johnson's non-metric trade-off procedure (Johnson, 1974). The procedures starts with generating a starting matrix \( L_1 \) of part-worth utilities at random; the subscript 1 indicates the utilities for the first iteration. Next, given a specific (additive or multiplicative) combination rule, a vector \( Y \) of overall utilities for each pair of attributes is constructed. For the pair of attributes \( r \) and \( r' \) this vector is described as:

\[
Y = (Y_{11}, Y_{12}, \ldots, Y_{1n_r}, Y_{21}, Y_{22}, \ldots, Y_{2n_r}, \ldots, Y_{n_r n_{r'}}) \tag{5.2.17}
\]

where \( n_r \) and \( n_{r'} \) denote the number of attribute levels for attribute \( r \) and \( r' \). This vector \( Y \) is then compared to the observed rank orders, summarized in the vector \( Y^* \), on the basis of two measures:

\[
\frac{Y_m - 1}{Y_n} \quad \text{and} \quad \frac{Y^*_m - 1}{Y_n^*} \tag{5.2.18}
\]
where \((m,n)\) denotes each pair of cells \(m\) and \(n\) in each trade-off matrix \((m\neq n)\). The badness-of-fit measure at each iteration \(V\) is calculated as:

\[
\Phi_V = \frac{\sum_{m,n} \left( Y_m - Y_n \right)^2 \cdot \beta}{\sum_{m,n} \left( Y_m + Y_n + 2 \right)} \quad ; \quad (m\neq n)
\]  

(5.2.19)

where,

- \(\Phi_V\) is the badness-of-fit measure of iteration \(V\); 
- \(m,n\) are cells of the trade-off matrix; 
- \(Y_m\) is the value of the cell \(m\); 
- \(Y_n\) is the value of the cell \(n\); 
- \(\beta\) is a constant that depends on the order of the pairs of cells; 
- \(\beta = \begin{cases} 1 \text{ if } \text{sign} \left( Y_m - Y_n \right) = -1 \\ \text{sign} \left( Y_m^* - Y_n^* \right) -1 \\ 0 \text{ otherwise} \end{cases}\)

(5.2.20)

Hence, a good scaling solution is indicated by means of a low \(\Phi_V\) value. The measure has a value of zero if the model fits the data perfectly and a value of one if the order of every pair of cells is incorrectly predicted. The process of iterations continues until a good set of parameter estimates has been obtained. This is indicated by a drop in \(\Phi_V\) below some initially specified criterion value. At each iteration the matrix of the part-worth utilities is adjusted to the findings of the previous iteration:

\[
P_{V+1} = P_V - \Phi_V G_V
\]  

(5.2.21)

where,

- \(P_V\) is the \(R \times L\) matrix of part-worth utilities at iteration \(V\), with \(R\) denoting the number of attributes and \(L\) denoting the maximum number of attribute levels; 
- \(G_V\) is a \(R \times L\) gradient matrix at iteration \(V\), each element of which is the partial derivative \(\Phi_V\) with respect to the corresponding elements of \(P_V\); 
- \(G_V\) is computed proportionally to (5.1.21) as follows:

\[
G_V = \frac{\partial \Phi_V}{\partial P_V}
\]

The best combination combination rule may be identified by comparing the scaling solutions of different combination rules. The lowest \(\Phi_V\) value indicates the best combination rule.
Decision rules

Once the part-worth utilities have been measured, the preferences have to be linked to overt choice behaviour of individuals. Hence, a so-called decision rule should be identified. Four alternative rules will be discussed. $A_i$ denotes the set of shopping centres a choice has to be made of and $M_i$ be the number of shopping centres in the choice set.

The simplest form is the deterministic decision rule (rule I), implying that

$$
\text{iP}_j = \begin{cases} 
1 & \text{if } U_{ij} > U_{ij}' (V_j, j' \in A_i; j \neq j') \\
0 & \text{otherwise}
\end{cases} 
$$

(5.2.22)

where,

- $\text{iP}_j$ is the probability that individual $i$ will visit shopping centre $j$;
- $U_{ij}$ is the individual's $i$ overall evaluation of shopping centre $j$.

Hence, the deterministic decision rule implies that the shopping centre with the highest utility will be chosen. The rule avoids the estimation of parameters on the basis of observed choice probabilities, which is evidently an advantage given the previously defined requirements. On the other hand, however, the rule is rather simple and does not take into considerations the measurement errors and variances. Therefore, more complex decision rules of a probabilistic nature might be applied more successfully (previously presented in Timmermans and Van der Heijden, 1984).

One possibility is to relate the overall utilities directly to overt choice probabilities (decision rule II). A necessary condition for the application of this rule is, however, that the probability of choice for each alternative is independent of the number of alternatives in the choice set. Otherwise, these probabilities are not validly interpretable as derivatives of the overall evaluations of the choice alternatives. A solution to this problem is to convert the proportional interactions from $i$ to $j$ (denoted by $t_{ij}$) to pairwise probabilities as follows:

$$
\text{iP}(j,j') = \frac{t_{ij}}{t_{ij} + t_{ij}'} 
$$

(5.2.23)

where $\text{iP}(j,j')$ is the probability that the $j$-th alternative will be chosen to the $j'$-th alternative. The decision rule may be expressed as
where,

$$i\hat{p}(j,j') = \begin{cases} 
0.5 & \text{if } f(U_{ij} - U_{ij'}) = 0 \\
0.5 + \frac{f(U_{ij} - U_{ij'})}{\beta} & \text{otherwise}
\end{cases}$$

Parameter $\beta$ is a scaling factor and can be estimated by minimizing

$$\min \sum \left[ \frac{f(U_{ij} - U_{ij'})}{\beta} - i\hat{p}(j,j') \right]^2$$

(5.2.25)

where,

- $n$ is the number of pairwise comparisons;
- $i\hat{p}(j,j')$ is the observed pairwise choice probability;
- $f(U_{ij} - U_{ij'}) = \beta/2$ if $f(U_{ij} - U_{ij'}) > \beta/2$.

Let $f_{2ir}$ represent the functional relationship between the objective level of attribute $r$ of choice alternative $j$ ($X_{jr}; j=1, \ldots, M_i; r=1, \ldots, R_i$) and the subjective evaluation value of this level and assume further that a multiplicative combination rule applies to the integration of alternative $j$, then (5.2.25) implies:

$$\min \sum_n \left[ \frac{\prod_{r} f_{2ir}(X_{jr})}{\beta} - \prod_{r} f_{2ir}(X_{jr}) - i\hat{p}(j,j') \right]^2$$

(5.2.26)

Girt (1976) assumes a linear function for $f_{2ir}$ (eq. 5.2.10). Equation (5.2.26) illustrates that the nature of this decision rule is dependent upon observed choice probabilities. Other probabilistic decision rules assume that the individual's overall utility is composed of a fixed component and a random component:

$$U_{ij} = \bar{U}_{ij} + \varepsilon_j$$

(5.2.27)

Assuming that individuals maximize utilities, the probability that alternative $j$ is chosen from the set of alternatives equals:

$$iP_j = \max (U_{ij'}) \quad (\forall j, j' \in A_i; j' \neq j)$$

$$= \text{prob} (\bar{U}_{ij'} + \varepsilon_j > \bar{U}_{ij'} + \varepsilon_{j'}) \quad (\forall j, j' \in A_i; j' \neq j)$$

$$= \text{prob} (\varepsilon_j > \varepsilon_{j'} - \bar{U}_{ij'} - \bar{U}_{ij'}') \quad (\forall j, j' \in A_i; j' \neq j)$$

(5.2.28)
Different assumptions about the distribution of the overall utilities and the distribution of the error terms result in different probabilistic decision rules.

The third decision rule (rule III) assumes that the \( \varepsilon_j \)'s are independent, identically distributed random variables. The probability density distribution of the transformed variables

\[
\omega_j' = \varepsilon_j - \varepsilon_j
\]  
(5.2.29)

is assumed to be equal to

\[
g(\omega_j') = \int_{-\infty}^{+\infty} f(\varepsilon_j, \omega_j' + \varepsilon_j) \, d\varepsilon_j
\]  
(5.2.30)

This implies that

\[
p(\bar{U}_{ij}) = \max (\bar{U}_{ij}, j = 1, \ldots, M_i)
\]  
(5.2.31)

is equal to

\[
\int_{-\infty}^{\bar{U}_{ij}} \cdots \int_{-\infty}^{\bar{U}_{ij}} \int_{g(\omega_{ij}, \ldots, \omega_{im_i})}^{+\infty} \, d\omega_{ij} \cdots d\omega_{im_i}
\]  
(5.2.32)

If it is assumed that the \( \varepsilon_j \)'s follow Weibull distributions (McFadden, 1973) equation (5.2.31) will be equal to the logistic distribution of

\[
\pi_p(j | j \in A_i) = \frac{1}{1 + \sum_{j' = 1}^{M_i} e^{\bar{U}_{ij} - \bar{U}_{ij}'}} \quad (j \neq j')
\]  
(5.2.33)

Further, let \( f_{2ir} \) again represent the functional relationship between the \( R \) objective characteristics of choice alternatives \( j \) and let a multiplicative combination rule represent the way in which these subjective evaluations of attributes are combined into an overall utility, then substitution means that the probability that choice alternative \( j \) will be chosen is

\[
\pi_p(j | j \in A_i) = \frac{1}{1 + Z_0 \cdot e^{-[Z_1 + Z_2 \prod_{r} f_{2ir}(x_{jr})]}}
\]  
(5.2.34)

with \( Z_0 \), \( Z_1 \) and \( Z_2 \) as parameters.
Louviere and Meyer (1979) have adopted this decision rule in a study of destination choice although they have argued that equation (5.2.34) can be approximated by way of the simpler linear form (given a linear form for $f_{2i}$)

$$iP(j | j \in A_i) \approx Z_3 + Z_4 \sum_r \alpha_{ijr}$$  \hspace{1cm} (5.2.35)

especially over the middle range of the objective values $X_{jr}$ and the subjective evaluation values $x_{ijr}$. Clearly, the parameters $Z_3$ and $Z_4$ have to be estimated on the basis of observed choice behaviour.

An alternative decision rule (rule IV) also assumes that overall utilities for shopping centres are random variables. Let $\mu_{jj'}$ denote the difference between the overall evaluations of $j$ and $j'$:

$$\mu_{jj'} = U_{ij} - U_{ij'}$$  \hspace{1cm} (5.2.36)

Then, an alternative description for equation (5.2.31) is

$$iP_j = p(U_j > U_{j'}) \hspace{0.5cm} (\forall j, j' \in A_i; j \neq j')$$

$$= p(\mu_{jj'} > 0) \hspace{0.5cm} (\forall j, j' \in A_i; j \neq j')$$  \hspace{1cm} (5.2.37)

The assumption with regard to the error terms $\epsilon_j$ and $\epsilon_{j'}$ in this decision rule is that their joint distribution is bivariate normal with means 0 and 0 for $\epsilon_j$ and $\epsilon_{j'}$ respectively, and the variances $\sigma_j^2$ and $\sigma_{j'}^2$. The correlation coefficient is denoted by $\rho_{jj'}$. Then the distribution of $U_j$ and $U_{j'}$ will be bivariate normal with means $\bar{U}_j$ and $\bar{U}_{j'}$, variances $\sigma_j^2$ and $\sigma_{j'}^2$, and the correlation $\rho_{jj'}$. The distribution of $\mu_{jj'}$, consequently, is univariate normal $N(\mu_{jj'}, \sigma_{jj'}^2)$, where,

$$\mu_{jj'} = \bar{U}_j - \bar{U}_{j'}$$  \hspace{1cm} (5.2.38)

and

$$\sigma_{jj'}^2 = \sigma_j^2 + \sigma_{j'}^2 - 2\rho_{jj'} \cdot \sigma_j \cdot \sigma_{j'}$$  \hspace{1cm} (5.2.39)

Then the probability that an individual will choose $j$ can be defined as

$$iP_j = \frac{1}{\sqrt{2\pi\sigma_{jj'}^2}} \int_0^\infty \exp \left[ - \frac{1}{2} \left( \frac{y - \mu_{jj'}}{\sigma_{jj'}} \right)^2 \right] dy$$  \hspace{1cm} (5.2.40)

Similarly, the choice probabilities among $M$ choice alternatives are described by way of a multivariate normal density function. Their specific distribution is dependent upon the values of $\mu_{jj'}$ and $\sigma_{jj'}$.
If, however, it is assumed that all variances are equal it follows that, given alternatives \( j, j' \) and \( j^* \),

\[
\rho_{jj', jj^*} = \frac{\sigma_{j} - \sigma_{j} \sigma_{j'} \rho_{jj^*} + \sigma_{j} \sigma_{j^*} \rho_{j'j^*}}{\sigma_{jj} \sigma_{jj^*}}
\]


Bock and Jones (1968) have shown that the generalized multivariate logistic distribution is a useful approximation of the multivariate normal distribution. To use this function it is only necessary to adjust the scale of the variates to fit the normal distribution. This may be accomplished by using \( \frac{\pi}{\sqrt{3}} \) times the unit normal deviates as logistic deviates. Thus, decision rule IV yields

\[
P(j; j \in A_i) = \frac{1}{1 + \sum_{j' \neq j} e^{-\left( \frac{\pi}{\sqrt{3}} \frac{\rho_{jj'}}{\sigma_{jj'}} \right)}}
\]

This decision rule implies that choice probabilities are fully theoretically derived from the individual's preferences. Unlike decision rule III, no parameters have to be estimated using observed choice probabilities.

III Consumer spatial choices and expenditure distribution over shopping centres

The translation of the spatial choices of consumers with regard to shopping centres in the study area into expenditure flows and turnover for each shopping centre is necessary for establishing the link between the demand and the supply side of the retail system. This translation starts from the assumption that a model for consumer spatial choices regarding shopping centres has been defined. In the case of an individual (de)compositional multiattribute preference model, it is
necessary to subdivide the study area into a number of residential zones and, in addition, to apply the individual model for the respondents who are located in each origin zone in order to predict the choices of these subgroups. Let in the remaining each residential zone be denoted by \( i \). The assumption is that the inhabitants of each zone \( i (i=1,\ldots,N) \) constitute a reasonably homogeneous group in terms of the spatial context of shopping. Assume further that the model predicts spatial choices of consumers in the context of several shopping sectors. Let \( z \) denote a sector of retailing goods \((z=1,\ldots,Z)\). Finally, predictions are made for the particular time \( t \) \((t=1,\ldots,T)\) given the conditions of a particular plan alternative \( k \) \((k=1,\ldots,K)\).

First, the model is used to predict the proportion of the total number of interactions between consumers of residential zone \( i \) at time \( t \) and a particular shopping centre \( j \) \((j \in A_i)\) in sector \( z \). Let \( A_i \) in this context denote the set of shopping centres belonging to the spatial information field of consumers living in residential zone \( i \).

\[ p_{ijzt} \]

denotes this proportion of interactions. It is calculated on the basis of the predictions of individual choices of respondents within each zone. This means that the group of respondents, whose answers to the consumer questionnaire have been used for the specification of the consumer spatial choice model, is subdivided over the residential zones in a way that enables a valid generalization of the predictions with regard to the spatial choices of the subgroups of respondents to the consumers of the zone as a whole. The total spending power of consumers in origin \( i \) at time \( t \) for sector \( z \) can be calculated by means of the formula:

\[
E_{it}^k = B_{it}^k \cdot z_{it}^k
\]

where,

\[ E_{it}^k \]

is the total spending power in origin \( i \) at time \( t \) for sector \( z \) given plan \( k \);

\[ B_{it}^k \]

is the population in origin \( i \) at time \( t \) given plan \( k \);

\[ z_{it}^k \]

is the expenditure level per capita in origin \( i \) at time \( t \) for sector \( z \);

It is unlikely that all spending power will be allocated over the
shopping centres within the retail system to be studied. Part of it is allocated external to that retail system. Hence, total expenditures allocated within the retail system is calculated by subtracting these 'external' expenditures from the total spending power:

\[ E_i^{kZ} - E_0^{kZ} \]  

(5.2.44)

where,

- \( E_i^{kZ} \) is the amount of expenditures allocated within the retail system in sector \( z \) by consumers in origin \( i \) at time \( t \) given the conditions of plan \( k \);
- \( E_0^{kZ} \) is the amount of expenditures allocated external to the retail system in sector \( z \) by consumers in origin \( i \) at time \( t \) given the conditions of plan \( k \).

Note that in this context a prediction of population size in origin \( i \) and the proportion of expenditures allocated external to the retail system studies is required.

The amount of expenditure flowing from origin zone \( i \) to zone \( j \) in sector \( z \) at time \( t \) under the conditions of plan alternative \( k \) (\( E^{kZ}_{ijt} \)) then equals:

\[ E^{kZ}_{ijt} = z^{p^{kZ}}_{ijt} \cdot E^{kZ}_{ijt} \]  

(5.2.45)

The total turnover in sector \( z \) at each centre \( j \) at time \( t \) given plan \( k \) (denoted by \( V^{kZ}_{jt} \)) can in addition be calculated by summing up the expenditure across origins and all expenditures from origins outside the study area (e.g. recreational spendings):

\[ V^{kZ}_{jt} = \sum_{i=1}^{N} z^{kZ}_{ijt} + z^{EX^{kZ}}_{jt} \]  

(5.2.46)

where,

- \( z^{EX^{kZ}}_{jt} \) denotes the expenditures in sector \( z \) by consumers with any origin outside the study area in shopping centre \( j \) at time \( t \) under the conditions of plan \( k \).

Evidently, these extra expenditures have to be calculated external to the applied spatial choice model.

Finally, the total turnover in sector \( z \) in shopping centre \( j \) can be translated into a turnover-to-floorspace ratio by means of the formula:
\[ \frac{z_{jt}^k}{z_{jt}} = \frac{z_{jt}^k}{V_{jt}^k} \]  

(5.2.47)

where,

\[ z_{jt}^k \]  
denotes the turnover-to-floorspace ratio in shopping centre \( j \) at time \( t \) in sector \( z \) given plan alternative \( k \);

\[ F_{jt}^k \]  
is the total floorspace in shopping centre \( j \) in sector \( z \) at time \( t \) given plan alternative \( k \).

5.2.3 (De)compositional multiattribute preference models versus discrete choice models.

In the past decade, an increasing interest was paid to the development and application of models based on discrete choice theory. In fact, discrete choice models are gaining an important position in applied retail research. Notwithstanding the fact that, unlike the traditional spatial interaction models, discrete choice models are based on a behavioural approach of consumer spatial choices, (de)compositional multiattribute preference models are preferred for the support of retail planning. Since this implies a deviation from the accepted practice in applied retail research, it is important to discuss the rationale behind this choice. In order to better appreciate this discussion, first a summary of the principles of discrete choice models will be presented.

Like multiattribute preference models, discrete choice models assume that individuals view choice alternatives as bundles of attributes and that these individuals arrive at a choice by cognitively integrating the part-worth utilities for the attribute levels according to some mathematical function. Moreover, both approaches assume that the individual's choice of an alternative is based on the position of the alternative within the order of the overall utilities of all alternatives. Both modelling approaches, however, differ in terms of the procedures used to estimate the parameters of the utility function and in the way choice probabilities are derived (Timmermans, 1984a). These differences are not only relevant for the theory of consumer spatial choice behaviour, but also in the context of the support of retail planning.

The main characteristic of the discrete choice models is that the dependent variable is observed choice among the choice alternatives in the area, while the independent variables are typically objective
values or subjective evaluations of the various choice alternatives with regard to a set of a priori defined attributes. The parameters of the utility function are directly related to observed choice probabilities in the context of their estimation. Discrete choice models also assume that the overall utility of alternative $j$ is composed of a fixed utility value and an error term. The best known discrete choice model is the Multinomial Logit Model. It assumes that the error terms $\varepsilon_j$'s are independent and identically distributed random variables, following a Weibull distribution. Hence, this results in

$$P_j \left( j \mid j \in \mathcal{A} \right) = \frac{\exp \left( \beta \cdot X_j \right)}{\sum_{j'} \exp \left( \beta \cdot X_{j'} \right)} \tag{5.2.48}$$

where,

- $\beta$ is the parameter vector;
- $X_j$ is a vector of objective values of shopping centre $j$.

As noted before, it is typical for discrete choice models that the parameter vector $\beta$ is estimated by statistically correlating observed choice probabilities with subjective evaluations or objective measurements of the levels of the attributes of real-world choice alternatives as independent variables. Although others besides the multinomial logit model have been developed, the multinomial logit model dominates the applications, since it is the simplest discrete choice model from the point of view of estimation of choice behaviour (see for example several contributions in Pitfield, 1984).

In chapter I some requirements for theory-building on the retail system have been formulated. One of them states that the relationship between independent variables (the retail plans) and dependent variables (the impacts of these plans) should be understandable in terms of causalities. This is extremely relevant in the context of predicting future retail system performances, particularly when the system is influenced through a set of retail planning measures. By means of planning shopping facilities might be introduced in the study area, the multiattribute nature of which goes beyond the domain of the set of existing retail facilities. It is theoretically more reliable to deal with such situations in terms of predictions, when the domain of the applied model(s) fits to the new, extended multidimensionality
of the choice space. This demands for the specification of models which are as independent as possible from the typical characteristics of the particular physical- and functional structure of the area studied.

Discrete choice models assume that choice behaviour is interpretable in terms of revealed preferences. Further discrete choice models assume that those revealed preferences are applicable in predicting choice behaviour in situations changed by means of retail planning. However, since the parameters of the discrete choice models are estimated by fitting the models as best as possible to their observed choice patterns, they may be highly influenced by the physical structure of that moment (compare Rushton, 1969, 1971, for a similar argument in the context of spatial interaction models). This limits their generalizability. The question is whether the revealed preferences equal the real preferences of consumers and whether these real preferences are not constrained and transformed because of the specific features of the spatial structure. A negative answer to this question implies very serious doubts of the theoretical validity and reliability of discrete choice models, irrespective of the fact that these models are generally good descriptors.

The second main requirement for the retail theory and the operational models based on it was that they should account as much as possible for the existing real-world variety within the operations of the retail system. With respect to the subsystem of consumer spatial shopping behaviour this requirement implies that both the theory and the models should be interpretable and definable on the individual level to account for individual differences in decision making. On the level of the theory, the proposed framework is not discriminatory among discrete choice models and (de)compositional multiattribute preference models. In terms of the operationalization, however, discrete choice models rely on some rigorous assumptions about heterogeneity among individuals, whereas the (de)compositional multiattribute models are strictly individual-level models. This implies that discrete choice models can capture heterogeneity in preferences, evaluations and personal constraints less easily. In contrast, the inherent option for the estimation of (de)compositional multiattribute preference models on the individual level implies that specific influences on the individual's decision making process, such
as the relative relevance of different attributes, the limits in knowledge the individual possesses of the retail environment, the specific nature of the combination- and decision rules etc., can be accommodated into the modelling process in a methodological sound and consistent way. This possibility of disaggregation towards the individual level inherently implies that (de)compositional multi-attribute preference models have more flexibility in analysing the data than discrete choice models have. An example of such analyses on the individual level is provided by Timmermans, Van der Heijden and Westerveld (1984b).

5.2.4 Retailer reactive behaviour model

As has been argued in chapter 4, the pursued cognitive-behavioural approach to retailer reactive behaviour is rather new and cannot be linked easily to current retailer's behaviour modelling traditions. Therefore, the elaboration in this section of some options for model building bears a preliminary character. First, a pragmatic model will be outlined, particularly for use in applied retail research without considerable needs for data. This approach can be directly included in the retail planning DSS. Secondly, some options for a more sophisticated approach will be outlined. These options are primarily meant as a research program for future basic retail research.

I A pragmatic approach

The use of some retailer reactive behaviour model in applied retail research has been argued for as to improve the prediction of the dynamic operation of the retail system and, consequently, as to improve the quality of the body of knowledge for the support of retail planning. The experimental and preliminary status of the theory implies that some pragmatic approach should be followed. It is particularly relevant for applied retail research that such an approach requires a minimum amount of extra data-collection activities. The aim of pragmatic modelling is to predict the direction of changes in some basic attributes of shopping centres, which are caused by retailer reactions to turnover developments, since the expenditure distribution model primarily focuses on the prediction of these developments. Such a pragmatic model may be outlined as follows.
First, assume that the actual evaluation at a time $t$ of a retailer of his/her retailing context is purely based on the level of turnover and costs, then the actual evaluation has been denoted earlier by $0_{ht}$, with $h$ indicating the retailing context of the retailer. This assumption implies that the proportional shift in a particular time period in the turnover level given a particular level of costs, brings about a change in evaluation value. The theory further states that in this case, the retailer might react in a particular way by conducting some type of reaction. Theoretically, 'doing nothing' has been included in the set of different types of reactions.

This approach on the individual level has, however, some practical problems. First, it is very time- and data-consuming to find out what the nature of the relationship between subjective evaluation and reaction is on the individual level of each retailer in a study area. Secondly, it is difficult to establish a link to the expenditure distribution model because of the fact that this model does not calculate turnover levels on the individual level but on the level of a cluster of shops. An approach on the aggregate level of a shopping centre might be a pragmatic solution. In that case one extra assumption is that every retailer is confronted with the same proportional change in a particular time period as found on the aggregate level. Next, it is necessary to explore the nature of the functional relationships between the probability that a particular reaction $q$ will be conducted and the proportional change in turnover in a particular time period. These relationships have to be applied on an aggregate level, the level of the shopping centre, and to the level of various shopping centres. Moreover, they may be estimated for different sectors $z$ of retailing ($z=1,\ldots,Z$). In that case, the functional relationship will be sector- and reaction-dependent, denoted by $zf_q$.

In order to reduce context-dependency it is necessary to use an experimental measurement approach. Such an approach has for instance been applied in the context of an explorative study among retailers in Eindhoven (Van der Heijden, 1984a,b,c,d). Retailers were asked to indicate the probability of choosing each reaction of a set of 22 different, a priori specified, reactions in case they would hypothetically, be confronted with 6 different levels of change in turnover level in a time period of one year. These yearly changes are
minus 5, 10 and 15 percent and plus 5, 10, 15 percent. Next, the average probabilities of conducting a particular course of action can be calculated, given the size levels of yearly proportional changes in turnover by aggregating responses across groups of respondents determined on the basis of the retailing sector they belong to. Given these average probabilities for sub-groups in each sector $z$, for each sector a set of equations can be fitted for $zf_q$ between a particular proportional shift in turnover and the probability that a particular reaction will be conducted. A flexible equation is needed in order to deal with the variety in scores and relationships. The following equation gives a multi-nodal functional relationship that might be used successfully:

$$p_q = \alpha + \beta x + \gamma x^2 + \delta x^3 + \varphi x^4 \quad (\forall q)$$

(5.2.49)

where,

- $x$ denotes the proportional shift in turnover;
- $p_q$ the probability that reaction $q$ will be chosen;
- $\alpha, \beta, \gamma, \delta, \varphi$ are parameters.

Evidently, depending upon the average probabilities, other equations might be used as well.

These fitted functions $zf_q$ are now applied on the level of the shopping centre to calculate the probability that each reaction $q$ will be conducted, given the proportional shift in turnover in sector $z$ in shopping centre $j$. Although (5.2.49) is, strictly speaking, not a probability function, the functions $zf_q$ can be used validly as long as no predictions are made beyond the domain associated with the fit of the equation.

Once the probabilities that a particular reaction will be conducted in sector $z$ in shopping centre $j$ have been calculated for each type of reaction $r$, the next step is to link these probabilities to a change in attributes of shopping centre $j$ in sector $z$. On the level of a shopping centre the nature of the probabilistic approach implies that more than one reaction can be applied at the same time in sector $z$. The following pragmatic approach to that problem can be outlined. Assume that a particular financial budget is fixed upon an increased level of turnover in sector $z$ calculated over two subsequent years, then one part of this amount may be used to increase the income.
level of the retailer so that it will have no consequences for the multiattribute nature of the shopping centre (non-reaction). The other part of this amount may, in contrast, be used for some investment in the shop. Perhaps also some aspects of the shop-external part of the retailing context may, collectively, be changed. Of course, various reactions may be conducted at the same time. The actual effect realized on the levels of the attributes depends on the costs of investments associated with each type of reaction on the one hand and the available budget for investment on the other hand. Let $zG_q$ denote the available budget in one year for reaction $q$ implemented in the shops in the shopping centre selling goods in sector $z$. $zG_q$ can be calculated by assuming that the ratios between these $zG_q$'s are equal to the ratios between the probabilities of conducting $q$ denoted by $zP_q$. Hence, each amount $zG_q$ can be calculated by means of:

$$zG_q = \frac{zP_q}{\sum_{q=1}^{Q} zP_q} \cdot \left[ \frac{\begin{array}{c} k \\ z \end{array}}{\begin{array}{c} k \\ z \end{array}} \right] (V_q); (\begin{array}{c} k \\ z \end{array}) (V_q; \begin{array}{c} k \\ z \end{array})$$

Equation (5.2.50) states that $zG_q$ is a proportion of the increase in turnover level depending upon the standardized probability that reaction $q$ will be conducted.

A similar approach applies to the situation that retailers are confronted with a drop in the level of turnover in a time period $t$ in the sector $z$. In this situation, one part of the loss may, on the overall level, be translated by retailers into a decrease in income level: the fact that the level of turnover was decreased is only partly accepted. Hence, this part of the decrease has no consequences for the multiattribute nature of the shopping centre. The remaining part of this decrease, however, is assumed to be not acceptable for retailers. Therefore, some 'compensating' reactions are most likely. Generally, these reactions are focused on reducing the fixed cost level of retailing and/or the increase of attractiveness for consumers. Measures may be taken which require some investment but which ultimately result in a net positive effect (for example: establishing a considerable greater variety in assortment or increasing the level of service). Other measures hardly require any investment and they nevertheless
have a positive effect (for example, decreasing the number of employees). Again it is emphasized that the scale of the pursued effect of a particular reaction and the scale of the reactions itself depends on the amount of not accepted decrease in turnover in sector z. Similar to the investment-budgets for each reaction q, the pursued financial effects of each reaction q, denoted by $z_{q}^{*}$, is calculated as follows

$$z_{q}^{*} = \frac{z_{PQ}}{Q} \left[ \sum_{z,j,t} \frac{k}{z_{jt+1}} - \frac{k}{z_{jt}} \right] ; (\forall q) ; (\forall z_{jt+1} \leq z_{jt}) \quad (5.2.51)$$

Equation (5.2.51) assumes that $z_{q}^{*}$ is a particular proportion of the absolute decrease in turnover level. The proportion depends upon the standardized probability that reaction q will be conducted.

A final step involves the translation of $z_{q}$ and $z_{q}^{*}$ into some change in attribute levels by assuming a set of q-dependent transfer-rules. For example, dismissing one employee results in a reduction of costs of, say, $C_{1}$, while the costs of extension of floorspace is, say, $C_{2}$, for each $m^{2}$. Translation norms may be deducted from general data.

The above described pragmatic model of retailer reactive behaviour might be used in the context of applied retail research to indicate the scale and direction of changes in some dimensions of the multi-attribute nature of shopping centres. The model requires a minimum of data collection. Future research should pay attention to the question whether the functions $z_{f_{q}}$ are generalizable, provided that they are measured in the context of some experimental measurement. When such an assumption is found to be valid the outlined pragmatic model may be linked to the expenditure distribution model directly, once the functions $z_{f_{q}}$ have been included in the DSS. The identification of reliable translation norms might be a problem. Fortunately, from the perspective of data-collection, a limited number of such norms have to be defined in the context of retail planning, namely as far as they are related to manipulable variables.

II Modelling subjective evaluations

So far, the elaborated model of retailer reactive behaviour bore a rather pragmatic and simple character. The main advantage of that model is its easy incorporation in applied retail research. However, a more
sophisticated approach should be developed and applied in future. In particular more attention should be paid to the way retailers arrive at some overall evaluation of their retailing context. In this section some options for dealing with that problem will be discussed.

Subjective evaluation of the retailing context

The retail planning-orientated theory assumes that retailers subjectively evaluate their retailing context. The pragmatic model made the assumption that this evaluation process is determined by the level of turnover in respect of a given level of costs at a particular moment. Alternatively, the assumption can be made that the retailer's evaluation of the retailing context is not only based on the trade-off between turnover and costs. Other relevant variables might be identified in addition. The previously discussed methods for identifying relevant attributes explaining consumer spatial choice behaviour may be used in this context. Moreover, the assumption can be made that retailers evaluate their retailing context in respect of some ideal point, as is empirically illustrated in the studies of Timmermans (1985) and Van der Heijden (1984a,b,c,d).

The first step is then to identify the overall evaluation of an individual's retailing context on the basis of the levels of relevant variables, where R denotes the number of relevant variables dominating the evaluation process (turnover and cost level included), by using some ideal point model. This type of model does not assume that the separate utilities for attributes of an object linearly increase or decrease according to the changes in the levels of these attributes. Rather, they assume that an individual's overall evaluation of an object is some function of the distance between the object's location in the subjective evaluation space and the position of the ideal point. Hence, utility decreases with the departures from the ideal point. The general form of this type of model is defined as:

\[
U_j = \sum_{r=1}^{R} \left( w_r \left( x_{jr} - x_r^* \right)^5 \right)^{-1}
\]

(5.2.52)

where,

- \( U_j \) is the overall utility for choice object \( j \);
- \( w_r \) denotes the subjective weight attached to attribute \( r \);
x_{jr} denotes the subjective evaluation of object j on attribute r; 
X^* denotes the ideal point/level of attribute r; 
\( f \) is an integer.

If \( f = 1 \), the model is termed the weighted additive city block ideal point model. If \( f = 2 \), the weighted additive Euclidian ideal point model results. Alternatively, Timmermans (1985) proposes the so-called weighted exponential city block ideal point model:

\[
U_j = \frac{1}{\sum_{r=1}^{R} \left( \exp \left( w_r \left| x_{jr} - X_r^* \right| \right) \right)^{-1}}
\]  

(5.2.53)

Instead of weighting the factors separately, equal weights \( (w_r = 1, \forall r, r=1, \ldots, R) \) could be given to each factor, which yields the unweighted versions of the models mentioned above. All these ideal point models typically assume a compensatory evaluation process. Alternatively, approximations of a noncompensatory evaluation process can be made, based on an ideal point approach, for example by means of the model:

\[
U_j = \frac{1}{\sum_{r=1}^{R} \left( \left| x_{jr} - X_r^* \right| w_r \right)^{-1}}
\]  

(5.2.54)

or some unweighted versions. Timmermans found that the unweighted multiplicative ideal point model gave the best results in representing evaluation processes of retailers in the context of locational behaviour. This suggests that noncompensatory elements are involved in the evaluation process. Further, he found that the ideal point models outperformed the non-ideal point models, which implies that retailers seem to attach some ideal point to at least some attributes. In terms of measurements the consequence of the use of ideal point models is that besides the separate evaluation of the actual level of various attributes also the ideal points/levels for these attributes have to be measured. A simple approach, directly related to the previously discussed measurement of evaluations of the actual levels of various attributes using a bipolar semantic rating scale for each attribute, is to ask retailers first to indicate their ideal point on that scale for each of the elicited attributes. In addition, the evaluations of actual levels can be measured with respect to the ideal points. An important question in this context is whether retailers are able to
express their ideal points independently from the actual situation they are confronted with. Some empirical evidence for the validity of the assumption that they are indeed able to express their ideal points is provided by the previously mentioned explorative study on retailer behaviour in Eindhoven. Retailers clearly distinguished between the actual and preferred shop-external retailing context.

A final step is to investigate the relationship between objective levels of the evaluated attributes and subjective evaluation scores. Such investigations might be linked to characteristics of the retailer and/or his/her retailing context because such characteristics might explain particular functional relationships satisfactorily. In addition, the outcomes of these investigations may be used to specify a more general predictive model.

Subjective evaluation and reactive behaviour

The pragmatic model was based on the direct measurement of the degree to which retailers are inclined to apply a particular type of reaction, given some proportional change in turnover level. A hypothetical measurement approach was suggested and in addition the estimation of functions $z_fq$ on an aggregate level was discussed. In contrast one could focus on the choice for a particular reaction in relation to changes in the subjective evaluation of the individual's retailing context and use that data for the estimation of $z_fq (V_q)$. The change in subjective evaluation might be calculated as in the pragmatic model, hence as a function of changes in turnover. Alternatively, the subjective evaluation might be calculated by means of one of the ideal point models discussed above. In terms of measurement again a hypothetical measurement approach might be used for measuring the choice for various types of reaction, given a number of hypothetical changes in subjective evaluation of the respondent's retailing context. Aggregating the answers of individuals results in the required set of data.

Given the set of functions, the question is how to generate changes in the nature of the supply-side of the retail system. The probabilistic interpretation of the application of different types of reactions in the pragmatic model was based on the assumption that all types of reaction are applied simultaneously in a particular shopping
centre. This interpretation does not take into consideration the possibility of a reaction that is based on an (evaluation) process over several years, resulting in a change of attribute levels that is more considerable than would be expected according to the assumption of yearly adjustments of the retailing context ('catastrophy effect'). A procedure for modelling this effect can be described as follows. First, given a set of functions $z_q$ denoting the relationship between average self-explicated probabilities of choice of a particular reaction and proportional changes in turnover or (proportional) changes in the subjective evaluation of the retailing context, calculate for a particular observed (proportional) change the related average probabilities of choice for all reactions on the level of each shopping centre. Secondly, standardize these probabilities such that they sum to unity. Thirdly, select at random from the observed distribution of standardized probabilities for each shopping centre $j$ one type of reaction and assume that this choice is exclusively applied in the context of sector $z$ in shopping centre $j$. Alternatively, because of the special nature of the non-reaction, included in the choice set, one could exclude non-reaction before the standardization of the calculated probabilities and the random selection of a type of reaction takes place. Non-reaction in this context is interpreted as some generally applied type of reaction that precedes any overt reaction which results in changes in attributes of retailing contexts and, consequently, always influences the budget for effectuating these overt reactions.

The implication of this procedure is that the change in the level of the attribute the selected reaction refers to will be considerably larger than in the context of the application of the pragmatic model, provided that this change in attribute level is calculated according to the same principles accepted in the pragmatic model. The above-mentioned two options for dealing with non-reaction have the following implications. If non-reaction is considered to be a type of reaction to be treated equally in relation to other types of reaction, then the budget for effectuating the randomly selected reaction $q (zG_q)$ equals the absolute difference in turnover level. Alternatively, if non-reaction is treated as a special type of reaction, one should first calculate the part of the total budget proportionally in relation to
the standardized probability of non-reaction, which, in addition, is subtracted from this total budget to yield the budget for effectuating q (q being not non-reaction). The additional translation of this budget into changes in attribute levels follows the same procedure as suggested in the pragmatic model.

This approach might cause considerable changes in the multiattribute nature of shopping centres in the context of predicting retail system dynamics. The changes in the levels of floorspace might be considerable for particular shopping centres. In turn, this might influence the attractiveness and the consumer patronage of shopping centres in a very considerable way. Future empirical research should focus on the likeliness of such changes and those predicted by the pragmatic model, so as to refine the modelling of the effectuation of retailers' reactions.

5.2.5 Model-based description of the retail system operations

Assume that a consumer spatial choice model and a retailer reactive behaviour model have been specified, then the combination of them makes it possible to analyse the future demand-supply dynamics systematically. That analysis is aimed at identifying the nature of future, not planning intervened, retail system performances. The resulting insights are of great relevance for the support of the process of identification of retail planning problems, which starts with the description of the present demand-supply relationship. The prediction of the trend development of the retail system enriches the analysis of the present situation by providing information of expected future changes in for example transport infrastructure, economic processes, population distribution, etcetera. The assumption is that these changes are definite in terms of plans, policy measures, accepted predictions and the like. These expected changes are defined in terms of the variables of the model.

The quantification of the predictions should be relevant for the explorative stage of the retail planning process. This implies that information should be generated using indicators of consumer-, retailer- and public interests. With respect to the definition of such indicators reference is made to the elaboration of a number of indicators in the next section, although the following considerations
apply to these indicators. First, the indicators that will be suggested in section 5.3 are in particular meant for the quantification of the predicted impacts of alternative retail plans, where the hypothetical trend development of the retail system serves as a basis for quantification and comparison. Consequently, these indicators are not directly applicable in the context of the present analysis. It is, however, relatively easy to define the major part of these indicators into indicators that do not refer to a hypothetical trend development. This leads to the second consideration. Defining these indicators in absolute terms also implies that absolute values are generated that quantify the performance of the retail system without using some basis for comparison. The evaluation of these absolute values requires absolute normative indicator values and/or values derived from experienced empirical knowledge of studies in other spatial contexts. Otherwise, a fundament for evaluation lacks. Traditionally, normative turnover-to-floorspace ratios are used as the main framework for evaluating retail system performances. In many practical retail planning projects no other normative indicator values exist. The task of the researcher is, however, to guide the definition of such normative values for the study area by the participants of the planning group. Particularly, this implies that interests should be explicated and access should be created to experienced knowledge. The ultimate evaluation of the predicted trend development of the retail system is, therefore, dominated by explicitness in planning views, availability of data and acceptance of reductions in the evaluation framework. It should be emphasized in this context that the definition of retail planning problems is only partially dependent upon the results of the evaluation of predictions of the trend. Therefore, the accepted evaluation framework plays a less crucial role in respect of the predictions of the trend than in the context of the evaluation of assessments on the likely impacts of alternative retail plans.

5.2.6 Supplementary descriptions
The description of consumer patronage of shopping centres, the assessment of the viability of shopping centres and the prediction of the most likely future trend development of the retail system require a systematic inventory of the retail facilities. This type of
descriptive analysis is a common aspect of currently applied retail research and this it should remain. In the context of that exploration attention is paid to the location of shopping facilities, the size of these facilities measured in terms of the number of shops and/or floorspace, the proportion of non-retailing functions, branch mix, types of retailing formula, accessibility (including parking facilities) and the like. However, given current opportunities for computerized storage of data, it is strongly recommended to design and/or further develop some computerized system for the storage of the type of data mentioned above, for example, on the municipal level. Such a system is easier to be linked to the retail planning DSS data bank then data stored otherwise. Moreover, the data of the retail facilities are more systematically collected and easier updated.

Apart from the pure description of retail facilities, the retail planning-orientated theory stresses that more attention should be paid to the perceptive processes of consumers and retailers with respect to the retail facilities. This might for instance be organized in terms of a number of smaller pilot studies. A number of possibilities have been mentioned more or less implicitly in the context of the elaboration of the modelling approach. With respect to consumers, the following issues might for example be dealt with:
- the nature of the cognitive image consumers held of the retail facilities in the study area;
- the information fields of consumers;
- the evaluation of attribute levels of shopping centres like choice range, accessibility, atmosphere, safety, branch mix;
- wishes with respect to retail facilities;
- shopping-behavioural patterns of consumers, not only in terms of where, for what and how much, but also, why;
- etcetera.

With respect to retailers' evaluations of retail facilities, one could for example pay attention to the following issues:
- the perceived advantages and disadvantages of the 'own' shopping centre;
- the problems of the shopping centres and wishes for future changes of environmental conditions;
- qualitative changes in a number of years in retail facilities and
the 'why' of it;
- perception of the type of consumers and the consequences for choice range, price level, service, and so on;
- evaluation of the shopping centre with respect to ideal points;
- etcetera.

Clearly, one should recognize that it is often difficult to stimulate retailers to participate in questionnaires. On the other hand, the insights resulting from more detailed information about the retailers' perceptions and expectations of the operating of the shopping centres could be very useful for the support of the most adequate and acceptable planning measures (see Van der Heijden et al. (1986), for the description of a situation that failed to deal with this type of information).

As noted in the beginning of this section there is no sense from the perspective of DSS building in mentioning all options for descriptive analyses on the retail system in the study area. Much depends on the scale of the planning project, the aims of analyses in respect if the information needs, the available data, the degree to which the retail planning problems have been defined, and other such conditions.

5.3 ASSESSMENTS OF IMPACTS OF ALTERNATIVE RETAIL PLANS

5.3.1 Introduction

An important part of the DSS is concerned with the assessment of impacts of alternative retail plans. These assessments involve the simulation of the retail system's operation under the (varying) conditions of these plans, using a predictive model as elaborated in the previous section of this chapter. The retail plans have to be defined in terms of the levels of the attributes included in the model. In addition, these levels are treated as input in the model. The main concern of this part of the DSS is to produce meaningful information about the expected impacts of alternative plans. As has been noted with regard to the analysis of the decision making process and the elaboration of the retail planning orientated theory, such information is assumed to be meaningful for decision makers when it deals with consumer-, retailer- and public interests. Moreover,
information indicating the changes relative to the hypothetical trend development is considered relevant. Therefore, the main focus in this section is on developing a system of indicators related to these interests that quantify the predicted impacts of alternative retail plans. In the next subsection such a quantitative equation system will be outlined.

5.3.2 System performance indicators

According to previous definitions, let

\[ \text{IN}^k_{ijt}, \text{p}^k_{ijt}, \text{E}^k_{ijt}, \text{V}^k_{jt}, \text{L}^k_{jt} \]

denote the number of interactions between origin zone \( i \) (\( i=1, \ldots, N \)) and shopping centre \( j \) (\( j=1, \ldots, M^* \)) at time \( t \) (\( t=1, \ldots, T \)) by consumers for buying goods in sector \( z \) (\( z=1, \ldots, Z \)) under the conditions of plan \( k \) (\( k=1, \ldots, K \));

\[ \text{B}^k_{it} \]

denote the probability of interaction between origin \( i \) and shopping centre \( j \) at time \( t \) for sector \( z \) given plan \( k \);

\[ \text{P}^k_{ijt}, \text{Z}^k_{ijt}, \text{L}^k_{zt} \]

denote the population of origin \( i \) at time \( t \) belonging to group \( g \) given plan \( k \);

\[ \text{E}^k_{ijt} \]

denote the flow of expenditure from origin \( i \) to shopping centre \( j \) at time \( t \) for sector \( z \) from consumers given plan \( k \);

\[ \text{V}^k_{jt} \]

denote the turnover in shopping centre \( j \) at time \( t \) in sector \( z \) given plan \( k \);

\[ \text{L}^k_{zt} \]

denote the turnover-to-floorspace ratio in shopping centre \( j \) at time \( t \) in sector \( z \) given plan \( k \).

The set \( (S) \) of \( M^* \) shopping centres in the area can be divided into two subsets: the set \( (S_1) \) consisting of those \( M_1 \) centres subject to certain retail planning measures and the set \( (S_2) \) consisting of the remaining \( M_2 \) shopping centres. Hence:

\[ (S) = (S_1) \cup (S_2) \text{ and } M^* = M_1 + M_2 \]

(5.3.1)

Finally, assume for the sake of the description of the indicators in this subsection, that \( t \) represents a time period of one year. Evidently in practice other periods may be used. In this subsection the indices will be indicated by means of \( \nu \) (\( \nu=1,2,3, \ldots \)) which implies that the use of \( C \) deviates from the use of \( C \) in chapter 4. Further, the superscript \( k \) will refer to the situation of plan \( k \), whereas the superscript will be used to denote the trend development characterized by the absence of retail planning.
I Retailer interests

As has been argued, it is important for the planning team to get insight in the development of turnover (as a surrogate variable of efficiency), given plan k, as compared to the development according to the trend. The first index describes the average yearly proportional change in the turnover-to-floorspace ratio as a result of plan k, as compared to the trend, for all shopping centres to which the plan applies. The index is expressed in the following way:

\[
M_k^{z_l} = \frac{1}{M_k^{l}} \sum_{j \in S_1} \sum_{t=1}^{T} \left( \frac{z_{jt}^k}{z_{jt}^o} \right) ; \quad (\forall z, k) \tag{5.3.2}
\]

where,

- \( z_{jt}^k \) is index \((1)\) for each plan \(k\) and each sector \(z\);
- \( M_k^{l} \) is the total number of shopping centres for which plan \(k\) applies;
- \( z_{jt}^o \) denotes the turnover-to-floorspace ratio in centre \(j\) in sector \(z\) at time \(t\) without planning interference (trend);

Note that index \((1)\) might be calculated for each shopping centre \(j \in S_1\) separately, in which case the following equation is used:

\[
M_k^{z_l,j} = \frac{1}{T} \sum_{t=1}^{T} \left( \frac{z_{jt}^k}{z_{jt}^o} \right) ; \quad (\forall z, k, j \mid j \in S_1) \tag{5.3.3}
\]

If index \((1)\) is lower than 1, it follows that plan \(k\) has the effect of yielding a lower average turnover-to-floorspace ratio than would be obtained if plan \(k\) is not effectuated.

Plan \(k\) might also be of influence on the shopping centres in the area not subject to plan \(k\). Like index \((1)\), index \((2)\) calculates this indirected impact in terms of the average yearly proportional change in the turnover-to-floorspace ratio as a result of plan \(k\) as compared to the trend for all shopping centres \(j \in S_2\) not included in plan \(k\). Index \((2)\) is expressed as:

\[
M_k^{z_l} = \frac{1}{M_k^{l}} \sum_{j \in S_2} \sum_{t=1}^{T} \left( \frac{z_{jt}^k}{z_{jt}^o} \right) ; \quad (\forall z, k) \tag{5.3.4}
\]
Like index (1), index (2) is interpreted in terms of causing a higher or lower average turnover-to-floorspace ratio than is obtained if plan \( k \) is not effectuated, indicated with an index value higher or lower than 1 respectively. Index (2) might be calculated for each shopping centre \( j \in S_2 \) separately as follows:

\[
 z_{c2,j}^k = \frac{1}{T} \sum_{t=1}^{T} \left( \frac{L_{jt}^k}{L_{jt}^o} \right); \quad (\forall z,k,j \mid j \in S_2) \tag{5.3.5}
\]

To answer the question whether a lower turnover-to-floorspace ratio for a particular sector \( z \) due to plan \( k \) is permanent rather than incidental, one might be interested in how frequently during the considered period this effect occurs. Index (3) therefore indicates the average number of times the turnover-to-floorspace ratio for sector \( z \) in the shopping centres \( j \) included in the retail plan \( (j \in S_1) \) as the result of plan \( k \) is worse than this ratio is in relation to the trend within the considered period, averaged over the number of centres involved in the plan. Index (3) is expressed as follows:

\[
 z_{c3}^k = \frac{1}{k} \sum_{j \in S_1} \sum_{t=1}^{T} \left( \frac{L_{jt}^k}{L_{jt}^o} \right); \quad (\forall z,k) \tag{5.3.6}
\]

where,

\[
z_{\Theta_j}^k = \begin{cases} 
1 & \text{if } L_{jt}^k < L_{jt}^o \\
0 & \text{otherwise}
\end{cases}
\]

Index (3) can be formulated centre-specifically as follows:

\[
 z_{c3,j}^k = \sum_{t=1}^{T} \left( \frac{L_{jt}^k}{L_{jt}^o} \right); \quad (\forall z,k,j \mid j \in S_1) \tag{5.3.7}
\]

Similarly, index (4) expresses the same effects for the centres not included in the plan:

\[
 z_{c4,j}^k = \frac{1}{M_2} \sum_{j \in S_2} \sum_{t=1}^{T} \left( \Theta_{jt}^k \right); \quad (\forall z,k) \tag{5.3.8}
\]

A centre-specific index (4) results in the equation
The indices (1) to (4) compare the predicted turnover-to-floorspace ratios for plan \( k \) with the turnover-to-floorspace ratios for the trend. In practice, attention is also paid to the question whether or not the effectuation of a plan will violate a norm turnover-to-floorspace ratio for a particular sector \( z \) at time \( t \). Index (5) and index (6) might be used to provide the required information. Index (5) measures the average number of times that the actual turnover-to-floorspace ratio is lower than the normative turnover-to-floorspace ratio for shopping centres in the plan, averaged over these shopping centres:

\[
\begin{align*}
z_{T}^{k} = \frac{1}{T} \sum_{t=1}^{T} \sum_{j \in S_{1}} \left( z_{j,t}^{k} \right) ; \quad (Vz,k) \\
\end{align*}
\]

(5.3.10)

where,

\[
\begin{align*}
z_{j,t}^{k} = \begin{cases} 
1 & \text{if} \quad z_{j,t}^{k} < L_{j,t}^{*} \\
0 & \text{otherwise}
\end{cases}
\end{align*}
\]

and

\( L_{j,t}^{*} \) denotes a norm turnover-to-floorspace for shopping centre \( j \) at time \( t \) for sector \( z \).

Index (5) might be calculated centre-specifically as follows:

\[
\begin{align*}
z_{T}^{k} & = \sum_{t=1}^{T} \left( z_{j,t}^{k} \right) ; \quad (Vz,k, j \mid j \in S_{1}) \\
\end{align*}
\]

(5.3.11)

Analogously, index (6) applies to the shopping centres not included in the plan:

\[
\begin{align*}
z_{c}^{k} = \frac{1}{M_{z}^{k}} \sum_{j \in S_{2}} \sum_{t=1}^{T} \left( z_{j,t}^{k} \right) ; \quad (Vz,k) \\
\end{align*}
\]

(5.3.12)

or, alternatively, for each shopping centre separately:

\[
\begin{align*}
z_{c}^{k} & = \sum_{j=1}^{T} \left( z_{j,t}^{k} \right) ; \quad (Vz,k, j \mid j \in S_{2}) \\
\end{align*}
\]

(5.3.13)
The planning team might further be interested in changes in the service area of shopping centres, especially in respect of their secondary service area located at a minimum distance of these shopping centres. Changes like these might indicate a loss of attractiveness for consumers at greater distance. Index (7), therefore, is constructed to provide the required information. It calculates the average yearly proportional shift in the ratio between the turnover in shopping centre \( j \) (\( j \in S_1 \)) for sector \( z \) within the conditions of plan \( k \), and the turnover according to the trend, as far as the turnover is related to those origins \( i \) for which the distance to the shopping centre is larger than or equal to a predefined threshold distance \( D_{ij} \). In formula:

\[
z_{c7k} = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j \in S_1} (z_{ijt}^k / z_{ijt}^0); \quad (Vi|d_{ijt}^k < D_{ij}; Vj; z) \quad (5.3.14)
\]

or, centre-specifically formulated:

\[
z_{c7kj} = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j \in S_1} (z_{ijt}^k / z_{ijt}^0); \quad (Vi|d_{ijt}^k < D_{ij}; Vj|j \in S_1; Vj; z) \quad (5.3.15)
\]

If index (7) is lower than 1, it indicates that due to the effectuation of plan \( k \) the area at a larger than the prespecified minimum distance from the shopping centres included in the plan is served less than in the conditions of the trend. In a similar way, index (8) calculates corresponding information with regard to the shopping centres of subset \( S_2 \):

\[
z_{c8k} = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j \in S_2} (z_{ijt}^k / z_{ijt}^0); \quad (Vi|d_{ijt}^k < D_{ij}; Vj; z) \quad (5.3.16)
\]

or, centre-specifically formulated:

\[
z_{c8kj} = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j \in S_2} (z_{ijt}^k / z_{ijt}^0); \quad (Vi|d_{ijt}^k < D_{ij}; Vj|j \in S_2; Vj; z) \quad (5.3.17)
\]

Further, the average yearly shift in the shortest distance turnover proportion of a shopping centre relative to the trend might be of interest for the planning team. The shortest distance turnover proportion indicates the proportion of the total turnover in sector \( z \) in shopping centre \( j \) based on expenditures by consumers living in the nearest residential zone ('primary' service area of shopping centre \( j \)). The index corresponds to index (7) except for the fact that its
condition is different. For shopping centres $j$ included in plan $k$ this index is:

$$z_{i_j}^c = \frac{1}{M_{1,T}} \sum_{t=1}^{T} \sum_{j \in S_1} \left( \frac{E_{i_jt}^k}{E_{i_jt}^0} \right); \quad (i|d_{i_jt}^k < d_{i_jt}^k; \; i'=1,...,N; \; i' \neq i; \; \forall k,z)$$

(5.3.18)

The same index can be defined for shopping centres not included in plan $k$ as follows

$$z_{i_j}^{a_k} = \frac{1}{M_{2,T}} \sum_{t=1}^{T} \sum_{j \in S_2} \left( \frac{E_{i_jt}^k}{E_{i_jt}^0} \right); \quad (i|d_{i_jt}^k < d_{i_jt}^k; \; i'=1,...,N; \; i' \neq i; \; \forall k,z)$$

(5.3.19)

The centre-specific definitions of the indices (9) and (10) correspond to (5.3.15) and (5.3.17) with the conditions specified in (5.3.18) and (5.3.19) respectively.

Next, the planning team might be interested in the impact of plan $k$ on the autonomous changes in the nature of shopping centres as compared to the expected changes in case of the trend. The changes might have consequences for the attractiveness of shopping centres. Index (11) therefore measures the average yearly proportional shift in the attractiveness of shopping centres $j$ not included in the plan as compared to the trend in respect of sector $z$:

$$z_{i_j}^{c_k} = \frac{1}{M_{2,T}} \sum_{t=1}^{T} \sum_{j \in S_2} \left( \frac{A_{i_jt}^k}{A_{i_jt}^0} \right); \quad (\forall k,z)$$

(5.3.20)

where,

$$z_{i_j}^{A_k}$$

denotes the attractiveness of shopping centre $j$ at time $t$ under the conditions of plan $k$ in sector $z$.

Variables like the number of employees, the amount of floorspace, the number of shops and the like can be used as approximates to attractiveness. The centre-specific form of index 11 is:

$$z_{i_j}^{c_11,j} = \frac{1}{T} \sum_{t=1}^{T} \left( \frac{A_{i_jt}^k}{A_{i_jt}^0} \right); \quad (\forall k,z; \; \forall j \in S_2)$$

(5.3.21)
Finally, the planning team might be interested in the changes in the consumers' subjective evaluation of the shopping centres due to the effectuation of plan k because of the relationship between the subjective evaluation of a shopping centre and the spatial choice pattern of consumers. Index (12), therefore, measures the average yearly proportional change as compared to the trend for the shopping centres in plan k with respect to attribute r:

$$z_{12,r}^k = \frac{1}{N^{k}_{\text{I,T}}} \sum_{h=1}^{H} \sum_{t=1}^{T} \left[ \frac{f_{hr}(z_{jrt}^k)}{z_{hr}(z_{jrt}^o)} \right] ; \quad (5.3.22)$$

where,

- $z_{jrt}^k$ denotes the objective level of attribute r of shopping centre for sector z at time t given plan k;
- $f_{hr}$ denotes individual's h evaluation function for attribute r with regard to sector z;
- I denotes the number of respondents.

A value of index (12) lower than 1 indicates that plan k causes a lower evaluation of the shopping centres in the plan with regard to attribute r. The centre-specific definition of index (12) for shopping centres $j \in S_1$ included in plan k is:

$$z_{12,r,j}^k = \frac{1}{N_{\text{I,T}}} \sum_{h=1}^{H} \sum_{t=1}^{T} \left[ \frac{f_{hr}(z_{jrt}^k)}{z_{hr}(z_{jrt}^o)} \right] ; \quad (5.3.23)$$

Alternatively, one could also formulate similar measures for the shopping centres $j \in S_2$ not included in the retail plan. Depending upon the point of view index 12 could also be interpreted as an indicator of consumer interests.

II Consumer interests
Retail plans may bring about changes in the nature of the consumers' knowledge of the retailing structure. This aspect may be of interest for retail planning, since more knowledge might imply that consumers possess a larger information field and, hence, a larger choice set in the spatial shopping behaviour. Index (13) provides a measure of the average yearly change in the knowledge of shopping opportunities measured in terms of floorspace by consumers due to the implementation of plan k, as compared to the trend:
\[ z_{13}^{k} = \frac{1}{T} \sum_{T}^{N} \sum_{t=1}^{N} \left[ \frac{\theta_{ijt}^{k} \cdot z_{jt}^{k} \cdot B_{it}^{k}}{\theta_{ijt}^{o} \cdot z_{jt}^{o} \cdot B_{it}^{o}} \right]; \quad (V_{j},k,z) \]  

(5.3.24)

where,

\[ \theta_{ijt}^{k} = \begin{cases} 1 \quad \text{if } j \text{ belongs to the information field of consumers in origin zone } i \text{ at time } t \text{ for plan } k; \\ 0 \quad \text{otherwise}; \end{cases} \]

\[ B_{it}^{k} \] is the number of individuals in origin zone \( i \) at a time \( t \) given plan \( k \);

\[ z_{jt}^{k} \] is the total floorspace in shopping centre \( j \) at time \( t \) in sector \( z \) for plan \( k \).

Note in this context that the use of a (deterministic or a probabilistic) model which predicts the information fields is assumed. The present definition of index (13) assumes a deterministic model. Index (13) can be formulated origin-specifically as follows:

\[ z_{13,i}^{k} = \frac{1}{T} \sum_{T}^{N} \left[ \frac{\theta_{ijt}^{k} \cdot z_{jt}^{k} \cdot B_{it}^{k}}{\theta_{ijt}^{o} \cdot z_{jt}^{o} \cdot B_{it}^{o}} \right]; \quad (V_{i,j,k,z}) \]  

(5.3.25)

under the same condition of equation (5.2.24). If index (13) is lower than 1, it indicates that plan alternative \( k \) has the effect of yielding a lower level of familiarity with retail facilities than the trend.

A simple measure of availability focuses on the presence of shopping facilities within a particular threshold distance \( D_{ij} \). Again, the focus is on the average yearly change relative to the trend development:

\[ z_{14}^{k} = \frac{1}{T} \sum_{T}^{N} \sum_{t=1}^{N} \sum_{j=1}^{M} \left( \frac{\varphi_{z}^{k} \cdot z_{jt}^{k} / \varphi_{z}^{o} \cdot z_{jt}^{o}}{\varphi_{z}^{k} \cdot z_{jt}^{k} / \varphi_{z}^{o} \cdot z_{jt}^{o}} \right); \quad (V_{k,z}) \]  

(5.3.26)

where,

\[ \varphi_{z} = \begin{cases} 1 \quad (\forall j \mid d_{ijt}^{k} < D_{ij}) \\ 0 \quad \text{otherwise} \end{cases} \]

\[ d_{ijt}^{k} \] is the actual distance between the residential location \( i \) and the shopping centre \( j \) at time \( t \) in plan \( k \);

\[ D_{ij} \] is a threshold distance between location \( i \) and shopping centre \( j \);
is the amount of floorspace in sector \( z \) in shopping centre \( j \) at time \( t \) given plan \( k \).

Obviously, instead of using the amount of floorspace, variables such as the number of different branches, the number of employees or the number of shops could be used as well. Index (14) evidently requires an a priori specification of some threshold distance. The origin-specific definition of index (14) is:

\[
C_{z14,i}^k = \frac{1}{M*T} \sum_{t=1}^{T} \sum_{j=1}^{M^*} \left( \frac{F^k_{jt} - F^0_{jt}}{Q^0_{jt}} \right) ; \quad (\forall i,k,z) \tag{5.3.27}
\]

given the condition of (5.3.26) In case index 14 results in a value lower than 1, the implementation of plan \( k \) causes the situation that less floorspace in sector \( z \) is available within the predefined distance as compared to the hypothetical trend development.

As has been argued, several measures have been developed that might be used to express accessibility to retail facilities. Index (15) measures the average yearly change, relative to the trend, in the local access to shopping centres in terms of the expenditures by consumers in their nearest centre in sector \( z \):

\[
C_{z15,i}^k = \frac{1}{T*M*N} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{M^*} \left[ \frac{z^{k}_{ijt} \cdot B^k_{ijt}}{z^{o}_{ijt} \cdot B^o_{ijt}} \right] ; \quad (\forall i,k,z) \tag{5.3.28}
\]

Alternatively, one could specify index (15) for each residential zone \((\forall i)\) separately as follows:

\[
C_{z15,i}^k = \frac{1}{T*M*T} \sum_{t=1}^{T} \sum_{j=1}^{M^*} \left[ \frac{z^{k}_{ijt} \cdot B^k_{ijt}}{z^{o}_{ijt} \cdot B^o_{ijt}} \right] \tag{5.3.29}
\]

given the condition of (5.3.28)

Index (15) indicates the degree to which the effectuation of a retail plan brings about a change in the nearest centre expenditure proportion. A value lower than 1 indicates that in general less money
is spent as compared to the trend in sector z in the nearest centre. This means that the introduction of plan k will bring about a less dispersed, spending pattern as compared to the trend development.

A more continuous measurement for accessibility is based on the trade-off between the attractiveness of shopping opportunities and the (cost of) distance (compare Hansen, 1959). Instead of an objective attractiveness variable (number of shops, floorspace) the subjective evaluation of attractiveness might be used. Assume that the variable denoting the number of shops \( W \) is chosen as the measure for attractiveness, than index (16) for shopping centres in plan k is defined as follows:

\[
\hat{c}_{16}^k = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j \in S_1} \left[ \frac{z_{ijt}^k / z_i^h(d_{ijt}^k)}{z_{ijt}^0 / z_i^h(d_{ijt}^0)} \right] ; \quad (V, k, z) \tag{5.3.30}
\]

where, \( z_i^h \) is some (cost-)function of the distance between the location of zone i and the shopping centre j.

Alternatively, index (16) can also be defined for the remaining shopping centres \( (j \in S_2) \). Like index (15) index (16) measures the average yearly proportional change in accessibility due to plan k as compared to the accessibility as for the trend, for some time horizon. Of course, index (16) might be specified for each origin separately, in which case the equation results:

\[
\hat{c}_{16,i}^k = \frac{1}{T} \sum_{t=1}^{T} \sum_{j \in S_2} \left[ \frac{z_{ijt}^k / z_i^h(d_{ijt}^k)}{z_{ijt}^0 / z_i^h(d_{ijt}^0)} \right] ; \quad (V_i, k, z) \tag{5.3.31}
\]

A final, alternative, measure of accessibility measures the relative change in the attractiveness of shopping facilities for consumers, within a particular threshold distance, in terms of the probability of choice as compared to the trend development:

\[
\hat{c}_{17}^k = \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{M} \left[ \frac{z_{ijt}^k \cdot b_{ijt}^k \cdot A_{ijt}^k \cdot \phi}{z_{ijt}^0 \cdot b_{ijt}^0 \cdot A_{ijt}^0 \cdot \phi} \right] ; \quad (V, k) \tag{5.3.32}
\]
where,

\[ z_{ijt}^k \] is a measure of attractiveness of the shopping centre \( j \) for sector \( z \) at time \( t \) in plan \( k \);

\[ \varphi = \begin{cases} 1 & (j| d_{ijt}^k < D_{ij}) \\ 0 & \text{otherwise} \end{cases} \]

\( p_{ijt}^k \) is the probability that consumers in origin \( i \) will visit centre \( j \) at a time \( t \) in plan \( k \);

\( B_{il}^k \) is the population in origin \( i \) in time \( t \) given plan \( k \).

III Public interests

As has been argued before, a set of indices is needed to quantify the degree of equality in the spatial and functional characteristics of the retail system. In particular, the outcomes of centre- and origin-specific indices as defined above might be considered as the input of equality analyses. Since these indices might be applied to the values of various variables, for the elaboration of the set of equity indices in this subsection the vector \( Y = [Y_h] \) is assumed with \( H \) values \((h=1, \ldots, H)\). Evidently, \( H \) might represent the number of shopping centres or the number of origin zones or subsets of these, etcetera. A useful overview of measures is provided by Gaile (1977). The major part of the set of indices outlined below stems from that overview.

Perhaps the simplest equality index is the function of the range of a distribution which measures the variety in variable values, defined as:

\[ EQ_1 = \left( \frac{\max_k y_h - \min_k y_h}{\sum_{h=1}^H y_h} \right) \]

Clearly, the extreme values of \( C \) have a strong impact on \( EQ_1 \) and, therefore, \( EQ_1 \) does not necessarily say anything about the distribution of values within the range. Given a particular sum of values, then it will be clear that the smaller \( EQ_1 \) is, the smaller the range in variable values will be. Reversely, given a particular range of values, it is obvious that the smaller the value of \( EQ_1 \) is, the larger the sum of values will be and the closer the variable values will be to the
maximum value of the range.

Another index is the mean deviation, which is defined as:

\[ EQ_2 = \frac{\sum_{h=1}^{H} \left| y_h - \frac{\sum_{h=1}^{H} y_h}{H} \right|}{H} \quad (5.3.34) \]

EQ_2 measures the mean deviation of values of the variable with respect to the mean value. A greater value of EQ_2 indicates a greater mean absolute deviation in variable values with respect to the arithmetic mean.

Both EQ_3 and EQ_4 are based on the measures of central tendency and variations. EQ_3 is the standard deviation:

\[ EQ_3 = \sqrt{\frac{H}{\sum_{h=1}^{H} \left( y_h - \frac{\sum_{h=1}^{H} y_h}{H} \right)^2}} \quad (5.3.35) \]

while EQ_4 is Pearson's coefficient of variation, written as follows:

\[ EQ_4 = \frac{100 \cdot EQ_3}{\left( \frac{\sum_{h=1}^{H} y_h}{H} \right) / H} \quad (5.3.36) \]

EQ_3 and EQ_4 share the assumptions of normality of the data. This assumption might not be met in all situations. Moreover, the values of both indices are dependent upon the scale of the values. A larger value of EQ_3 and EQ_4 indicates a more dispersed distribution of variable values.

An index provided by Niehans (1960) is closely related to EQ_4. This Niehans-index equals:

\[ EQ_5 = \frac{\sum_{h=1}^{H} \left( y_h - \frac{\sum_{h=1}^{H} y_h}{H} \right)^2 / H}{\sum_{h=1}^{H} y_h / H} + \frac{\sum_{h=1}^{H} y_h / H}{H} \quad (5.3.37) \]

Another index is the variance of logarithms:

\[ EQ_6 = \frac{1}{H} \sum_{h=1}^{H} \left[ k \log y_h - \log \left\{ \sum_{h=1}^{H} y_h / H \right\} \right]^2 \quad (5.3.38) \]
EQ6 has the disadvantage that its value is dependent upon the geometric mean of the values of the variable and hence it is only indirectly related to the measured phenomenon. This makes the measure somewhat difficult to interpret.

The next index is proposed by Herfindahl (1950) and is written as follows:

$$\text{EQ7} = \sum_{h=1}^{H} \left( \frac{y^k_h}{\sum_{h=1}^{H} y^k_h} \right)^2$$

Unlike the previously mentioned indices, the value of EQ7 is dependent upon the number of observations R. Therefore, its value is somewhat difficult to interpret. Given a particular number of observations, a higher value of EQ7 indicates that the proportion of high values among the observations is larger than in the case of a lower value of EQ7.

Some indices suggested are derived from the concept of statistical entropy (Shannon, 1948). The entropy of a distribution is given by way of the following equations:

$$\text{EN} = -\alpha \sum_{h} f^h \ln f^h$$

with $$f^h = \frac{y^h}{\sum y^h}$$

and $$\alpha$$ a scalar constant assumed equal to 1.

EN varies from 0 for complete inequality to a maximum of $$\ln(H)$$ for complete equality. By subtracting EN from its maximum, the simple index of inequality (EQ8) proposed by Theil (1967) is derived:

$$\text{EQ8} = \ln H - \sum_{h=1}^{H} \left( \frac{y^k_h}{\sum_{h=1}^{H} y^k_h} \right) \cdot \ln \left( \frac{y^k_h}{\sum_{h=1}^{H} y^k_h} \right)$$

Note that the problem with EQ8 is that it is scale dependent, i.e. the index varies with the size of R. Therefore, a simple correction might be introduced by making EQ8 relative. This relative entropy index of inequality is defined as:

$$\text{EQ9} = \frac{\text{EQ8}}{\ln(H)}$$
EQ9 varies between 0.0 and 1.0. It is not scale dependent nor the number of observations or extreme values influences the index value.

A final weighted relative entropy index of equality is suggested by Gaile (1977). The index is in particular useful in case the variable $y_h$ is applied to measurement units with different weights, number of constituent elements, and so on, such as origin zones with different numbers of people or shopping centres with different numbers of shops. When $n(o)$ denotes these weights, EQ10 is written as:

$$\text{EQ10} = - \frac{\sum_{h=1}^{H} \frac{n(h)}{\sum_{h=1}^{H} n(h)} \cdot \ln \frac{\sum_{h=1}^{H} n(h)}{\sum_{h=1}^{H} n(h)} y_h}{\ln \sum_{h=1}^{H} n(h)}$$

EQ10 also varies between 0 and 1.0. A value 1.0 indicates that the values $y_h$ are equal, regardless of the values of $n(h)$. A value 0 indicates that one particular value $y_h$ equals the sum of all $y_h$ and $n(h) = 1.0$. This implies that the measured effect is completely concentrated in one measurement unit and all other values $y_h = 0$.

Apart from equality, another general planning objective is to deal in an economic way with space. An index that measures the relative change in the average distance travelled by consumers within the retail system brought about by the effectuation of plan $k$ compared to the average amount of mobility in a trend development, is:

$$C_{18}^k = \frac{1}{T \cdot N \cdot M^* \cdot Z} \sum_{t=1}^{T} \sum_{i=1}^{N^*} \sum_{j=1}^{M^*} \sum_{z=1}^{Z} \left\{ \frac{p_{ij}^k \cdot R_{it}^k \cdot d_{ij}^k}{p_{ij}^o \cdot R_{it}^o \cdot d_{ij}^o} \right\} ; \quad (5.3.44)$$

Alternatively, one could define index (18) as an index that measures the change in total distance travelled, hence, not as a per capita value. In that case, first the total distance travelled within the conditions of the plan and within the the conditions of the trend are calculated, followed by the calculation of their ratio. The distance variable might be operationalized in terms of geographical distance as well as travel time.
Finally, an index of the occupation of land by means of shopping facilities measured per individual is:

$$C_{19}^k = \frac{1}{T} \sum_{T,M \tau = 1}^{M^k} \left[ \frac{\sum_{i=1}^{N} b_i^k}{\sum_{i=1}^{N} \sum_{z=1}^{Z} z_i^k j_t} \right] ; (V_k) \quad (5.3.45)$$

where,

- $z_i^k j_t$ is the total amount of floorspace in shopping centre $j$ in sector $z$ at a time $t$ in plan $k$;
- $PA_i^k j_t$ is the total amount of floorspace for parking in shopping centre $j$ in plan $k$ at a time $t$.
- $B_i^k j_t$ is the population of origin zone $i$ in plan $k$ at a time $t$.

Index (19) measures the average yearly change in occupation of land by shopping facilities per capita, due to the implementation of plan $k$, as compared to the trend development. Alternatively one could use cost-functions related to the levels of $F$ and $PA$ in order to express the cost of land occupation per capita. Like index (18), index (19) could also be alternatively defined in terms of an overall measure instead of a per capita measure.

5.4 MULTICRITERIA EVALUATION OF ALTERNATIVE RETAIL PLANS

5.4.1 Introduction

Retail planning currently lacks a systematic and comprehensive ex ante evaluation of alternative retail plans from the perspective of multiple criteria, at least in a quantitative manner. This is partly caused because of the fact that the perspective of multiple criteria seems not to be sufficiently specified. As has been argued, the emphasis is in general on the economic viability of retail facilities, which means a rather substantial reduction of the inherent multidimensionality of the retail planning problem. On the other hand however, this reduction is established because of the fact that no operational integration and evaluation methodology is used to cope with all aspects of the multidimensionality systematically and in a way comparable to the current approaches in respect of the assessment of the economic viability of retail facilities. Consequently, a quantitative operational ex ante
evaluation methodology is to be desired in the context of a DSS methodology in order to support comparable approaches on various aspects of the retail planning problem by decision makers. The ultimate objective of the development and application of such an approach is to improve the substantive quality of the decisions taken.

With regard to Voogd's (1983a) distinction of several types of evaluation, the abovementioned problem concerns the development of a methodology for the so-called 'explicit a posteriori ex ante evaluation' of retail plans. Typical for current ex ante evaluation of retail plans is that it is conceived as a single stage within the planning process during which the available information is weighed and judged. According to Breheny (1973) this way of looking at ex ante evaluation was rather common till the mid seventies. Since then however, there has been a shift in the discussion about ex ante evaluation related to the increasing openness of the planning process towards planning as a dialogue. In that context, deciding on planning strategies has increasingly become an iterative learning process in which goals, objectives and plans are not necessarily the inputs to the system but gradually evolve. Breheny therefore considers ex ante evaluation as the recursive learning process aimed at better informed decision making by the way of a gradual reduction of uncertainty. This implies that the focus is on a systematic and comprehensive ex ante evaluation as this might influence the character of a number of planning process phases. Voogd (1983a) describes the objectives of the development and application of such a systematic ex ante evaluation framework as follows:

- it is a means to enlighten the problem taken into consideration;
- it produces a better insight in the various value judgements;
- it relates factual information to political views in an explicit way (more openness);
- it is a means to reduce the available information;
- it might bring about a substantive improvement of the ultimate decisions;
- it is a means of arriving at a more controllable position of the expert in the planning process and it structures the research contributions in relation to the process more explicitly.

The consequence of such a view is that planning requires an ex ante
evaluation methodology that systematically links the understanding of the phenomenon at hand and the decisions about plans in terms of the development of information-rich and planning-relevant measures of the system performances (Breheny). Moreover, since the decision making process is not rigid, the ex ante evaluation framework must bear a flexible character, adaptable to various circumstances without changing the basic nature of the approach (Voogd).

Related to the field of retail planning, this view emphasizes the need for an approach

(a) that improves the understanding of the multidimensional nature of the operation of the retail system by providing a system of information-rich measures; and

(b) that supports a flexible systematic integrated evaluation of alternative retail plans.

In terms of the development of a methodology the first mentioned need for ex ante evaluation has been fulfilled in section 5.3, where a number of indicators related to the multidimensionality of the retail system have been developed. These measures can serve as the multiple set of criteria for evaluating the disadvantages and advantages of retail plans. These measures should be linked to a methodology aimed at systematically comparing and weighing the information about these criteria for particular plans in order to reach a better insight in the relative overall value of the evaluated plans. This part of the chapter describes some methods related to that task.

5.4.2 Multicriteria evaluation methods for mixed data

The essential element of the multicriteria evaluation is a two-dimensional matrix, where one dimension expresses the various alternatives and the other dimension the criteria by way of which these alternatives must be evaluated. The matrix is filled with evaluation scores on the criteria. A vector of weights reflects the importance attached to the various criteria. Although the performance indicators suggested in the previous section serve basically as the criteria set by way of which the alternatives are evaluated, the required flexibility implies that several other criteria might be added to this set. It is necessary, therefore, to recognize that not all evaluation scores are necessarily measured on a cardinal level.
Several evaluations might be measured on an ordinal level (expressing ranks). This is a typical mixed data evaluation situation. Voogd (1983a) notices that mixed data evaluation techniques did not receive much attention until recently, whereas the information about urban and regional planning problems very often bear a partially quantitative and a partially qualitative character. He argues that the few techniques that proved useful to evaluate mixed data evaluation sets have some disadvantages.

The first technique is the interactive goal-programming approach which demands of a decision maker to specify for each criterion desired aspiration levels. Hence, no weights as meant above are used. The disadvantage of the approach is its limit regarding the interactive communication with one single decision maker, whereas in structural retail planning several decision makers are involved with different interests and powers.

The second method, termed mixed ordinal analysis, is also highly restricted regarding the interaction with one particular decision maker. Typical for the approach is that alternatives are systematically and mutually compared, implying that the approach is only usable for a limited number of alternatives. This reduction in flexibility makes the approach less suitable in the context of urban and regional planning.

A third approach discussed by Voogd is the geometric scaling approach. The approach aims at locating (scaling) both alternatives and criteria in a multidimensional space in such a way that the distances between these locations fit as well as possible to the a priori defined rank order regarding the qualitative criteria and the a priori determined ratio scale scores regarding the quantitative criteria. Both qualitative and quantitative information is, hence, treated within an appealing theoretical structure. However, the algorithm is rather complex. Moreover, an important limitation is that the number of dimensions of the geometric space cannot be increased without setting limits to this. There is an upper-limit for the number of dimensions depending on the size of the evaluation matrix. In general a geometric scaling approach seems only effective if alternatives and criteria can be scaled in a geometric space with an upper limit of dimensions $F$: 

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\[ F < \frac{(K, Q^*)}{(K+Q)} \]  

(5.4.1.)

where

\[
\begin{align*}
F &: \text{the number of dimensions of the geometric space;} \\
K &: \text{the number of alternative plans;} \\
Q &: \text{the number of criteria;} \\
Q^* &: \text{the number of conflicting criteria.}
\end{align*}
\]

Two criteria are conflicting in case the alternatives on both criteria are ordered differently. Evidently, this requirement is not necessarily fulfilled in every mixed data evaluation problem. Consequently, these problems cannot be evaluated by this geometric scaling approach.

The disadvantages of these three methods reduce the flexibility in application. Therefore, Voogd (1983a) suggests three alternative analytical mixed data evaluation techniques that avoid such limits. The approach is elaborated as follows. Assume that \( K \) alternative plans need to be evaluated on a total set of \( Q \) evaluation criteria. The evaluation scores are arranged in a \( K \times Q \) matrix. This matrix will be denoted in this section by \( E; e^*_kq \) then denotes the evaluation score of alternative \( k \) on criterion \( q \) (\( q=1, \ldots, Q \)). The set of criteria is now divided into two subsets: one subset for the ordinal criteria and one subset for the cardinal criteria. These sets are denoted by means of \( \mathcal{O} \) and \( \mathcal{C} \) respectively: \( \mathcal{O} = \{ q | q = \text{ordinal} \} \) and \( \mathcal{C} = \{ q | q = \text{cardinal} \} \). In order to avoid confusion, note that the symbols \( E, C, Q \) and \( q \) have been used previously in chapter 4 and section 5.2 with another meaning.

Usually, the evaluation scores need to be standardized in terms of one common measurement unit in order to make the various criterion scores comparable. The most important standardization methods are:

a. a transformation of 'raw' scores into scores within a range from 0 to 1 with an additive constraint (in particular appropriate in the context of various sets of different criterion weights):

\[
\text{standardized score } e^*_kq = \frac{\text{raw score}}{\sum_{k} \text{raw scores}} = \frac{e^*_kq}{\sum_{k=1}^{K} e^*_kq} 
\]

(5.4.2)

b. a transformation of 'raw' scores into scores within a range from 0 to 1 for which holds that their ratio-scale properties are further used (very useful for standardizing an evaluation matrix that will be analysed by way of any technique which utilizes the magnitude of the individual scores):
standardized score \( e_{kq}^{*} = \frac{\text{raw score}}{\text{maximum raw score}} = \frac{e_{kq}}{\max_{k} e_{kq}} \) \hspace{1cm} (5.4.3)

c. a transformation of raw scores to scores within a range from 0 to 1 which holds that its interval-scale properties are further used (especially appropriate in case a technique is used which performs a pairwise comparison of the criterion scores):

\[
\text{standardized score } e_{kq}^{*} = \frac{\text{raw score} - \text{minimum raw score}}{\text{maximum raw score} - \text{minimum raw score}}
\]

\[
\frac{e_{kq}^{*} - \min_{k} e_{kq}^{*}}{\max_{k} e_{kq}^{*} - \min_{k} e_{kq}^{*}} \hspace{1cm} (5.4.4)
\]

Further, the standardized scores should be directed since for some criteria a higher score also indicates a worse score (for instance distance), while for others this implies a better score (for instance choice range). The directed scores are obtained by subtracting the standardized scores from 1 for those criteria the direction of which should be changed according to a specified direction (for example 'the higher, the better').

The analytic mixed data multicriteria evaluation methods then proceed as follows. The vector of weights \( W = [w_q] \) is normalized in such a way that the sum of weights equals 1. Dominance scores \( d_{kk'}^{*} \) for the ordinal criteria and dominance scores \( \delta_{kk'}^{*} \) for the cardinal criteria are calculated. These scores reflect the degree in which alternative \( k \) dominates alternative \( k' \):

\[
d_{kk'}^{*} = f_1(e_{kq}, e_{k'q}, w_q); \quad (\forall q \in \Omega)
\]

\[
\delta_{kk'}^{*} = f_2(e_{kq}, e_{k'q}, w_q); \quad (\forall q \in \Omega)
\] \hspace{1cm} (5.4.5)

Of course, in calculating the dominance scores several procedures might be followed. For instance regarding the ordinal criteria the dominance of \( k \) relative to \( k' \) might be expressed as the sum of the (quantitative, normalized) weights of those criteria for which \( k \) actually dominates \( k' \). As such only the existence of differences in values is taken into account and not the degree of difference. In calculating dominance scores for cardinal criteria, the degree of
difference might be taken into account by calculating the dominance score as the sum of the weighed differences in criterion scores for those criteria for which \( k \) dominates \( k' \). The resulting dominance scores have still different measurement units and different weights might be attached to them. Consequently, the dominance scores need to be standardized:

\[
\begin{align*}
\alpha_{kk'} &= h_1(\alpha_{kk'}) \\
\alpha_{kk'} &= h_2(\alpha_{kk'})
\end{align*}
\]

where \( h_1 \) and \( h_2 \) represent standardization functions. Several functions might be used, partly depending upon the standardization of 'raw' criteria scores to standardized criteria scores. Next, Voogd shows that when it is assumed that the weights \( w_q \) have quantitative properties, one is able to calculate the total weight \( W_0 \) of the qualitative criterion set \( O \) and similarly the total weight \( W_C \) of the quantitative criterion set \( C \), simply by summing up the weights attached to each of the criteria:

\[
\begin{align*}
W_0 &= \sum_{q \in O} w_q \\
W_C &= \sum_{q \in C}
\end{align*}
\]

Using the standardized dominance scores and overall weights for both criteria sets, an overall dominance measure \( \delta_{kk'} \) for each pair of alternatives is then calculated as follows:

\[
\delta_{kk'} = W_0 \cdot \alpha_{kk'} + W_C \cdot \alpha_{kk'}
\]

This overall dominance score gives the degree in which alternative \( k \) dominates alternative \( k' \). The set of these scores provides the basis for calculating an overall preference or appraisal score \( s_k \) for ranking the alternative plans.

Voogd suggests three mixed multicriteria evaluation methods based on this approach which differ in the way the dominance scores are calculated, the weights are defined and the calculation of the final appraisal scores. The basic principles of these methods will be outlined to illustrate these differences because not all readers will be familiar with these methods.
The first method is the *subtracted summation technique*. After the matrix E with raw criterion scores has been subdivided into two parts related to qualitative and quantitative criteria, the first step is to standardize the scores for the quantitative criteria. Since the dominance measurement concerns a pairwise comparison, Voogd suggests the third mentioned standardization procedure (5.4.4). The standardized scores have to be directed in the same way as the rankings $e_{kq} (q \neq 0)$ of the qualitative criteria.

The next step is to calculate the dominance scores for both the qualitative criteria set and the quantitative criteria set. It is important to note that very often the weights attached to the criteria are ordinal. The underlying cardinal weights of these criteria can be approximated by focusing on the extreme weight set that delimits the values the cardinal weights may have. For instance, let the weights attached to the criteria sum up to 1 and let there be 3 criteria $a$, $b$ and $c$ and $w_a \geq w_b \geq w_c$, then there are 3 ordinal levels. Consequently, there are three sets of cardinal weights that represent the extreme value of the (subsequent) criteria weights. The following extreme weight sets result:

$$W_1 = (1,0,0)$$
$$W_2 = (0.5,0.5,0)$$
$$W_3 = (0.33,0.33,0.33)$$

Each of such weight sets, denoted by the symbol $h$, can be used in the remaining of the multicriteria evaluation procedure.

The procedure proceeds by calculating the qualitative dominance measure $\alpha_{kk'h}$ for each extreme weight set $W_h$ as follows:

$$\alpha_{kk'h} = \left( \sum_{q \neq 0} (w_{qh} \cdot \text{sign}(e_{kq} - e_{k'q}))^f \right)^{1/f}$$

(5.4.9)

where $f$ denotes an arbitrary scaling parameter with any positive odd value ($1,3,5,\ldots$) because even values would distort the various signs and where

$$\text{sign}(e_{kq} - e_{k'q}) = \begin{cases} 
+ & \text{if } e_{kq} > e_{k'q} \\
0 & \text{if } e_{kq} = e_{k'q} \\
- & \text{if } e_{kq} < e_{k'q}
\end{cases}$$
This dominance score calculation rule expresses that the larger \( y \) is, the less influence the differences of the alternatives for the minor criteria will have on the value of the qualitative dominance measure \( \alpha_{kk'h}^{x} \). Voogd emphasizes that in case the criterion weights are fairly reliable, a value of 1 for parameter \( y \) might be assumed.

The quantitative dominance score for the set of quantitative criteria for each set of criterion weights are calculated in a way similar to that of the calculation of qualitative dominance scores:

\[
\alpha_{kk'h}^{x} = \left( \sum_{q \in C} (w_{qh} \cdot \text{sign}(e_{kh} - e_{k'h}))^{y} \right)^{1/y} \quad (5.4.10)
\]

In order to be consistent, the same value for the scaling parameter should be chosen as in (5.4.9).

The third step of the procedure aims at standardizing the dominance scores or in other words to equalize the dimensions of \( \alpha_{kk'h}^{x} \) and \( \alpha_{kk'h}^{*} \), in order to make the scores comparable. The following standardization measures are defined:

\[
\alpha_{kk'h}^{*} = \frac{\alpha_{kk'h}^{x}}{\left( \sum_{k} \sum_{k'} |\alpha_{kk'h}^{x}| \right)} \quad (5.4.11)
\]

\[
\alpha_{kk'h}^{*} = \frac{\alpha_{kk'h}^{x}}{\left( \sum_{k} \sum_{k'} |\alpha_{kk'h}^{x}| \right)} \quad (5.4.11)
\]

The overall dominance score is then given by means of

\[
\delta_{kk'h} = \omega_{Oh} \cdot \alpha_{kk'h}^{*} + \omega_{Ch} \cdot \alpha_{kk'h}^{*} \quad (5.4.12)
\]

The appraisal score for alternative \( k \) (\( s_{kh} \)) can now be found by assuming that the overall dominance score \( \delta_{kk'h} \) for a pair of alternative plans is equal to the difference in appraisal scores \( s_{kh} \) and \( s_{k'h} \). Consequently, \( s_{kh} \) can be found as follows:

\[
\sum_{k'=1}^{K} \delta_{kk'h} = \sum_{k'=1}^{K} (s_{kh} - s_{k'h}) \quad (5.4.13)
\]

\[
= K \cdot s_{kh} - \sum_{k'=1}^{K} s_{k'h} \quad (5.4.14)
\]

This means that \( s_{kh} \) can be expressed as:

\[
s_{kh} = \frac{1}{K} \sum_{k'=1}^{K} \delta_{kk'h} + \sum_{k'=1}^{K} s_{k'h} \quad (5.4.15)
\]
Additionally, it is assumed that the mean of the appraisal scores $s_{kh}$ is zero and consequently,

$$s_{kh} = \frac{1}{K} \sum_{k'=1}^{K} \delta_{kk'h}$$  \hspace{1cm} (5.4.16)

A second technique is the subtracted shifted interval technique. It differs from the previous technique in that the standardized dominance scores are obtained as follows:

$$\alpha_{kk'h} = \left[ \frac{\alpha_{kk'h} - \alpha_{h}}{\alpha_{h}^+ - \alpha_{h}^-} \right] - 0.5$$  \hspace{1cm} (5.4.17)
$$a_{kk'h} = \left[ \frac{a_{kk'h} - a_{h}^-}{a_{h}^- - a_{h}^+} \right] - 0.5$$

where,

- $\alpha_{h}$, $\alpha_{h}^-$ is the lowest qualitative, respectively quantitative, discrepancy score between two alternatives $k$ and $k'$ for a given extreme weight set $h$;
- $\alpha_{h}^+$, $\alpha_{h}^+$ is the highest qualitative, respectively quantitative, discrepancy score between two alternatives $k$ and $k'$ for a given extreme weight set $h$.

This standardization is nearly similar to the procedure used to standardize the raw quantitative criterion scores in the context of the previous technique, except for the substraction of 0.5. The appraisal score $s_{kh}$ for choice possibility $k$ is calculated as in the previous technique (equation 5.4.16). Hence, the subtractive summation technique and the subtractive shifted interval technique share the assumption that the overall dominance score is equal to the difference in appraisal scores.

The third proposed technique is termed the additive interval technique. This technique assumes that the functional relationship between the overall dominance score and the appraisal scores $s_{kh}$ and $s_{k'h}$ is of the following form:

$$\delta_{kk'h} = \frac{s_{kh}}{s_{kh} + s_{k'h}}$$  \hspace{1cm} (5.4.18)

which implies that
\[ \delta_{kk'h} + \delta_{k'kh} = 1 \]  \hspace{1cm} (5.4.19)

In order to arrive at overall dominance scores with this additivity characteristic the following definitions of the standardized dominance scores for the qualitative criteria (\( \alpha_{kk'h} \)) and for the quantitative criteria (\( \alpha_{k'kh} \)) are used:

\[ \begin{align*}
\alpha_{kk'h} &= \left( \alpha_{kk'h}^+ - \alpha_{kk'h}^- \right) / \left( \alpha_{h}^+ - \alpha_{h}^- \right) \\
\alpha_{k'kh} &= \left( \alpha_{k'kh}^+ - \alpha_{k'kh}^- \right) / \left( \alpha_{h}^+ - \alpha_{h}^- \right)
\end{align*} \]  \hspace{1cm} (5.4.20)

where the symbols have the same meaning as before. The dominance scores are calculated by applying equation (5.4.12). Given the functional relationship between the overall dominance score \( \delta_{kk'h} \) and the appraisal scores (equation 5.4.18), these appraisal scores can be found as follows. Equation (5.4.18) implies that

\[ s_{kh} = \delta_{kk'h} \cdot s_{kh} + \delta_{kk'h} \cdot s_{k'h} \]  \hspace{1cm} (5.4.21)

or, alternatively

\[ \frac{s_{k'h}}{s_{kh}} = \frac{1 - \delta_{kk'h}}{\delta_{kk'h}} \]  \hspace{1cm} (5.4.22)

thus

\[ \sum_{k'} s_{k'h} = \sum_{k'} \frac{1 - \delta_{kk'h}}{\delta_{kk'h}} \]  \hspace{1cm} (5.4.23)

or

\[ \frac{1}{s_{kh}} \sum_{k'} s_{k'h} = \sum_{k'} \frac{1 - \delta_{kk'h}}{\delta_{kk'h}} \]  \hspace{1cm} (5.4.24)

Assuming that the appraisal scores \( s_{k'h} \) add up to 1 and given equation (5.4.19) than equation (5.4.24) can be rewritten as follows

\[ \frac{1}{s_{kh}} = \sum_{k'} \frac{\delta_{k'kh}}{\delta_{kk'h}} \]  \hspace{1cm} (5.4.25)

or

\[ s_{kh} = 1 / \sum_{k'} \frac{\delta_{k'kh}}{\delta_{kk'h}} \]  \hspace{1cm} (5.4.26)
Now that the three approaches have been outlined, the question arises how the results of the application of a particular method have to be interpreted. If a particular metric weight set for all criteria is a priori defined, the calculated appraisal scores $s_{kh}(V_k,h)$ provide a ranking of the alternatives. Obviously, the weight set might be of great influence on the outcome, which is on the other hand in accordance with a main objective of the application of multicriteria evaluation methods: the enlightenment of the consequences of particular 'political' priorities and the importance attached to particular interests. The interpretation problem is somewhat more complex in case the weights are on an ordinal scale. Every alternative then gets as many appraisal scores as there are extreme weight sets fulfilling the ordinal criteria weight conditions.

5.5 EXPLORATION OF THE MARGINS OF RETAIL PLANNING

5.5.1 Introduction
The problem dealt with in this part of the DSS methodology is, from the point of view of conceptualization and modelling, a very difficult and in current practices of applied retail research not systematically handled problem. The problem can be summarized by the question: where do the alternatives come from that are seriously considered in the ultimate decision making in the planning group? The question refers to aspects of synthesis and creativity in planning which make it a difficult issue from the perspective of analysis. The intention in this section is to bring some order in the process of exploring the margins of retail planning. The approach is not focused on generating the 'best solution', given a number of policy aims, but rather on the elimination of hypothetical alternatives in order to limit and systematize the discussion in the planning group. It serves the following aims:
- to bring order in these discussions;
- to explicate aims of decision makers and criteria they use; and
- to improve the efficiency of further research activities with regard to decision making.

This section is structured as follows. First, the characteristics of the problem will be discussed in more detail (5.5.2). Next, an approach
will be outlined (5.5.3). Finally, the main conclusions will be summarized (5.5.4).

5.5.2 Characteristics of the problem
As has been argued in chapter 1, retail plans are basically built upon the notions: where (locations), how much (size of shopping facilities), for whom (consumer distribution) and how accessible (infrastructure, parking facilities). Each plan proposed to tackle a retail planning problem is defined in terms of these notions, since they are directly related to the interests of retailers, consumers and public agencies. More directly, these aspects are covered by using the variables of distance, floorspace (or number of shops), population distribution and parking, which have been mentioned and used previously in the context of the predictive model and the impact indicators. Building retail plans upon these notions does not imply that no other aspects can be and are actually incorporated in retail plans. The abovementioned notions, however, constitute the mainlines of retail plans and, as such, can serve as a point of departure for the DSS approach.

The current approach of defining feasible retail plans in the context of plan preparation is typically a matter of trial and error. The iterative process is based on the initial definition of a few plans and the evaluation of some assessment of their consequences. The great advantage of this approach is that it improves the awareness of the retail planning problems. The disadvantage of the current situation is, however, that this iterative process is generally not well ordered and is rather ad hoc. As noted before, in many retail planning projects the ideas about what kind of measures should be taken are basically determined by translating recognized over- and under- expenditures in shopping centres into amounts of floorspace that should be reduced or that might be added to the existing retail floorspace. This frequently creates the situation that on the basis of the outcomes of the exploration particular plans are determined by means of some simple calculation rule or by referring to some analogous context without inquiring whether other alternatives may yield equal or perhaps better results from the perspective of multiple interests. The conclusion of these considerations is that the support of the decision makers in this stage of plan preparation might be based successfully on some
iterative approach, which however should guarantee a certain systematic comprehensiveness without reducing the decision freedom of these decision makers.

An additional consideration is that the pursued support should be focused on giving a rough indication about the direction of the effects of the types of solutions regarding the planning problems, given the aim to contribute to the ultimate identification and definition of feasible alternative plans that will be subject to further detailed analyses. A scenario-based approach can be sufficiently and effective in this context. The typical feature of scenarios is the acceptance of (sometimes considerable) reductions and an extreme emphasis on a limited set of (often also extreme and mutually significantly different) variable values. Insights in the effects of these scenarios improve the awareness about the scale and directions of consequences of these emphases. The rough assessment of these consequences implies the need for using a theoretically reliable approach. On the other hand, that approach should be simple and easy to apply without having significant cost increasing effects.

Further, it has to be recognized that beforehand uncertainty exists in respect of the development of such an approach about which variables are, in a specific planning context, really manipulable and which, though hypothetically manipulable, are in fact fixed parameters. The locations of shopping facilities or the housing building program (and hence future population distribution), for example, might be exactly known. Consequently, the approach has to be flexible with respect to this type of uncertainties.

In the next section an iterative scenario evaluation and elimination approach will be suggested that can easily be dealt with in the context of the use of a computerized system for the support of retail planning.

5.5.3 A systematic approach

In Table 1 the mainlines of the approach to be outlined have been summarized in terms of a sequence of steps. It is noted beforehand that, because of the use of a predictive model and the fact that such a model has been defined for distinguished sectors \( z = 1, \ldots, Z \) of retailing, the approach should be applied for the situation of each sector separately.
Table 1: Mainlines of the scenario evaluation and elimination approach

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Determine manipulable variables</td>
</tr>
<tr>
<td>2</td>
<td>Determine scenarios for each manipulable variable</td>
</tr>
<tr>
<td>3</td>
<td>Define each possible combined scenario</td>
</tr>
<tr>
<td>4</td>
<td>Predict retail system performance for each combined scenario</td>
</tr>
<tr>
<td>5</td>
<td>Calculate selected indicators for retail system performance</td>
</tr>
<tr>
<td>6</td>
<td>Confront indicators with normative values, eliminate combined scenarios and evaluate remaining scenarios</td>
</tr>
<tr>
<td>7</td>
<td>Define feasible alternative retail plans.</td>
</tr>
</tbody>
</table>

In the first step, the abovementioned hypothetical manipulable variables are, in the specific context of the retail planning project, evaluated in terms of the degree of manipulability by means of retail planning. This might imply an inquiry within related fields of land use planning to determine the degrees of freedom for retail planning or nature of the decisions that have caused the future levels of the variables to be fixed.

The second step involves the definition of some scenarios for each of the manipulable variables. Assume manipulability in respect of the location of some shopping facilities and/or residential zones (distance), the size of the shopping centres j the planning applies to \( (j_{S_1}) \), the parking facilities in some of these shopping centres j and the size of population in some residential zones i. Evidently, the definition of such scenarios is largely a matter of discussions in the planning team on the basis of available information on the retail system.

In most retail planning situations, the locational pattern of shopping centres is fixed, even if a new shopping centre is planned. The location of such a shopping centre is generally fixed in the general land use plan for the study area. When, however, the planning question also focuses on for example whether one larger shopping centre or two smaller ones should be realized, the locational pattern need not to be fixed beforehand. This results in at least 2 different locational patterns. Alternatively, the situation might occur that
doubts exist about the realization of a new residential zone. This also might result in a few alternative locational patterns of residential zones. Locational patterns are transferred to distance measures between shopping centres and residential zones. Let $n_1$ denote the number of basically different locational scenarios, then, consequently, $n_1$ different distance matrices can be calculated. Generally, the main parts of these matrices will be similar.

As far as the sizes of the shopping centres $j$ candidate for retail planning are concerned, it is most likely that the results of the first, explorative stage of the planning process suggest the direction of a deliberate change in floorspace. Considerable over-expenditure may suggest that extra floorspace for retailing may be reconsidered, while considerable under-expenditure may suggest the reduction of floorspace. For each of the shopping centres $j$, involved in the retail planning, a few size scenarios can be defined in terms of the type of variable used as an independent variable in the predictive model. In case $x$ shopping centres are influenced by planning and for each shopping centre $y$ size or scenarios are defined, then in total $y^x$ size scenarios result. This total can be denoted by $n_2$. Evidently, $n_2$ might be large when $x$ and $y$ are large. However, in practice retail plans seldom involve more than 3 or 4 shopping centres at one time. Moreover, the number of scenarios per shopping centre can, in practice, be limited to 2 or 3. Otherwise the discriminatory effects of the scenarios are too small.

The next variable concerns the parking facilities related to the shopping centres $j$ retail planning focuses on. This variable may be used to influence retail system operations in terms of creating considerably improved circumstances for parking at a limited number of shopping centres. Hence some significantly different parking scenarios may result. The number of such scenarios, denoted by way of $n_3$, will generally be small, given that parking facilities in most shopping centres need not to be improved or cannot be improved to such a degree that basically different scenarios result.

Finally, depending upon the program for building dwellings, there might exist some variability within the size of population in distinguished residential zones. Again it should be noted that, in practice, this will only apply to a limited number of zones. The
population size in the majority of residential zones in the study area is normally fixed (except from uncertainties in normal demographic developments), because the number of dwellings will not be changed significantly. Let \( n_4 \) denote the total number of significantly different population distributions.

The third step of the procedure involves the definition of all alternative scenarios on the basis of the scenarios for each of the four variables discussed above. Depending upon by means of what variables the retail system is manipulated, this step implies the definition of the following maximum \( L \) combinations (or plans) or a subset of these (1: variable levels; 0: fixed levels):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I II III IV</td>
<td>( n_1 ) ( n_2 ) ( n_3 ) ( n_4 )</td>
</tr>
<tr>
<td>1 0 0 0</td>
<td>( n_1 )</td>
</tr>
<tr>
<td>0 1 0 0</td>
<td>( n_2 )</td>
</tr>
<tr>
<td>0 0 1 0</td>
<td>( n_3 )</td>
</tr>
<tr>
<td>0 0 0 1</td>
<td>( n_4 )</td>
</tr>
<tr>
<td>1 1 0 0</td>
<td>( n_1 \cdot n_2 )</td>
</tr>
<tr>
<td>1 0 1 0</td>
<td>( n_1 \cdot n_3 )</td>
</tr>
<tr>
<td>1 0 0 1</td>
<td>( n_1 \cdot n_4 )</td>
</tr>
<tr>
<td>0 1 1 0</td>
<td>( n_2 \cdot n_3 )</td>
</tr>
<tr>
<td>0 1 0 1</td>
<td>( n_2 \cdot n_4 )</td>
</tr>
<tr>
<td>0 0 1 1</td>
<td>( n_3 \cdot n_4 )</td>
</tr>
<tr>
<td>1 1 1 0</td>
<td>( n_1 \cdot n_2 \cdot n_3 )</td>
</tr>
<tr>
<td>1 1 0 1</td>
<td>( n_1 \cdot n_2 \cdot n_4 )</td>
</tr>
<tr>
<td>0 1 1 1</td>
<td>( n_2 \cdot n_3 \cdot n_4 )</td>
</tr>
<tr>
<td>1 0 1 1</td>
<td>( n_1 \cdot n_3 \cdot n_4 )</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>( n_1 \cdot n_2 \cdot n_3 \cdot n_4 )</td>
</tr>
</tbody>
</table>

Assume, for example, that the number of scenarios for locational patterns \( (n_1) \) equals 2; that 3 shopping centres are planning candidates and that for each of them 2 size levels have been defined \( (n_2 = 8) \); that there are 2 parking scenarios \( (n_3 = 2) \), and that also 2 population size scenarios \( (n_4 = 2) \) have been defined, in that case the retail planning context can be considered as complex, given that each of these scenarios implies a significant change with respect to the initial situation. Therefore, such a context of planning can be considered as at least reasonably complex. The present step of the approach results in this example in a total of 242 alternatives. Clearly, without any systematic support, this number of alternatives is too large to be systematically evaluated by the participants in the planning group.
without being supported by means of some computerized system.

The fourth step in the procedure involves that for each of the L combinations a prediction of the retail system performance is made for some time horizon in order to get an idea about the direction of the development of the retail system. In structural planning contexts the time horizon is generally 10 years. The end state might be chosen in order to reduce the number of data processing operations. Predictions is made by means of the predictive model that has been defined to assess the trend development and the impacts of alternative plans. Evidently, conditions for predictions not dependent upon the specific nature of the scenarios are the same for all these L combinations.

In the fifth step the predicted end states for the retail system under the L different conditions are indicated in respect of the predicted retail system's end state within the conditions of non-intervention (trend). In order to make the evaluation not necessarily complex, only a few indicators may be used. The following earlier discussed 'strong' measures of different aspects may for example be used. Note that in case of a prediction for the end state of the system, T equals 2. Further, the reader is referred to section 5.3 for the meaning of the symbols used below.

a. Equation 5.3.2:

\[ z^{c_1} = \frac{1}{M_{1,T}} \sum_{j \in S_1} \sum_{t=1}^{T} \left( \frac{z_{jt}^{O}}{z_{jt}^{I}} \right) ; \quad (\forall k,z) \]

measures the average proportional change in turnover-to-floorspace ratios in sector z as compared to the trend for the shopping centres in the plan.

b. Equation 5.3.4:

\[ z^{c_2} = \frac{1}{M_{2,T}} \sum_{j \in S_2} \sum_{t=1}^{T} \left( \frac{z_{jt}^{O}}{z_{jt}^{L}} \right) ; \quad (\forall k,z) \]

measures the average proportional change in turnover-to-floorspace ratios in sector z as compared to the trend for the shopping centres not included in the plan.

c. Equation 5.3.26:

\[ z^{c_4} = \frac{1}{T \cdot M \cdot N} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{M^*} \left( \frac{\varphi_{z,j}^{k}}{\varphi_{z,j}^{O}} \right) ; \quad (\forall k,z) \]
where,
\[
\varphi_z = \begin{cases} 
1 & (V_{ij} d_{ij}^k < D_{ij}) \\
0 & \text{otherwise}
\end{cases}
\]
measures the average proportional change in the availability of floor-space in sector \( z \) within a particular distance \( D_{ij} \) at time \( t \), as compared to the trend.

d. Equation 5.3.44:
\[
C_{z}^{k} = \frac{1}{T \cdot N \cdot M \cdot Z} \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{M} \sum_{z=1}^{Z} \left[ \frac{\{ p_{ijt}^{k} B_{it}^{k} d_{ijt}^{k} \}}{B_{it}^{k}} \right] \quad (\forall k)
\]
measures the average relative change in the per capita distance travelled within the retail system.

Clearly, apart from those four indicators, other indicators may be used as well or alternative indicators may be defined, but especially the expressive strength of the indicators and the comparability of their values predicted under \( L \) different conditions are of relevance.

The sixth step of the procedure is focused on evaluating the impacts of \( L \) conditions indicated in terms of the values of the limited set of indicators, summarized in a matrix of \( L \times Q^* \), where \( Q^* \) denotes the number of elicited indicators. On behalf of that evaluation some threshold value has to be defined for each criterion. When the attractiveness of shopping centres \((j \mid j \in S_1)\) is, for example, improved then it is likely that the turnover of the remaining shopping centres decreases, which implies a value of \( C_2 < 1.0 \). A hypothetical threshold for \( C_2 \) is, for instance, .98, which implies an average proportional shift in the turnover-to-floorspace ratio of a maximum of -2%.

Similarly, the upper threshold value for \( C_{18} \) might be 1.0, which implies that the total distance travelled should not increase as compared to the trend, etcetera.

The use of these criteria causes the elimination of a number of alternatives. The evaluation can be based on the values of separate indicators as well as on some total (un)weighed summary index value for each of the \( L \) alternatives. The definition of a weighed integrated index requires some a priori weight definition, which may be difficult in vague decision contexts. On the other hand, it means that beforehand
priorities should be explicated and, hence, different views of decision makers should be clarified. Another advantage is that the weighed integrated effects may result in some rank ordering of alternatives on the basis of the net effect. This supports the further definition of serious strategies. Clearly, it is very important for this preliminary evaluation and elimination process that the criteria values are exactly identified. Therefore, the use of a very limited number of indicators is put forward, because it avoids unnecessary complexity in such an early stage of plan preparation. Moreover, the more critical the normative values are defined the stronger the filtering and elimination process will be. The results of these operations are, in addition, discussed by the planning group and, if necessary, repeated in adjusted circumstances. Finally, this process leads in the seventh stage of the procedure to the definition of a number of feasible alternatives that will be subjected to detailed and extended impact assessments and additional discussions.

5.6 MONITORING AND EARLY WARNING

5.6.1 Introduction
In this section some options for a monitoring and an early warning approach will be discussed. This part of the retail planning DSS refers to the control over the retail system operations in respect of previous expectations about the system development on the one hand and planning objectives on the other hand. The control over the retail system's development is one stage of the continuous decision making process in the context of retail planning. This control should be simple in terms of data required but on the other hand effective with regard to decision making. In the next section, first the notions of monitoring and early warning will be clarified in short. Then, in section 5.6.3. an approach to monitoring is discussed, whereas section 5.6.4 briefly describes the idea of an early warning approach.

5.6.2 The monitoring and early warning notions
As noted in chapter 3, until the end of the seventies the regular approach in urban and regional planning could be characterized by focusing on the end state of the pursued plan and a minimum of feedback
on the efficacy of it during the implementation of planmaking. The typical attitude to the discrepancies between the developments in the planned system and those pursued by the plan was to develop a new plan without really inquiring what happened to the previous plan (are goals partially or totally met? Why is the previous plan not successful?) (Calkins, 1979). In the past decade, however, this typical feature of end state planning was criticized. As noted, there has been a gradual change to dynamic planning and more or less continuous decision making. Inherent to this change in the art of planmaking is the recognition of monitoring as an activity most valuable for planmaking (Haynes, 1974; RPD, 1977; Wedgwood-Oppenheim, Hart and Cobley, 1975; Masser, 1979).

Basically, the main task of monitoring is to review the extent to which plan objectives of system performance can be achieved (development control). Monitoring is therefore generally defined as a

Fig. 10: Components of the monitoring process (Bennett, 1978, p. 312)
continuous inquiry of the planned system after plan effectuation and
the measurement of significant deviations from the plan and/or the
underlying assumptions. The monitoring aims at supporting the ex post
evaluation of plan implementation and decision making with respect to
taking new policy measures, updating the planning framework and so on.
The basic elements of the monitoring approach are summarized in a
scheme suggested by Bennett (1978) (Figure 10).

An effective connection of monitoring to the plan preparation
demands for the inclusion of basic elements of the monitoring system
into the preparation of the plan, and reversely, so as to base at least
partially the monitoring approach on the elements that are used in the
plan preparation (compare Calkins, 1979; Van Meyel, 1979). Particularly
in the United Kingdom monitoring has become a tradition within urban
and regional planning. In the Netherlands monitoring has become a more
regular issue since the end of the seventies (compare e.g. Postma-Van
Dijck et al, 1977; Slob 1978; Van Gestel and Klaassen, 1980; Van der
Meulen and Overduin, 1980; Voogd, 1980).

Monitoring as described above is typically concerned with the
actual performances of the system planned. In contrast, among others
Floyd (1978) argues that it is often more interesting to look forward
and to explore possible future system developments as compared to the
planning aims. This preventive approach is termed early warning. The
value of early warning lies in a more timely response by decision
makers to the expected deviations between the retail system development
and the defined targets.

In the context of retail planning neither monitoring nor early
warning are aspects of common practices. Only in recent years attempts
are known to develop data banks containing data about the supply-side
of the retail system. Generally, data on the location of shops, their
owners, the floorspace, the number of employees, etcetera, are stored.
This is a valuable development, but it is not sufficient for
considering it to be a part of the retail planning DSS. Additional
data-processing operations are required for the production of the
information required. In the next two sections an approach will be
outlined briefly. In that context, Figure 11 summarizes the basic idea
of monitoring and early warning. The meaning of this Figure will be
explained in the next sections.
Updated assessment of the trend development, given observations for $t_0 - t_T$, predicted at $t_n$.

$F_3'$: observed development of the system in period $t_0 - t_n$.

$F_3''$: predicted development of the system for period $t_n - t_T$, predicted at $t_n$.

$F_2$: development of the system after effectuation of $k$, predicted at $t_0$.

$F_1$: pursued development of the system.

$t_0$: effectuation plan $k$.

$t_n$: moment of monitoring.
5.6.3 Monitoring approach

The typical aim of monitoring is to evaluate the real-world effects of plan implementation from the perspective of expectations and norms or goals. Assume that retail plan $k$ has been implemented in the retail system at time $t_0$. The expected effects of the implementation have been calculated at $t_0$ by applying an impact assessment model, for example of the type discussed in section 5.2. Aggregate choice patterns of consumers and expenditure flows as well as turnover and autonomous changes have been predicted for a number of moments during the period $t_0-t_T$. The effects expected ($F_2$ in Figure 11) are indicated in terms of the impact indicators discussed in section 5.3. The values of these indicators basically express the average proportional shift in the development of the represented aspect of the retail system performances as compared to the expected, hypothetical, trend development ($F_4$ in Figure 11). Since $t_0-t_T$ can be subdivided into a number of $n$ segments ($n=0,1,2,\ldots,T$), for each indicator, denoted by $q$ ($q=1,\ldots,Q$) a value $e_{qT_n}^k$ can be calculated for each moment $t_n$ expressing the average proportional shift in the development of the represented aspect with regard to the trend expected over the time period $t_0-t_n$. For example, $e_{qT_n}^k$ can be calculated for each year of a decade.

Consequently, for each moment $t_n$ a vector $E_{E_n}^k$ with $Q$ values can be constructed, which can serve as a base for the ex post evaluation of plan $k$. $E_{E_n}^k$ then represents the expected and accepted retail system performance at moment $t_n$, quantified as a ratio with regard to the predicted trend. This does not necessarily imply that the goals of the decision makers with respect to the values of the indicators are equivalent to the values of $E_{E_n}^k$. There might exist some difference ($F_4$ in Figure 11). Therefore, if possible, a vector of normative indicator values for moment $t_n$, denoted by $O_{E_n}^k$, should be defined for $t_n$ in order to serve the evaluation of the retail system performance of time $t_n$. The construction of $O_{E_n}^k$ might be a rather difficult task. The explicit quantification of normative indicator values as pursued by the decision makers in the planning group might be problematic as a consequence of a lack of sufficient explicitness, general qualitative goal definitions, fuzziness in dealing with future uncertainties and so on. If the researcher is not able to explicate all the values of $O_{E_n}^k$, the corresponding value of $E_{E_n}^k$ can serve as an approximation.
The next step in the ex post evaluation concerns the provision of data regarding (a) the conditions of retail system's operations and (b) the real-world development of the retail system. These data are necessary for the answering of two questions. The first one is: does the evolution in the conditions of retailing, such as population distribution, distance, the spending power of individuals, etcetera, agree with the assumptions regarding these variables at $t_0$? These assumptions underlie the simulation of the retail system performance ($F_4$ and $F_2$ in Figure 11) and, consequently, influence the values of $E_{\text{in}}$. The second question is: how does the retail system operate during the period the prediction is made for? The answer to this question implies whether or not the pursued effects have been effectuated. Generally, the more data are collected and the greater the variety in those data, the better the researcher will be able to answer both questions in a reliable way. However, more data generally increase the cost level of research. Therefore, a trade-off between costs of data collection and effectiveness of collected data to serve the aim of monitoring has to be considered. The consequence might be that only a subset of $Q^*$ ($Q^*<Q$) indicators that require a minimum of data will be considered in the ex post evaluation of the plan effectuation.

Given data about the evolution of the conditions of retailing in the period $t_0$ to $t_T$, one has to evaluate whether or not that development corresponds to the assumptions regarding these conditions made for time $t_T$. This requires a comparison between expectations and observations. If the conclusion is that significant differences have occurred, then the hypothetical trend development predicted at $t_0$ ($F_4$ in Figure 11) can no longer serve as a base for the quantification of the observed development of the retail system (indicated by $F_3'$ in Figure 11) at $t_n$ in terms of the $Q^*$ indicators. Such a trend would not have taken place in case the retail system would not have been influenced by means of planning and the assumptions regarding the conditions for the trend would in fact have been different from the assumptions that were actually made at $t_0$. Hence, a valid quantification of the observed development in terms of the $Q^*$ indicators and the evaluation of the real effects of plan $k$ has to be based on an updated prediction of the hypothetical trend development. This prediction is made by applying the expenditure distribution model using updates of the variables denoting the conditions in retailing.
in the time period the predictions apply to (F_5 in Figure 1).

In addition, the observed developments in the operation of the retail system, given the effectuation of plan k at time t_0, are quantified for the period t_0-t_n in terms of values of impact indicators in respect of the updated trend prediction. As noted, the choice of the impact indicators depends on the variety of data and the observations during the time period t_0-t_n. The least cost demanding type of data-collection is the measurement of aspects of the supply-side, like the number and locations of shops, the amount of floorspace for several main sectors of retailing, the parking facilities, the number of employees, and so on. Such data on the supply-side are currently often collected by various local agencies for retailing or by public agencies. If necessary, such data can be made anonymous by means of aggregation on the level of the shopping centres and made accessible for monitoring purposes. If only this type of data has been collected, the subset of indicators suggested in Table 2a might be used for the ex post evaluation. This is a subset of the indicators discussed in section 5.3 and the reader is referred to that section for detailed descriptions. Basically, the ex post evaluation focuses on aspects of attractiveness of shopping centres, measured in terms of attributes of these shopping centres, aspects of availability of shops and accessibility to shops and aspects of land occupation. Hence, no clear insight is given in the economic dimensions of the retail system operations.

There are at least two options for the extension of the monitoring information with on the economic dimension. The first option is the use of the expenditure distribution model to predict the economic operation of the retail system. In case the conditions of retailing have developed as has been assumed for the period t_0 to t_n and, consequently, assumptions regarding these conditions need not to be changed, the impact assessment for plan k at t_n results in the vector E_{t_n}^k. Hence, there is little sense in taking this step when no further data are collected about real expenditure flows, turnover and so on, in order to check these predictions. In contrast, in case the conditional variables have developed differently from the assumptions, the updated prediction of the economic operation of the retail system makes sense, as it results in an updated vector E_{t_n}^{k*} with indicator
Table 2: Indicators for monitoring and early warning

a. Excluding the economic operation:
- average shift in attractiveness of shopping centres
- average shift in accessibility to shopping centres
- average shift in familiarity with shopping centres
- average shift in the trade-off between attractiveness of shopping centres and the distance to be travelled
- average shift in the average land occupation by shopping facilities

b. Including the economic operation:
- average shift in turnover-to-floorspace ratios
- average number of times turnover-to-floorspace ratio lower than the trend turnover-to-floorspace ratio
- average number of times turnover-to-floorspace ratio lower than the normative turnover-to-floorspace ratio
- average shift in sales to consumers within a predefined distance
- average shift in shortest distance turnover proportion
- average shift in subjective evaluation of shopping centres
- average shift in nearest centre expenditure proportion
- average shift in average distance travelled

values. In addition, \( E_{tn}^{k*} \) can be compared to \( E_{tn}^k \) and \( \sigma_{tn}^k \). The disadvantage of this approach is that no check is provided to the reliability of the predictions. Therefore, the second option is to collect at time \( t_n \) data about the consumer patronage of the shopping centres in the area and to translate these insights into measures of the economic operation of these shopping centres. This data collection activity is generally quite cost demanding and therefore, in practice, it will be limited to a procedure which takes place only once in 4 to 5 years. On the other hand, it should be recognized that monitoring is rather aggregate in nature and, consequently, the measurement of the consumer patronage of shopping centres merely focuses on updating choice probabilities for the shopping centres. This measurement of spatial choice patterns implies that no additional data regarding individual perception, evaluation and preferences necessarily need to be collected. Consequently, the consumer questionnaire can be quite straightforward. Respondents are asked where they shop, how frequently, what transport mode they use and how much they spend at each visit to the patronaged shopping centres. Borchert, Doorn and Floor (1984), for example, suggest a computer assistant telephone-based consumer questionnaire which has the advantage of reducing costs considerably.
and increasing speed in data-processing.

Once insights have been gained in the consumer patronage of shopping centres in the study area at t₀, the turnover and turnover-to-floorspace ratios in shopping centres can be calculated. Given that this type of data is additional to the earlier discussed data regarding the supply-side, additional indicators, such as suggested in Table 2b, can be used in the evaluation to express the retail system performance in terms of economic dimensions. Like the set of indicators in Table 2a, the indicators in Table 2b have been discussed in detail in section 5.3. Again, readers are referred to that particular section for the details. Basically, the indicators include aspects of choice proportions, turnover and turnover-to-floorspace ratios. In the context of calculating the values of these indicators it should be recognized that since the consumer patronage of shopping centres is not continuously measured, the average shift should not be calculated with regard to all n moments, but rather should be calculated with regard to a limited number of segments. Assuming that between t₀ and tₙ no such data have been collected, this implies 2 points of measurement: t₀ and tₙ. Note that for more continuously measured data (like those regarding the supply-side), the number of points might be larger. Evidently, the calculation of the values of Eₙ and Oₙ that serve as a basis for evaluation have to be adapted to the data collected on indicators included in order to make a valid evaluation possible.

The evaluation of the retail system performance at tₙ is based on the comparison of the vectors Eₙ (the predicted development of the retail system), Oₙ (the pursued development of the retail system) and a vector including values that express the development observed in the retail system, denoted as Eₙ. Basically, the comparison can, for instance, be quantified in terms of percentages of difference in value, where Oₙ (or the approximate Eₙ) serves as a base. These percentages can be compared to normative percentages for deviation, for example adjusted to assessments of standard deviations in the values of the indicator, to determine the significance of real-world discrepancies in relation to pursued and/or expected processes.

The evaluation of retail system performance from the perspective of expectations and/or aims can cause the decision makers to take new,
additional, measures to influence the system operations. Evidently, this is primarily a political decision. Alternatively, the evaluation may lead to the collection of additional data. Finally, the evaluation may bring about a redefinition of the expenditure distribution model to improve its predictive value. This in turn might have implications for the data required and collected.

5.6.4 Early warning approach
Two situations can be distinguished in the context of an early warning approach. The first one is the situation that no plans have been implemented (yet) and/or that no expectations about the evolution of the retail system have been formulated. In that case early warning aims at predicting the future (trend) development of the retail system at moment $t_n$ for the period $t_{n+1}$ to $t_T$. The second situation is a follow up of the monitoring of an effectuated plan. In that case, early warning aims at making predictions at time $t_n$ of the development of the retail system during period $t_{n+1}$ to $t_T$, using updated assumptions on the conditions of retailing. Where, in that context, the predictions made at time $t_0$ have been translated into values of a number of indicators, summarized by the vectors $E_1^k, E_2^k, \ldots, E_n^k, \ldots, E_T^k$, early warning at moment at time $t_n$ results in an update of $E_{n+1}^k$ to $E_T^k$.

Early warning requires the use of some model to predict the future operations of the retail system. In respect of the first abovementioned situation several models can serve this aim, given that no model is available specifically specified for the study area. The choice of a model then largely depends on the availability of models, data and budget for research. For example, a multiattribute preference model for consumer choices might be defined based on preference functions measured elsewhere. Alternatively, conditional extrapolations could be made. Clearly, such applications require additional research on indicated problems and developments in terms of additional data collection and analyses, so as to test the reliability of the findings. In respect of the second point of departure, the model that has specifically been defined for the study area can be used for predictions for $t_{n+1}$ to $t_T$. The predictions are expressed in terms of relevant indicators. Again, the indicators elaborated in section 5.3 can be used for this purpose. More precisely, they express the values
of \( F_3 \) (Figure 11) as a ratio to the values of \( F_5 \) (Figure 11), resulting in a series of vectors denoted by \( \mathbf{E}_{nT}^* \) to \( \mathbf{E}_{T}^* \) containing predicted values of the indicators of future retail system performances. These values can be compared to \( \mathbf{E}_{n}^t \) to \( \mathbf{E}_{T}^t \) and \( \mathbf{0}_{n}^t \) to \( \mathbf{0}_{T}^t \) to distinguish similarities and discrepancies in the same way as mentioned in the context of monitoring. Alternatively, one might consider the situation of moment \( t_n \) as a completely new one implying that the indicators have to be used merely to express the predicted trend development for \( t_n \) to \( t_T \). Consequently, they have to be defined in absolute terms and not as a ratio to some hypothetical trend. Hence, in that case the vector for each time contains absolute values. Evidently this means that the pursued development should also be indicated in absolute values to make a valid comparison possible.

5.7 CONCLUSIONS
This chapter focused on elaborating options for methods, techniques and approaches to be included in the retail planning DSS. Section 5.2 focused on the performance of descriptive analyses on the retail system. Basically, these analyses involve two foci: (a) the description of the current performance of the retail system and (b) the prediction of the most likely future trend development of the retail system. In respect of the first issue, it was argued that the number of types of descriptive analyses is large and dependent upon the conditions of the research project. Moreover, the larger part of this kind of analysis is common practice in currently applied retail research. This particularly applies to the systematic description of the nature of retail facilities. Therefore, minor attention has been paid to this subject. The consequence of the elaborated retail planning-orientated theory is that attention should more systematically be paid to the perception of retail facilities by consumers as well as by retailers. In respect of the second issue, detailed attention has been paid to options for the definition of an expenditure distribution model and a retailer reactive behaviour model. These models are, in conjunction, in this stage of the planning process applied for the prediction of future retail system performances. With respect to the expenditure distribution model, first attention was paid to the use of a model for predicting information fields of consumers on an aggregate level.
Next, options for the specification of (de)compositional multiattribute preference models were presented. Related issues of measurement, model specifications and model estimation were discussed. In addition, the (dis-)advantages of these models were compared to discrete models that have been accepted in applied retail research. This was followed by the specification of a pragmatic retailer reactive behaviour model. Moreover, some options for a more sophisticated approach of aspects of that model were discussed.

The elaboration of a DSS-methodology for the assessment of impacts of alternative retail plans involves (a) the definition of a model for predicting retail system dynamics and (b) the definition of indicators for quantifying the impacts in a meaningful way for supporting the decision makers. The first aspect has been discussed in the section 5.2. The second aspect has been elaborated in section 5.3. According to the theory, attention was paid to retailer-, consumer and public interests and a number of indices quantifying these interests suggested. This set should, however, not be considered as limiting. Other indices might be developed as well. Typical for the suggested indices is their direct link to the cognitive-behavioural model(s) for simulating retailing system performances. This implies that any extension of the model used (data, variables) can bring about new related indices.

In section 5.4 some options for multicriteria evaluation techniques were described. These models are incorporated in the retail planning DSS especially for the ex ante evaluation of the impacts of alternative retail plans. The assumption underlying this elaboration is that retail planning generally deals with so-called mixed data sets. In particular three models, suggested by Voogd, to evaluate such data sets were memorized: the substractive summation model, the substractive shifted interval model and the additive interval model. The application of these models is aimed at arriving at a rank ordering of the retail plans studied given different sets of weights attached to the evaluation criteria.

In section 5.5 a procedure was suggested for supporting the exploration of the margins of retail planning aimed at solving identified retail planning problems. The data-processing operations associated with the procedure use the definition of scenario values...
for each independent variable as the input while the filtered and rank ordered effect matrix constitute the output. Clearly, the procedure is not basically different from current practices as far as it concerns the dimensions of trial, impact assessment, evaluation and selection. However, the present procedure provides a clearly more systematic approach and explicates the subsequent steps. Moreover, the procedure can be computerized. It improves the awareness of decision makers of their decision task in this stage of plan preparation and the direction of the consequences of the choices made.

Finally, section 5.6 paid attention to an approach for monitoring and early warning to support decision making in retail planning. Both research activities involve the evaluation of developments of the retail system. Monitoring deals with observed developments, primarily after plan effectuation as compared to planning aims. The essence of early warning is the prediction and evaluation of future developments. The evaluation is focused on recognizing deviations from pursued retail system developments. Three aspects are of relevance in the context of both approaches: (a) an effective collection of data with regard to the real-world retail system performance and the evolution of the conditions of retailing, (b) the application of an expenditure distribution model and (c) the quantification of observed and predicted performances by indicators. Considerations with regard to these aspects have led to the following conclusions. First, the previously elaborated simulation model and set of indicators can serve as operational tools in the context of monitoring and early warning. Secondly, the subset of indicators actually used depends upon the nature of available data. Thirdly, the question what data should be collected should be answered from the perspective of the trade-off between costs and effectiveness for decision making. Finally, it has become clear that the approach of monitoring and early warning is dependent upon their planning contexts (yes or no plan implementation, the moment of evaluation, the dynamics observed and/or expected, the data collected and/or accessible, etcetera).
6.1 Introduction
In this chapter the retail planning DSS elaborated in the preceding chapters will be partly illustrated in the context of a case study. The monitoring aspect is not illustrated because of a lack of necessary data; the exploration of planning space is not illustrated because the approach in the planning situation the case study refers to is accepted. Nevertheless, sufficient insights are given in the meaning of the DSS for the support of strategic retail planning. In particular, attention is paid to the description of the initial retail system performance, impact analysis and ex ante evaluation of alternative retail plans. The chapter is structured as follows. In section 6.2 the context of the case will be described. Next, in section 6.3, some results of the exploration of the retail system at the year of departure (1980) will be presented. Section 6.4 discusses the expected trend development. Section 6.5 presents the alternative retail plans as available in 1980. Section 6.6 presents the result of the impact analysis and section 6.7 the application of the multicriteria evaluation analysis. Finally, in section 6.8 the main conclusions of this chapter are summarized.

6.2 Context
The case study has been applied in the region of Maastricht. This medium-sized town is located in the very south of the Netherlands, near to the boarders of Belgium and Germany (Figure 12). The region of Maastricht counted 150,538 inhabitants January 1, 1980; 109,273 of whom lived in the town of Maastricht and the rest in adjacent municipalities. In 1979, the municipal authorities of Maastricht decided to develop a spatial structure plan for the City District of Maastricht. According to the legal prescriptions for the preparation of structure plans attention had to be paid to the future retailing structure. Because of these prescription and the experience of particular problems in the current operation of the retail system
Figure 12: Location of the study area in the Netherlands
the authorities decided to develop a special retail plan for the central area of Maastricht that could later be integrated with plans on other fields of urban planning into the spatial structure plan for the municipality of Maastricht. Applied retail research was considered necessary to support retail planning.

The more specific aim of applied retail research was to produce insights in the present and future operations of the retail facilities in the city of Maastricht as well as the facilities in the suburbs and the municipalities in the region of Maastricht (PARTNERS, 1982). Evidently, the latter part of the research aim stems from the fact that there exists a clear relationship between the service function of the retail facilities in Maastricht and those in the surrounding municipalities. The other boundaries were determined on the basis of the results of previous sub-provincial projects for retail planning. Within the region 38 mutually exclusive shopping centres were identified: 27 within the municipality of Maastricht and 11 in adjacent municipalities (Figure 13).
The aim of the research project implied at least the following information production activities:

I explorative description of the current situation within the retail system to find out whether or not problems in the operation of the retail system exist and what the nature of these problems is;

II a forecast of the trend-development of the retail system.

Further research had to focus on

III the definition of retail plans;

IV the assessment of the likely impacts of the alternative plans;

V a systematic evaluation ex ante of these plans.

The main data sources to be used in this case study are:

a. an exploration of the retail facilities in the study area in 1980;

b. a consumer questionnaire among 724 households in the region of Maastricht in January 1981.

Additionally, some findings are used of

c. a consumer questionnaire among 194 households in the municipality of Eindhoven in summer 1980;

d. a retailer questionnaire among 141 retailers in Eindhoven in summer 1984.

Details about these data-sets will be provided later.

6.3 Explorative description of the current operation of the retail system in the Maastricht region

Relationship with the DSS

The first stage of the decision process model that underlies the DSS concerns the explorative analysis of the retail system. This section presents information on current aspects of the retail system in the region of Maastricht.

<table>
<thead>
<tr>
<th>Exploration (6.3 &amp; 6.4)</th>
<th>Retail Plans (6.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Assessments (6.6)</td>
<td>Multicriteria Evaluation (6.7)</td>
</tr>
</tbody>
</table>

The exploration of the supply-side, the shopping centres, focused on the floorspace per branch, the number of units per branch, the branch mix and the evaluation of choice range, price, atmosphere and parking facilities by consumers. Results of the exploration are summarized in Table 3. A distinction is made between two branches: daily goods and...
non-daily goods, a distinction which is quite common in applied retail research and in the context of data collection about retail systems. The values for price, atmosphere and parking are deduced from the subjective evaluations of these attributes of the respondents of the 1981 consumer questionnaire assuming that in general the differences in subjective evaluation of levels of attributes express the objective differences in levels satisfactorily. The choice for this approach had to be made because objective measurements with regard to these aspects were not available.

There exists empirical evidence that subjective evaluations of the levels of attributes of shopping centres like price, choice range and parking facilities are functionally related to their objective counterparts, in such a way that the evaluations are monotone in anticipated directions with the objective measurements. For instance, in the context of the study among consumers in Eindhoven, the Spearman's rank correlation $R_s$ for the relationship between the average subjective evaluation across 102 respondents of the price level for the section of daily goods in 13 shopping centres and the objective measurement of the price levels for a large list of representative daily goods in those shopping centres, was calculated. $R_s$ appeared to have a value of -0.86, which indicates a strong negative relationship. Evidently, the negative value stems from the fact that the evaluation value decreases when the price level increases. Similar measurements for the choice range of daily goods and non-daily goods resulted in the $R_s$-values of 0.85 and 0.94 respectively, whereas the measurements for parking facilities resulted in a $R_s$-value of 0.91 (compare Timmermans and Van der Heijden, 1983).

In the consumer questionnaire of Maastricht respondents were asked to evaluate subjectively the price, choice range and parking facilities of the shopping centres on a 0-100 mm evaluation scale, varying from very bad to excellent. Further they were asked to express their wishes with regard to each shopping centre and the disadvantages of each alternative freely. The subjective evaluations are indicated in the table by means of a value between the extreme values 1.0 and 3.0. For price the value 1.0 indicates an extremely low price level while 3.0 indicates an extremely high price level. Similarly, 1.0 for atmosphere indicates an extremely bad atmosphere while 3.0 indicates
Table 3: Inventory of shopping centres in the region of Maastricht

<table>
<thead>
<tr>
<th>Shopping centre</th>
<th>floorspace in m²</th>
<th>number of branches</th>
<th>level of functional hierarchy</th>
<th>index for price atmosphere parking</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 City</td>
<td>13323</td>
<td>57</td>
<td>5</td>
<td>1.9 3.0 1.0</td>
</tr>
<tr>
<td>2 Oud-Wyck</td>
<td>4801</td>
<td>48</td>
<td>4</td>
<td>1.9 2.8 1.8</td>
</tr>
<tr>
<td>3 Brusselse Poort</td>
<td>12233</td>
<td>29</td>
<td>4</td>
<td>1.8 2.5 3.0</td>
</tr>
<tr>
<td>4 Mariaberg</td>
<td>3916</td>
<td>26</td>
<td>4</td>
<td>1.9 2.4 3.0</td>
</tr>
<tr>
<td>5 Belfort</td>
<td>1679</td>
<td>8</td>
<td>2</td>
<td>1.8 2.2 3.0</td>
</tr>
<tr>
<td>6 Pottenberg</td>
<td>853</td>
<td>9</td>
<td>2</td>
<td>1.8 2.3 3.0</td>
</tr>
<tr>
<td>7 Malpertuis</td>
<td>859</td>
<td>19</td>
<td>2</td>
<td>1.7 2.4 3.0</td>
</tr>
<tr>
<td>8 Caberg</td>
<td>1821</td>
<td>16</td>
<td>2</td>
<td>1.5 2.1 3.0</td>
</tr>
<tr>
<td>9 Malberg</td>
<td>1911</td>
<td>12</td>
<td>2</td>
<td>1.7 2.4 3.0</td>
</tr>
<tr>
<td>10 Daalhof</td>
<td>915</td>
<td>13</td>
<td>3</td>
<td>1.8 2.4 3.0</td>
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<tr>
<td>11 Wyckerpoort</td>
<td>870</td>
<td>11</td>
<td>2</td>
<td>1.7 2.5 3.0</td>
</tr>
<tr>
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<td>1118</td>
<td>8</td>
<td>3</td>
<td>1.8 2.5 3.0</td>
</tr>
<tr>
<td>13 Oostermaas</td>
<td>5408</td>
<td>29</td>
<td>4</td>
<td>2.0 2.1 2.6</td>
</tr>
<tr>
<td>14 Nazareth</td>
<td>1662</td>
<td>22</td>
<td>3</td>
<td>1.8 2.2 3.0</td>
</tr>
<tr>
<td>15 Limmel</td>
<td>642</td>
<td>8</td>
<td>1</td>
<td>1.8 2.2 3.0</td>
</tr>
<tr>
<td>16 Scharn</td>
<td>1347</td>
<td>23</td>
<td>3</td>
<td>2.0 2.0 2.9</td>
</tr>
<tr>
<td>17 Amby</td>
<td>1927</td>
<td>13</td>
<td>3</td>
<td>2.2 1.8 2.8</td>
</tr>
<tr>
<td>18 Villapark</td>
<td>1577</td>
<td>17</td>
<td>3</td>
<td>1.8 2.3 3.0</td>
</tr>
<tr>
<td>19 Jekerdaal</td>
<td>287</td>
<td>9</td>
<td>1</td>
<td>1.7 2.3 3.0</td>
</tr>
<tr>
<td>20 Biesland</td>
<td>1931</td>
<td>13</td>
<td>3</td>
<td>1.9 2.4 2.8</td>
</tr>
<tr>
<td>21 Campagne</td>
<td>315</td>
<td>2</td>
<td>1</td>
<td>2.0 1.6 3.0</td>
</tr>
<tr>
<td>22 Wolder</td>
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<tr>
<td>23 Heugem</td>
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<td>4</td>
<td>1.9 2.2 2.7</td>
</tr>
<tr>
<td>25 De Heeg</td>
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<td>7</td>
<td>2</td>
<td>1.8 2.0 3.0</td>
</tr>
<tr>
<td>26 Borgharen</td>
<td>514</td>
<td>10</td>
<td>2</td>
<td>1.8 2.3 3.0</td>
</tr>
<tr>
<td>27 Itteren</td>
<td>349</td>
<td>3</td>
<td>2</td>
<td>1.8 2.2 3.0</td>
</tr>
<tr>
<td>28 Bunde</td>
<td>1877</td>
<td>19</td>
<td>2</td>
<td>2.2 1.8 3.0</td>
</tr>
<tr>
<td>29 Berg &amp; Terblijt</td>
<td>1547</td>
<td>15</td>
<td>2</td>
<td>2.0 1.9 3.0</td>
</tr>
<tr>
<td>30 Cadier</td>
<td>2699</td>
<td>12</td>
<td>3</td>
<td>2.2 1.7 2.6</td>
</tr>
<tr>
<td>31 Eijsden</td>
<td>2833</td>
<td>23</td>
<td>4</td>
<td>2.2 1.8 2.7</td>
</tr>
<tr>
<td>32 Gronsveld</td>
<td>1136</td>
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<td>2.2 1.8 2.7</td>
</tr>
<tr>
<td>33 Margraten</td>
<td>1085</td>
<td>12</td>
<td>2</td>
<td>2.0 2.1 2.9</td>
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<tr>
<td>34 Meerssen</td>
<td>2824</td>
<td>39</td>
<td>4</td>
<td>2.1 1.9 2.6</td>
</tr>
<tr>
<td>35 Mheer</td>
<td>140</td>
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<td>1</td>
<td>2.3 1.6 2.7</td>
</tr>
<tr>
<td>36 St.Geertruid</td>
<td>352</td>
<td>7</td>
<td>2</td>
<td>2.0 1.9 3.0</td>
</tr>
<tr>
<td>37 Noorbeek</td>
<td>553</td>
<td>5</td>
<td>1</td>
<td>2.0 1.6 3.0</td>
</tr>
<tr>
<td>38 Slenaken</td>
<td>145</td>
<td>4</td>
<td>1</td>
<td>2.2 1.7 2.9</td>
</tr>
</tbody>
</table>
an excellent atmosphere. The value 1.0 and 3.0 for parking are interpretable respectively as extremely bad and good.

The table indicates that the main shopping centre, the city of Maastricht, generally scores best as far as the 'atmosphere' is concerned. In contrast, the score for parking facilities is lowest for the city, which is caused by the fact that the shopping area is congruent with the mediaeval centre of the city. The atmosphere in the shopping centres in the villages in the adjacent municipalities (indicated by the numbers 26 to 38) is generally judged less favourable in respect of the judgement of atmosphere in the shopping centres in the suburban areas of Maastricht. This is the same for 'price' and parking facilities. Evidently, many differences among the shopping centres in the Maastricht region exist.

The determination of the level of each shopping centre in the context of a functional classification is based on the size of the shopping centre, the branch mix and the choice range. Therefore, the number of units for 70 branches, the number of employees, the total floorspace, the net floorspace and the number of functions for each shopping centre were identified. The classification, based on 74 variables, was executed by means of the hierarchical-agglomeration method (PARTNERS, 1982, p. 26/27). Level 1 indicates an incomplete local functional level; level 2 a complete local level; level 3 an incomplete sub-regional level; level 4 a complete regional level and level 5 a supra-regional functional level.

Apart from the abovementioned features of the 38 shopping centres one is interested in the operation of these facilities with respect to consumer shopping behaviour. This particularly implies that insight is gained in their patronage of the shopping centres and the turnover in shopping centre for each branch group. Therefore, in the consumer questionnaire respondents were asked to indicate how frequently and where they usually buy daily and non daily goods. These data were used to construct an origin-destination matrix for daily and non-daily goods, expressing the proportion of the total spending of the population of each origin zone in each of the 38 shopping centres. Hence, it was necessary to distinguish a number of origin zones, representing clusters of respondents. Within the Maastricht region 21 residential zones were identified (Figure 14). This identification is
Based on the relative spatial homogeneity of each zone. Information was available about the size of the population and the average income level for each residential zone. The construction of the origin-destination matrix of proportional expenditure flows, the observed expenditures of respondents belonging to one of the residential zones were assumed to be generalizable in relation to the whole population of that zone. Part of the total expenditure of each residential area is not allocated to one of the 38 shopping centres in the Maastricht region but is allocated external to these shopping centres. This external expenditure was measured as well and summarized in a dummy category. The resulting overview of expenditures in 1980 is summarized in Table 4.

The calculations for each residential zone in Table 4 are based on:

a. a mean spending power per capita of Dfl. 2489 for 1980 for daily goods and Dfl. 3019 for 1980 for non-daily goods;

b. an expenditure correction index per residential zone, based on observed mean incomes for inhabitants of each zone.
Table 4: Expenditures in the residential zones in the region of Maastricht, 1980

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<tr>
<th>Residential zone</th>
<th>inhabitants 1.1.1980</th>
<th>expenditure daily goods</th>
<th>expenditure non-daily goods</th>
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<td></td>
<td></td>
<td>in region abs.*</td>
<td>prop. of total expenditure</td>
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<td>8.63</td>
<td>.98</td>
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<tr>
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<td>31.56</td>
<td>.94</td>
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<tr>
<td>zone 4</td>
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<td>15.64</td>
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<tr>
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<td>9.04</td>
<td>.80</td>
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<td>82.73</td>
<td>.94</td>
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<td>17.102</td>
<td>42.52</td>
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(*absolute expenditures: x 1,000,000 Dfl.)
Table 4 shows that 2/3 of all inhabitants in the region of Maastricht live in the municipality of Maastricht. As can be expected these people spend more of their total spending power in the shopping centres in the region, in the context of buying both daily goods and non-daily goods, than inhabitants of the remaining municipalities do. Overall, the proportion expenditures in the shopping centres in the Maastricht region for non-daily goods is higher than for daily goods.

The expenditure by people living in the Maastricht region with regard to the 38 shopping centres is distributed over these centres according to the observed proportions, standardized such that they sum up to 1, resulting in the calculation of turnover per shopping centre. Since the whole region however fulfills a strong recreational function, the extra turnover that is the result of this function should be added to the expenditures in the shopping centres by the inhabitants of the Maastricht region. On the basis of previous research an extra expenditure of a total amount of Dfl. 100.2 million for the daily goods and Dfl. 148.2 million for the sector non-daily goods has been calculated for 1980 (PARTNERS, 1982, p. 49-50). However, no data were available about the distribution of these amounts of money over the 38 retailing zones. The recreational expenditure was therefore distributed over these centres according to the centre's proportion of the total expenditure for each branch by the inhabitants of the Maastricht region. The resulting turnover for each shopping centre is summarized in Table 5 and 6. Also, in Table 5 and 6 this turnover is transferred into turnover-to-floorspace ratio, that are additionally compared to centre-specific normative turnover-to-floorspace ratio. This norm is based on yearly published figures about the nationally realized turnover for a great number of branches. As such, each shopping centre which has a specific branch mix and various amounts of floorspace for these branches, has an own specific normative turnover-to-floorspace ratio. As noted before, the use of this evaluation criterion is not without problems. Specific factors like age of shops, sales formula, cost structure and so on that might also influence the normative turnover-to-floorspace ratio, are not included. Evidently, the larger a shopping centre, the more likely it is that the general norm approaches the real normative turnover-to-floorspace for that centre. Still, the use of these norms as evaluation criteria might be useful.
<table>
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<tr>
<th>Centre</th>
<th>Turnover (x Dfl. 1 milion)</th>
<th>Turnover-to-floorspace ratios observed</th>
<th>Turnover-to-floorspace ratios normative</th>
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Region of Maastricht 410.32 4740 4138 14.5
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<td>-94.3</td>
</tr>
<tr>
<td>36. St. Geertruid</td>
<td>0.43</td>
<td>7172</td>
<td>2067</td>
<td>247.0</td>
</tr>
<tr>
<td>37. Noorbeek</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>38. Slenaken</td>
<td>0.55</td>
<td>4188</td>
<td>4079</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Region of Maastricht 564.27 3929 2828 38.9
to get an impression of the economic operation of each shopping centre. Table 5 then shows that, in general, the situation for the daily goods in 1980 is satisfactory, since the observed turnover exceeds the normative turnover with almost 15%. The overall situation for the non-daily goods (Table 6) is even better where the actual turnover exceeds the normative turnover with almost 40%. Specific shopping centres vary, however, considerably with regard to the mean situation which is illustrated by the following figures. The average turnover-to-floorspace ratio for daily goods is Dfl. 4740, with a range of Dfl. 847 (for Noorbeek) to Dfl. 14.763 (for shopping centre Mheer). The standard deviation is Dfl. 2854. For the non-daily goods an average turnover-to-floorspace ratio has been calculated of Dfl. 3929, with a range of Dfl. 12.541 (for shopping centre Wyckerpoort) and Dfl. 107 (for shopping centre Mheer). The standard deviation is Dfl. 2323.

The previous tables give a lot of information about the shopping centres in the region of Maastricht. Given the specific focus of the planning project on the central area of Maastricht (Figure 15),

Figure 15: Central area of Maastricht and the northern Maas bridge
the situation of the centres within that area (City and Oud-Wyck) are of special interest. It then happens that shopping centre Oud-Wyck realizes far too little turnover in both the sectors of daily and non-daily goods. The development of a retail plan for the central district requires special attention for this shopping centre that seems to operate on a suboptimal level. To gain more insight in the problematic nature of this centre, insight is required in the future trend development of the retail system, particularly because in 1984 a new bridge across the river north of the city of Maastricht was planned to be opened. This bridge would imply a better accessibility to several main shopping centres. Moreover, a considerable increase of population in some residential zones (particularly the zones 2, 9 and 10) was planned, whereas a considerable decrease of population was expected in residential zone 3 as the result of urban renewal programs. The next section deals with the trend analysis.

6.4 Prediction of the trend development of the retail system in the region of Maastricht

Relationship with the DSS
The first stage of the decision process model that underlies the DSS also involves the prediction of the trend. This section presents the applied models and the results of the prediction of the trend for the retail system in the region of Maastricht.

6.4.1 Introduction
Gaining insight in the trend development of the retail system requires a model to forecast expenditure distribution over the existing shopping centres in the planning area. Changes in the distribution of expenditure can give an impression of the changes in the viability of these centres. The use of a multiattribute preference model is preferred for predicting the spatial choices of consumers, because the model's parameters are relatively independent of the spatial structure.

The rest of this chapter will only focus on the situation
with regard to the non-daily goods. The reason is that no data were available for the specification of a multiattribute preference model for the spatial choices of consumers in the context of buying daily goods. This fact also implies that no retail planning options with regard to daily goods will be considered. However, basically the situation regarding the daily goods will be treated in the same way as that for non-daily goods. In addition, the changes in patronage of shopping centres have to be considered as the input in a retailer reactive behaviour model. The reduction to non-daily goods sufficiently illustrates the DSS.

Before discussing the outcomes of the analysis of the trend development, first attention will be paid to the specification of the required models. The multiattribute preference model for consumer spatial choice is elaborated first (6.4.2) and next a retailer model is outlined (6.4.3). In addition the results of the predictions are discussed (6.4.4).

6.4.2 The consumer spatial choice model
The aim of the consumer spatial choice model is to predict the distribution of expenditures by consumers of 21 residential zones over 38 shopping centres. The operationalization of the consumer choice spatial model involves the following steps:
- the specification of a submodel for the information field of consumers. The application of this model is aimed at determining a number of structural zero-cells in the 21x38 matrix. The corresponding centres are not considered included in the information fields of consumers of a particular residential zone and are, consequently, excluded from the distribution of expenditure by consumers of that residential zone;
- the definition of a multiattribute preference model for the distribution of expenditure over the shopping centres included in the predicted information fields.

Information fields model
The elaboration of a submodel for predicting information fields of consumers in the region of Maastricht is handicapped by the fact that no direct measurement of consumers' familiarity with shopping centres
was included in the consumer questionnaire. Hence, no direct definition of information fields is possible. Therefore, the logistic model estimated in the earlier mentioned Eindhoven study was used to predict (on an aggregate level) the probabilities that consumers living in a particular residential area are familiar with the shopping centres in the Maastricht region. The model is defined as (Van der Heijden and Timmermans, 1984):

\[
\text{iP}_j = \frac{\exp(-0.090 + 1.292 X_{1j} - 0.885 X_{2j} - 2.222 X_{3j})}{1 + \exp(-0.090 + 1.292 X_{1j} - 0.885 X_{2j} - 2.222 X_{3j})}
\] (6.1)

where,

- \text{iP}_j is the probability that an individual at location i will be familiar with the j-th shopping centre;
- \(X_{1j}\) is the size of the j-th shopping centre;
- \(X_{2j}\) is the distance between an individual's home and shopping centre j;
- \(X_{3j}\) is a variable denoting the existence or absence of an intervening opportunity between an individual's home and shopping centre j; a value 1 implies the presence of an intervening opportunity and a value 0 the absence of an intervening opportunity.

To apply this model in the region of Maastricht, it was first necessary to define each of the 38 shopping centres in terms of the independent variables related to the parameters of the model. The variable for size, measured in terms of the number of functional units per centre, was divided into 4 categories: 0-20 functional units, 20-70 functional units, 70-200 functional units and >200 functional units. A shopping centre was said to have an intervening opportunity if some other shopping centre existed on at least two levels in the functional hierarchy higher within an angle of 35° of the shopping centre / home axis. 'Home' in this context was considered to be the core of the cluster of consumers in the particular residential zone. In other situations, the shopping centre was coded as not having an intervening opportunity. Finally, the variable of distance was subdivided into 4 categories: 0-0.8 km, 0.8-1.5 km, 1.5-3.5 km and >3.5 km for the distance between the consumer's 'home' and the shopping centres. The application of the model resulted in a 21 x 38 probability matrix,
expressing the probability that consumers living in one of the 21 residential zones are familiar with the 38 shopping centres.

The concept of information fields is interpreted in this study as a means of introducing structural zero cells in the expenditure distribution matrix. This implies that the next step in the analysis involves the formulation of a heuristic rule on the basis of which these cells can be identified. This problem is conceived of as dichotomizing the probability matrix by assuming a discriminatory probability \( p_n \) which represents a threshold for the familiarity with a shopping centre. The choice for \( p_n \) is based on an arbitrary criterion but can be made plausible by checking the congruence between the resulting information fields and observed information fields. As noted before, however, the predicted information fields cannot be checked directly against observed ones because the information fields of consumers in the Maastricht region were not measured. An indirect procedure had to be followed. The usage fields of consumers, measured in the questionnaire, are assumed to be the cores of the information fields. The plausibility of this assumption is supported by means of empirical evidence indicating that the shape and size of the information fields of consumers highly correspond with those of their usage fields (compare Potter, 1979; Timmermans, Van der Heijden and Westerveld, 1982a). Therefore, the predicted information fields can be compared with the observed usage fields of consumers. The relatively low number of respondents in the questionnaire could cause biases in the observed usage fields. In order to avoid too large biases it was decided to use observed usage fields for comparison determined by way of interactions for any type of good larger than 0.5% or, in a second analysis, alternatively, 1.0% of the total expenditure per residential zone.

The results of the comparison of the predicted information fields and the observed usage fields are presented in Table 7. Three discriminatory probability levels of familiarity were applied to identify the structural zero cells in the interaction matrix: 0.10, 0.15 and 0.25. These probabilities are related to an empirical study by Hanson (1977). She concludes in her study in Uppsala, Sweden, on the familiarity of individuals with shops, that the probability that a store's location is known beyond 2½ kilometers fluctuates around 0.28
and that the probability that a store's interior attributes are known beyond that distance hovers around 0.10. These probabilities are reasonably invariable with increasing distance. These findings suggest that on the individual level a probability spectrum of .10 to .25 might be critical for being familiar with specific retail facilities.

Table 7 shows that the overall percentage of correctly predicted cells is quite satisfactory. The number of predicted, known centres is generally larger than the observed number of used centres, which is evidently correct since the individual's information field is normally as large as or greater than his/her usage field. The number of predicted, known centres is, of course, larger when the heuristic probability for familiarity \(p_n\) is lower. Moreover, the number of correctly predicted cells is somewhat lower when these normal probabilities decrease. The table also shows that the number of centres in observed usage fields predicted to be not familiar to consumers is generally lower for the 1%-usage fields than for the 0.5% usage.

| Tabel 7: Information fields predicted by the Eindhoven-model compared to observed usage fields in region of Maastricht |
|-------------------------------------------------|-----------------|-----------------|-----------------|
| criterion \(p_n\):                              | 0.10 | 0.15 | 0.25 |
| % correctly predicted cells:                     | 79.32 | 84.21 | 87.22 |
| total number of observed used centres:           | 181 | 181 | 181 |
| predicted known centres:                         | 302 | 247 | 201 |
| not predicted centres in usage fields:           | 12.51 | 16.57 | 22.65 |
| (percentage:)                                    | 100 | 100 | 100 |
| (number:)                                        | 20 | 15 | 21 |
| distribution of consumers                        | 0.83 | 0.83 | 0.85 |
| \(R\) interactions                               | 0.68 | 0.69 | 0.73 |
| \(R^2\) interactions                             | 0.96 | 0.87 | 0.87 |
| \(R\) destinations                               | 0.91 | 0.76 | 0.77 |
| \(R^2\) destinations                             | 0.82 | 0.82 | 0.86 |
|                                                   | 0.67 | 0.67 | 0.73 |
|                                                   | 0.96 | 0.86 | 0.86 |
|                                                   | 0.93 | 0.74 | 0.74 |
fields. This indicates that the applied model generally predicts the average structure of the usage fields and the information fields rather well. The indicators $R$ and $R^2$ for the comparison of the overall distribution of consumers over the shopping centres on the basis of the predicted information fields and the observed usage fields have satisfactory levels and, as such, are consistent with the other indicators. These indicators point out that the applied model for the prediction of information fields generally has a very acceptable spatial transferability, realizing that the model's parameters are estimated for the municipality of Eindhoven. In other words: there is evidence that the predicted information fields express real-world information fields of consumers in the Maastricht region.

Additional evidence is provided by means of the following analyses. The observed usage fields were used to estimate the parameters of the same type of model. The same definition of the independent variables was used. The analysis focused on the descriptive value of the estimated models. Three methods for the estimation of the parameters were used: the maximum likelihood method, the stepwise maximum likelihood method and the weighted least squares method. The results are presented in Table 8. Although the descriptive value of the estimated models varies slightly among the methods, it is obvious that overall, the descriptive models do not give a significantly better result in describing the usage fields or in predicting the information fields, than the Eindhoven model does.

Given these results, it seems theoretically valid to use the Eindhoven model in the context of the further analysis to predict the information fields of consumers in the region of Maastricht. In addition, the most acceptable discriminatory probability level for familiarity (which also determines the structural zero-cells in the origin-destination matrix of expenditure distribution) is 0.15, because of the following reasons. The percentage of correctly predicted cells of the 21x38 matrix is highest when a probability of 0.25 is accepted. However, the number of shopping centres predicted as being not known, but in contrast observed to be patronaged, is also very high. Acceptance of a probability of 0.15 implies a small decrease in the percentage of correctly predicted cells. The decrease in that percentage is larger if the results for 0.15 and 0.10 are compared. On
Table 8: Estimation of logit model to predict information fields of consumers in the region of Maastricht

<table>
<thead>
<tr>
<th>input level usage fields:</th>
<th>maximum likelihood</th>
<th>stepwise maximum likelihood</th>
<th>weighted least squares</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5%</td>
<td>1.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Pn-value:</td>
<td>0.10</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>% correctly predicted:</td>
<td>74.7</td>
<td>79.3</td>
<td>84.7</td>
</tr>
<tr>
<td>number of observed</td>
<td>181</td>
<td>181</td>
<td>181</td>
</tr>
<tr>
<td>-predicted known cells</td>
<td>347</td>
<td>302</td>
<td>243</td>
</tr>
<tr>
<td>not predicted cells</td>
<td>9.9</td>
<td>12.2</td>
<td>16.6</td>
</tr>
<tr>
<td>percentage:</td>
<td>18</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>distribution population:</td>
<td>0.77</td>
<td>0.83</td>
<td>0.84</td>
</tr>
<tr>
<td>R interactions</td>
<td>0.59</td>
<td>0.68</td>
<td>0.70</td>
</tr>
<tr>
<td>$R^2$ interactions</td>
<td>0.73</td>
<td>0.96</td>
<td>0.87</td>
</tr>
<tr>
<td>R destinations</td>
<td>0.55</td>
<td>0.91</td>
<td>0.75</td>
</tr>
<tr>
<td>$R^2$ destinations</td>
<td>0.71</td>
<td>1.07</td>
<td>1.04</td>
</tr>
<tr>
<td>Parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>intercept</td>
<td>1.0028</td>
<td>0.9424</td>
<td>0.7250</td>
</tr>
<tr>
<td>size</td>
<td>1.2856</td>
<td>1.3412</td>
<td>1.0630</td>
</tr>
<tr>
<td>distance</td>
<td>-0.9863</td>
<td>-1.0970</td>
<td>-0.9067</td>
</tr>
<tr>
<td>interv.opp.</td>
<td>-2.5709</td>
<td>-3.3250</td>
<td>-1.8170</td>
</tr>
</tbody>
</table>
the other hand, the decrease in percentage and the number of 'not known' predicted shopping centres that are actually patronaged, is larger for the comparison of the probabilities of 0.25 and 0.15 than in for the comparison of 0.15 and 0.10. Further, the ratio of the number of observed patronaged centres and the number of predicted known centres can serve as a criterium. Potter (1977, 1979) in a study in Stockport found a ratio of 0.74, with a mean number of known centres of 4.12 and a mean number of patronaged centres of 3.05. Timmermans, Van der Heijden and Westerveld (1982b) in their study in Eindhoven found a mean number of used centres of 4.58 and a mean number of known centres of 6.41, which implies a ratio of 0.71.

Returning to the figures in Table 7, the ratio of patronaged and known centres is 0.60 for the 0.10 familiarity probability, 0.73 for the 0.15 level and 0.90 for the 0.25 level, where the 0.5%-usage field serves as a base. The acceptance of the ratio of about 0.73 implies that an acceptable discriminatory probability level for the determination of information fields of consumers in the Maastricht region is 0.15. The average overall number of predicted known centres is 11.5 (11.8 for the inhabitants of the municipality of Maastricht and 10.9 for the inhabitants of the other municipalities). The range of known centres varies from 7 to 16. Shopping centres of the size-category 1 are on average known by inhabitants of 2.8 residential zones. On average, the inhabitants of 7.8 residential zones are familiar with shopping centres of the size-category 2. The shopping centres of the size-category 3 and 4 are both predicted to be known by inhabitants of all 21 residential zones.

Multiattribute preference model

According to the part of the DSS discussed in chapter 5.3, the first step in the specification of the multiattribute preference model for consumer spatial choice is to identify the attributes of the choice alternatives to be included in the model. These attributes are meant to be the ones on which consumers base their evaluation of choice alternatives. The choice of the attributes is based on a study among consumers in Eindhoven in 1980. In particular two methods were used to identify the attributes on the bases of which consumers evaluate retail centres: the repertory grid approach (among 20 respondents) and the
factor listing approach (among 131 respondents). The reader is referred to Timmermans, Van der Heijden and Westerveld (1982c) for details of the study. Both measurements yielded very similar results. Attributes of an economic nature turned out to be more important in deciding where to shop than advertising and social factors. In the context of buying non-daily goods, the attributes of choice range, distance, parking facilities, atmosphere and quality versus the price of goods appeared to be the most important attributes. Service and atmosphere came next. Therefore the following attributes for the definition of the multiattribute preference model were chosen in this study: distance, choice range, price of goods, atmosphere and parking facilities.

The second step in the definition of the spatial choice model is the conjoint measurement of the part-worth utilities consumers attach to the various levels of the attributes to arrive at an overall utility of each choice alternative. The measurement requires consumers to rank order a number of hypothetical choice alternatives defined in terms of the elicited attributes. These rank orderings are, in addition, decomposed into the part-worth utilities for each level of each attribute. Therefore, to define each hypothetical alternative, each attribute was first assumed to vary over three levels. Choice range varied over limited, medium and wide. Price varied over low, average and high. Atmosphere and parking varied over bad, average and good and distance varied over 5, 25 and 45 minutes travel time. Then, these attribute levels were combined according to the principles of experimental design to yield a set of hypothetical choice alternatives. A full factorial approach would imply $3^5$ hypothetical choice alternatives. This would imply that every respondent would be asked to rank order 243 stimulus combinations, which is evidently a too demanding task. Therefore the trade-off matrix approach (Johnson, 1974) was applied in the present study. According to this approach, each hypothetical choice alternative is defined in terms of the levels of two attributes. This implies that $\frac{3}{2}(5 \times 4)$ pairs of attributes and consequently 10 trade-off matrices with each 9 (3x3) combinations of levels of the two attributes are defined. The 724 respondents in the Maastricht study were all asked to rank order the alternatives in each trade-off matrix from most preferred to least preferred. In total, 678
respondents fully finished this ranking task.

The third step is to decompose this ranking for the hypothetical choice alternatives and to estimate the part-worth utilities for each level of each attribute. The decomposition is based on an integration rule assumed to be a good descriptor of the process of integration of part-worth utilities into an overall utility of a choice alternative. Findings of several conjoint measurement studies suggest that the linear additive integration rule is a satisfactory descriptor. Therefore, this rule is accepted in this illustration. Formally, the model can be expressed as follows:

\[ U_i = \sum_{r=1}^{R} \sum_{h=1}^{H} \beta_{irh}Z_{rh} + \varepsilon_h \] (6.2)

where,

- \( U_i \) is the overall preference or utility measure for individual \( i \) (the results of the ranking);
- \( \beta_{irh} \) is the individual \( i \)'s part-worth contribution of the \( h \)-th level of the \( r \)-th attribute (\( h=1, \ldots, H; r=1, \ldots, R \));
- \( Z_{rh} \) is the presence (\( Z_{rh}=1 \)) or absence (\( Z_{rh}=0 \)) of attribute level \( h \) of the \( r \)-th attribute;
- \( \varepsilon_h \) is a stochastic error term.

Since the dependent variable \( U \) is only measured on an ordinal scale, it is, strictly speaking, necessary to apply non-metric scaling methods or linear programming techniques to estimate the part-worth utilities. There is some empirical evidence, however, that the results from ordinary least squares (OLS) do not significantly differ from those obtained by way of the theoretically preferable methods (compare Carmone et al., 1978; Jain et al., 1979; Wittink and Cattin, 1981). Moreover, the computational costs of OLS are far less than these preferred methods. Therefore, the equation is estimated for each respondent separately by using standard regression analysis.

In particular, the analysis proceeds as follows. The 9 rank order values for a trade-off matrix are translated into preference values for all pairs of different alternatives. This implies that preference values for \( 9 \times 8 = 72 \) comparisons are generated, in which for each pair of alternatives the value 1 is given to the alternative that is...
preferred of and 0 for the other alternative. Since there are rankings for 10 trade-off matrices, this implies that in total 720 (9x8x10) observations are available for each of the 678 individuals. These are the values of the dependent variable. Next, each of the 720 values of the dependent variables has to be explained by the independent variables. The number of independent variables is determined by the fact that for the estimation of the part-worth utilities for an attribute with H categories only (H-1) linearly independent variables are needed. Hence, given 5 attributes with 3 categories each, in total the values of (5x2^3) 10 independent variables have to be coded. In this study the effect coding procedure (see e.g. Kerlinger and Pedhazur, 1973) was applied.

For each independent variable, a number of coded vectors equal to the number of categories minus one for each individual (=2) was constructed. Values of 1 were assigned to choice alternatives characterized by an arbitrarily chosen attribute level, values of 0 were assigned to alternatives which were characterized by all remaining categories but one, and all the alternatives characterized by that excluded category were assigned values of -1. The value of the independent variable was set equal to 0 if that attribute did not appear in the trade-off matrix under study. Each trade-off matrix generates (9x8/2=) 36 implicitly paired comparisons. The value of the dependent variable was set to 1 for the preferred combination of attribute levels in the paired comparison and 0 for the other combination. The 720 observations for each individual were then subjected to the regression analysis.

The goodness-of-fit of the resulting model was assessed by calculating Kendall's (1938) tau between predicted and measured rankings in all trade-off matrices and by checking for monotonicity in anticipated directions for all estimated vectors of part-worth utilities. The tau-measure can be expressed as follows:

\[ \tau = \frac{n.P_s - n.P_d}{n-1} \]  

(6.3)

where,

- \( n \) denotes the total number of observations.

- \( P_s \) denotes the probability that the direction in the values of one
pair is the same as the direction in the values of the other pair;

$P_d$ denotes the probability that the direction in the value of one pair is different from the direction in the values of the other pair.

The denominator of (6.3) gives the total number of combinations of 2 elements from a collection of n elements. $P_a$ and $P_d$ are calculated on the basis of the frequency of events. Tau expresses the ordinal relationship between the predicted and the observed rank orderings in the trade-off evaluation matrices. Its value varies between 0 and 1.0 and is calculated for each individual separately. A summary of the results is presented in Table 9. A tau-value of 1 expresses a perfect monotonic relationship, whereas the value 0 expresses a complete difference. The table shows that the results of the estimation are satisfactory. The mean tau-value is 0.88, its standard deviation is 0.07 and 89.4% of the respondents have a tau-value that exceeds 0.8.

The second method to check the fit of the model is to analyse whether the derived utility scales for each attribute are monotone in a priori hypothesized directions. For the attributes parking facilities, atmosphere and choice range, the utility should increase when the levels of these attributes increase. Of course, for the attributes price and distance, the utilities are expected to decrease when the levels of these attributes increase. The monotonicity for each attribute is checked for each individual separately. These results have been summarized in Table 10. Clearly, the majority of respondents

<table>
<thead>
<tr>
<th>value of tau</th>
<th>frequency</th>
<th>percentage</th>
<th>cum.percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-0.1</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.1-0.2</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.2-0.3</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.3-0.4</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.4-0.5</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0.5-0.6</td>
<td>5</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>0.6-0.7</td>
<td>10</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>0.7-0.8</td>
<td>57</td>
<td>8.4</td>
<td>10.8</td>
</tr>
<tr>
<td>0.8-0.9</td>
<td>218</td>
<td>32.2</td>
<td>42.9</td>
</tr>
<tr>
<td>0.9-1.0</td>
<td>387</td>
<td>57.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 10: Summary of test for monotonicity

<table>
<thead>
<tr>
<th>variable</th>
<th>monotonicity present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>absolute</td>
</tr>
<tr>
<td>choice range</td>
<td>663</td>
</tr>
<tr>
<td>distance</td>
<td>638</td>
</tr>
<tr>
<td>price</td>
<td>656</td>
</tr>
<tr>
<td>parking facilities</td>
<td>654</td>
</tr>
<tr>
<td>atmosphere</td>
<td>658</td>
</tr>
</tbody>
</table>

have part-worth utilities monotone in anticipated directions.

The results for the test of monotonicity can be related to the tau-value by cross-tabulating both variables. Table 11 gives the results. The table shows that the respondents that have relatively low tau-values are also not monotone in a priori defined directions. Only few respondents with high tau-values are not monotone in their part-worth utilities too. Likewise, most respondents showing monotonicity in their part-worth utilities have high tau-values.

The model has now been estimated on the individual level, that is to say, the individual part-worth utilities for the levels of each attribute have been estimated. The fourth step is the determination of the overall utility value of each of the shopping centres the individual is familiar with. The procedure involves three main steps:

a. the definition of the 38 choice alternatives in terms of the attribute levels used in the experimental measurement of the

Table 11: Cross-tabulation of fit measure tau versus monotonicity

<table>
<thead>
<tr>
<th>value of tau</th>
<th>Monotonicity absent</th>
<th>Monotonicity present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>absolute percentage</td>
<td>absolute percentage</td>
</tr>
<tr>
<td>0.0 - 0.1</td>
<td>0 0.0</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.1 - 0.2</td>
<td>0 0.0</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.2 - 0.3</td>
<td>0 0.0</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.3 - 0.4</td>
<td>0 0.0</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.4 - 0.5</td>
<td>1 0.1</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.5 - 0.6</td>
<td>5 0.7</td>
<td>0 0.0</td>
</tr>
<tr>
<td>0.6 - 0.7</td>
<td>9 1.3</td>
<td>1 0.1</td>
</tr>
<tr>
<td>0.7 - 0.8</td>
<td>24 3.5</td>
<td>33 4.9</td>
</tr>
<tr>
<td>0.8 - 0.9</td>
<td>34 5.0</td>
<td>184 27.1</td>
</tr>
<tr>
<td>0.9 - 1.0</td>
<td>10 1.5</td>
<td>377 55.6</td>
</tr>
</tbody>
</table>
utilities;
b. the definition of the objective values underlying the attribute levels used in the experiment; and
c. the calculation of the overall utilities for each of the 38 choice alternatives by inter- or extrapolating the levels of their attributes determining the corresponding part-worth utility for each attribute and combining these utilities into an overall utility by applying the linear additive model.

For the first step, the results of the exploration of the supply-side of the retail system as summarized in Table 3, are used. The variable choice range is interpreted in terms of the total amount of floorspace. Timmermans, Van der Heijden and Westerveld (1982b) argue that the number of shops as well as the amount of floorspace are often used by consumers as synonyms for choice range. The variable amount of floorspace has been chosen in this case study because of the easy link that can be made with the changes in floorspace resulting from the retailer's model (see the next subsection). The variable distance has been measured in terms of the geographic distance in kilometres from the consumer's residential home and the shopping alternatives. The distance is measured by focusing on the most likely route. Finally, the three variables of atmosphere, parking facilities and price are used. The levels of each shopping centre in respect of these variables have already been indicated in Table 3. Every shopping centre can hence be defined in terms of the five variables mentioned.

The second step involves the definition of the part-worth utility functions. Each of the five variables is continuous and, consequently, their part-worth utilities also have to describe a continuous function. This is achieved by determining a corresponding objective counterpart for each of the three measured utilities for each variable, thereby defining a continuum of part-worth utilities for the complete domain of the objective variables used in the measurement of preferences of hypothetical choice alternatives. For each value of each objective variable, the corresponding value can thus be calculated by interpolating or extrapolating the corresponding utility function. The anchor-points of the utility functions are found by way of trial and error: the best possible definition of the utility functions is found through checking the effects of each definition of the utility
functions on performed choice behaviour. This implies that part-worth utilities are calculated by means of the estimated utility functions, given the definitions of the shopping alternatives. In addition, the overall utility for each shopping centre is calculated and some decision rule is performed to arrive at actual choices. Observed choice patterns are thus used as checks on predicted choice patterns.

The third step is to calculate the overall utility of each known shopping centre for each respondent by combining the calculated part-worth utilities of the real-world levels of the attributes of these shopping centres according to the individual linear additive rule.

The final step in the definition of the spatial choice model involves the choice of a decision rule that links the overall evaluations to spatial choices. In the context of this illustration decision rule IV, described in section 5.2, was employed because of the very satisfactory results that have been reached in other studies with this rule (e.g. Timmermans and Van der Heijden, 1984).

<table>
<thead>
<tr>
<th>Measures</th>
<th>Interactions</th>
<th>Destinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Comparison on basis of observed usage fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion correctly predicted turnover</td>
<td></td>
<td>0.938</td>
</tr>
<tr>
<td>Coefficient of correlation</td>
<td>0.866</td>
<td>0.998</td>
</tr>
<tr>
<td>Coefficient of determination</td>
<td>0.749</td>
<td>0.996</td>
</tr>
<tr>
<td>Robinson's agreement measure</td>
<td>0.939</td>
<td>0.999</td>
</tr>
<tr>
<td>Calibration coefficient</td>
<td>0.830</td>
<td>0.998</td>
</tr>
<tr>
<td>Theil's inequity coefficient</td>
<td>0.238</td>
<td>0.004</td>
</tr>
<tr>
<td>Root mean square standardized</td>
<td>1.110</td>
<td>0.481</td>
</tr>
<tr>
<td>Mean absolute error standardized</td>
<td>0.586</td>
<td>0.252</td>
</tr>
<tr>
<td>2. Comparison on basis of predicted information fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion correctly predicted turnover</td>
<td></td>
<td>0.978</td>
</tr>
<tr>
<td>Coefficient of correlation</td>
<td>0.849</td>
<td>0.997</td>
</tr>
<tr>
<td>Coefficient of determination</td>
<td>0.720</td>
<td>0.993</td>
</tr>
<tr>
<td>Robinson's agreement measure</td>
<td>0.924</td>
<td>0.996</td>
</tr>
<tr>
<td>Calibration coefficient</td>
<td>0.825</td>
<td>0.995</td>
</tr>
<tr>
<td>Theil's inequity coefficient</td>
<td>0.273</td>
<td>0.009</td>
</tr>
<tr>
<td>Root mean square standardized</td>
<td>1.184</td>
<td>0.425</td>
</tr>
<tr>
<td>Mean absolute error standardized</td>
<td>0.570</td>
<td>0.199</td>
</tr>
</tbody>
</table>
After having predicted preferences on the individual level, this rule results in the calculation of aggregate choice probabilities and the determination of expenditure distribution in the Maastricht region. The observed distribution of expenditures serves as a check on the predictive value of the model. The results of this check are summarized in Table 12. The comparison of the predicted and observed

<table>
<thead>
<tr>
<th>Centre</th>
<th>observed</th>
<th>predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. City</td>
<td>61.30</td>
<td>62.46</td>
</tr>
<tr>
<td>2. Oud-Wyck</td>
<td>2.63</td>
<td>2.65</td>
</tr>
<tr>
<td>3. Brusselse Poort</td>
<td>11.24</td>
<td>10.87</td>
</tr>
<tr>
<td>4. Mariaberg</td>
<td>1.51</td>
<td>1.38</td>
</tr>
<tr>
<td>5. Belfort</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>6. Pottenberg</td>
<td>0.06</td>
<td>0.07</td>
</tr>
<tr>
<td>7. Malpertuis</td>
<td>0.30</td>
<td>0.22</td>
</tr>
<tr>
<td>8. Caberg</td>
<td>0.66</td>
<td>0.68</td>
</tr>
<tr>
<td>9. Malberg</td>
<td>0.43</td>
<td>0.22</td>
</tr>
<tr>
<td>10. Daalhof</td>
<td>0.71</td>
<td>0.60</td>
</tr>
<tr>
<td>11. Wyckerpoort</td>
<td>0.81</td>
<td>0.34</td>
</tr>
<tr>
<td>12. Akerpoort</td>
<td>0.39</td>
<td>0.22</td>
</tr>
<tr>
<td>13. Oostermaas</td>
<td>1.12</td>
<td>1.03</td>
</tr>
<tr>
<td>14. Nazareth</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>15. Limmel</td>
<td>0.73</td>
<td>0.68</td>
</tr>
<tr>
<td>16. Scharn</td>
<td>2.29</td>
<td>2.56</td>
</tr>
<tr>
<td>17. Amby</td>
<td>0.35</td>
<td>0.37</td>
</tr>
<tr>
<td>18. Villapark</td>
<td>0.16</td>
<td>0.10</td>
</tr>
<tr>
<td>19. Jekerdaal</td>
<td>0.15</td>
<td>0.07</td>
</tr>
<tr>
<td>20. Biesland</td>
<td>1.71</td>
<td>1.65</td>
</tr>
<tr>
<td>21. Heugem</td>
<td>0.24</td>
<td>0.23</td>
</tr>
<tr>
<td>22. Heer</td>
<td>4.36</td>
<td>4.54</td>
</tr>
<tr>
<td>23. De Heeg</td>
<td>0.04</td>
<td>0.05</td>
</tr>
<tr>
<td>24. Borgharen</td>
<td>0.41</td>
<td>0.37</td>
</tr>
<tr>
<td>25. Itteren</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>26. Bunde</td>
<td>1.06</td>
<td>0.97</td>
</tr>
<tr>
<td>27. Berg en Terblijt</td>
<td>0.29</td>
<td>0.33</td>
</tr>
<tr>
<td>28. Cadier en Keer</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>29. Eysden</td>
<td>1.77</td>
<td>2.09</td>
</tr>
<tr>
<td>30. Gronsveld</td>
<td>0.33</td>
<td>0.59</td>
</tr>
<tr>
<td>31. Margraten</td>
<td>0.77</td>
<td>0.69</td>
</tr>
<tr>
<td>32. Meerssen</td>
<td>3.52</td>
<td>3.50</td>
</tr>
<tr>
<td>33. Mheer</td>
<td>0.00</td>
<td>0.02</td>
</tr>
<tr>
<td>34. St. Geertruid</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>35. Slenaken</td>
<td>0.10</td>
<td>0.12</td>
</tr>
</tbody>
</table>

100.00  100.00
choice patterns for the non-daily goods is expressed in terms of a number of goodness-of-fit measures (Timmermans and Borgers, 1985). Two types of predictions have been made. The first one is based on the distribution of expenditures over the predicted information fields of consumers and the second one on the distribution of expenditures over observed usage fields. Evidently, given the use of the model for prediction, the first type of prediction is more important than the second one. Table 12 shows that, overall, the predictive value of the model is quite satisfactory and that the predictions based on the information fields are slightly better than the predictions based on the usage fields. The predicted expenditure distribution over the information fields of the consumers and the observed expenditure distribution are summarized in Table 13 in terms of the percentage for each shopping centre of the total amount of expenditures by consumers in the region of Maastricht for non-daily goods. According to the table, there is a tendency to give a slight under-prediction for the smaller shopping centres, whereas the proportions for some of the larger shopping centres are somewhat over-predicted.

6.4.3 The retailer (spatial) reactive behaviour model
The second main part of the predictive model focuses on the (spatial) reactive behaviour of retailers. As argued in chapter 4 and section 5.2, the model that tries to capture this behaviour will bear a somewhat pragmatic character in this study. Because of the general lack of insights in the cognitive-behavioural dimensions of retailer's reactive behaviour, the earlier mentioned study in 1984 among retailers in Eindhoven was not focused on the collection of data for the specification of a particular a priori outlined model, but was primarily explorative. Data on several issues were collected, some of which are usable for the specification of the pragmatic model outlined in chapter 5.2.

In the questionnaire among retailers in 4 retail areas in Eindhoven, the respondents were asked to express the probability that they would (hypothetically) conduct 22 predefined types of reactions if their turnover would yearly increase with 5, 10 or 15% or yearly decrease with 5, 10 or 15%. 141 Retailers in total answered this hypothetical question, 38 of whom were retailers mainly selling daily
goods and 103 retailers mainly selling non-daily goods. The model is not defined on the level of the individual retailer, but on the aggregate level. Therefore, the average probabilities were calculated for each of the 22 types of reactions and each of the 6 hypothetical changes in turnover. The average probabilities are presented in Table 14a and b for the categories daily and non-daily goods. Probabilities >10.0% are underlined.

The tables show that retailers clearly discriminate among the types of reaction and that some reactions are more favoured than others. There appears to exist a remarkable resemblance between the average probability-scores of the 'daily' retailers and those of the 'non-daily' retailers. This points to clear preferences. Relatively high are the average probabilities for reduction of the number of employees in the context of a decrease in turnover and those for increasing the number of employees when the turnover increase are relatively high. The probabilities for extension of assortment, selling cheaper goods, advertising and investments in the lay-out of the shop point to attempts to change the image of the shop. In the context of a drop in turnover this is aimed at attracting more and possibly other consumers, while in the context of an increase in turnover a more specialized image is pursued: distinction in respect to competitors in order to stabilize the new situation. Another remarkably high set of probabilities is related to the reaction 'extending service'. This might be seen in the same way as the four types of reaction above. On the other hand, it should be recognized that the reaction is labeled in very general terms. Various meanings and interpretations can be given to it. The more vaguely labeled reaction types leave many individual options for reaction and consequently they score higher probabilities than more specified types of reaction. In the context of applied retail research particularly the types of reaction that have spatial consequences are of special interest. The related mean probabilities are relatively low compared to reactions that have to do with 'image' without large investments and other more permanent consequences.

Next these mean probabilities are used to estimate the probability function with the general form
Table 14: Average probabilities of reaction by retailers

<table>
<thead>
<tr>
<th>Types of reaction</th>
<th>Yearly % change in turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-15%</td>
</tr>
<tr>
<td>a. (daily goods)</td>
<td></td>
</tr>
<tr>
<td>1. increase of total floorspace</td>
<td>3.4</td>
</tr>
<tr>
<td>2. decrease of total floorspace</td>
<td>4.4</td>
</tr>
<tr>
<td>3. increase of sales floorspace</td>
<td>3.9</td>
</tr>
<tr>
<td>4. decrease of sales floorspace</td>
<td>5.4</td>
</tr>
<tr>
<td>5. increase of number of employees</td>
<td>0.3</td>
</tr>
<tr>
<td>6. decrease of number of employees</td>
<td>34.7</td>
</tr>
<tr>
<td>7. extension of assortment</td>
<td>21.4</td>
</tr>
<tr>
<td>8. reduction of assortment</td>
<td>8.1</td>
</tr>
<tr>
<td>9. raise the price level</td>
<td>11.3</td>
</tr>
<tr>
<td>10. lower the price level</td>
<td>12.3</td>
</tr>
<tr>
<td>11. increase of sales floorspace</td>
<td>13.6</td>
</tr>
<tr>
<td>12. decrease of sales floorspace</td>
<td>7.4</td>
</tr>
<tr>
<td>13. start of additional shop</td>
<td>24.8</td>
</tr>
<tr>
<td>14. more advertising</td>
<td>1.4</td>
</tr>
<tr>
<td>15. less advertising</td>
<td>20.3</td>
</tr>
<tr>
<td>16. invest in layout of shop</td>
<td>13.3</td>
</tr>
<tr>
<td>17. cheaper employees</td>
<td>7.8</td>
</tr>
<tr>
<td>18. selling more expensive goods</td>
<td>20.9</td>
</tr>
<tr>
<td>19. selling more cheap goods</td>
<td>49.3</td>
</tr>
<tr>
<td>20. extending service</td>
<td>2.5</td>
</tr>
<tr>
<td>21. reducing service</td>
<td>5.5</td>
</tr>
<tr>
<td>b. (non-daily goods)</td>
<td></td>
</tr>
<tr>
<td>1. increase of total floorspace</td>
<td>0.5</td>
</tr>
<tr>
<td>2. decrease of total floorspace</td>
<td>5.6</td>
</tr>
<tr>
<td>3. increase of sales floorspace</td>
<td>2.8</td>
</tr>
<tr>
<td>4. decrease of sales floorspace</td>
<td>6.7</td>
</tr>
<tr>
<td>5. increase of number of employees</td>
<td>0.8</td>
</tr>
<tr>
<td>6. decrease of number of employees</td>
<td>39.7</td>
</tr>
<tr>
<td>7. extension of assortment</td>
<td>21.0</td>
</tr>
<tr>
<td>8. reduction of assortment</td>
<td>11.7</td>
</tr>
<tr>
<td>9. raise the price level</td>
<td>5.8</td>
</tr>
<tr>
<td>10. lower the price level</td>
<td>2.5</td>
</tr>
<tr>
<td>11. increase of sales floorspace</td>
<td>10.6</td>
</tr>
<tr>
<td>12. decrease of sales floorspace</td>
<td>4.6</td>
</tr>
<tr>
<td>13. start of additional shop</td>
<td>3.2</td>
</tr>
<tr>
<td>14. more advertising</td>
<td>19.8</td>
</tr>
<tr>
<td>15. less advertising</td>
<td>2.4</td>
</tr>
<tr>
<td>16. invest in lay out of shop</td>
<td>21.2</td>
</tr>
<tr>
<td>17. cheaper employees</td>
<td>11.7</td>
</tr>
<tr>
<td>18. selling more expensive goods</td>
<td>9.2</td>
</tr>
<tr>
<td>19. selling more cheap goods</td>
<td>16.2</td>
</tr>
<tr>
<td>20. extending service</td>
<td>30.6</td>
</tr>
<tr>
<td>21. reducing service</td>
<td>1.5</td>
</tr>
<tr>
<td>22. doing nothing</td>
<td>7.4</td>
</tr>
</tbody>
</table>
\[ P_q = \alpha + \beta x + \gamma x^2 + \delta x^3 \]  
(6.4)

for each type of reaction \( q (q=1, \ldots, 22) \).

Evidently, \( P_q \) denotes the probability that the particular reaction \( q \) will be performed, while \( X \) denotes the % change in turnover. Strictly speaking, equation 6.4 is not a probability function. However this need not be problematic as long as the equation is not used outside its domain. The results of the estimation are summarized in the Tables 15 and 16 for the daily and non-daily goods respectively. In addition to the values of the parameters, a measure (percentage explained

Figure 16 Some examples of reaction-functions of retailers in the context of selling non-daily goods

1: doing nothing
2: increasing number of employees
3: increasing amount of floorspace
4: raise the price level

yearly % change in turnover →
variance) for the fit on the six observations per type of reaction is
given. As an illustration, some of the fitted functions for non-daily
good are shown in Figure 16.

The fitted probability functions are now used in the context of
forecasting as has been described in chapter 5.3 to determine unplanned
(autonomic) changes in the attributes of shopping centres. This means
that for each shopping centre which is not directly influenced by
retail planning in the preceeding year the change in turnover is
calculated as the percentage of the turnover of the preceeding year.

Table 15: Results of the fit of probability functions for each type of
reaction for the sector of daily goods

<table>
<thead>
<tr>
<th>Types of reaction</th>
<th>Parameter values</th>
<th>% expl. variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 increase of total floor-space</td>
<td>1.72857</td>
<td>0.30079</td>
</tr>
<tr>
<td>2 decrease of total floor-space</td>
<td>1.57143</td>
<td>-0.15785</td>
</tr>
<tr>
<td>3 increase of sales floor-space</td>
<td>2.50000</td>
<td>0.39222</td>
</tr>
<tr>
<td>4 decrease of sales floor-space</td>
<td>0.58571</td>
<td>-0.14032</td>
</tr>
<tr>
<td>5 increase number of employees</td>
<td>2.22857</td>
<td>0.57889</td>
</tr>
<tr>
<td>6 decrease number of employees</td>
<td>5.30500</td>
<td>-1.36710</td>
</tr>
<tr>
<td>7 extension of assortment</td>
<td>8.88857</td>
<td>-0.12032</td>
</tr>
<tr>
<td>8 reduction of assortment</td>
<td>0.69290</td>
<td>-0.10262</td>
</tr>
<tr>
<td>9 start of shop elsewhere</td>
<td>-0.24286</td>
<td>-0.12754</td>
</tr>
<tr>
<td>10 raise of price level</td>
<td>0.86428</td>
<td>0.10357</td>
</tr>
<tr>
<td>11 lower price level</td>
<td>3.34286</td>
<td>-0.28785</td>
</tr>
<tr>
<td>12 liquidation shop</td>
<td>1.65714</td>
<td>-0.19778</td>
</tr>
<tr>
<td>13 start of additional shop</td>
<td>1.25000</td>
<td>-0.31563</td>
</tr>
<tr>
<td>14 more advertising</td>
<td>5.10000</td>
<td>-0.73254</td>
</tr>
<tr>
<td>15 less advertising</td>
<td>1.25000</td>
<td>-0.05294</td>
</tr>
<tr>
<td>16 invest in layout shop</td>
<td>9.54290</td>
<td>0.17590</td>
</tr>
<tr>
<td>17 cheaper employees</td>
<td>4.20000</td>
<td>-0.44857</td>
</tr>
<tr>
<td>18 selling more expensive goods</td>
<td>4.45000</td>
<td>0.12849</td>
</tr>
<tr>
<td>19 selling more cheap goods</td>
<td>5.40000</td>
<td>-0.48222</td>
</tr>
<tr>
<td>20 extending service</td>
<td>23.53571</td>
<td>-1.06627</td>
</tr>
<tr>
<td>21 inducing service</td>
<td>1.11786</td>
<td>0.03722</td>
</tr>
<tr>
<td>22 doing nothing</td>
<td>37.14286</td>
<td>1.44095</td>
</tr>
</tbody>
</table>
Next, the related probabilities for all types of reactions are calculated by using the 22 fitted functions. The procedure involves the following steps. The probability that retailers will conduct each of the 22 types of reactions have been calculated. The ratio between these probabilities are kept when they are standardized to sum to 1. These standardized probabilities are additionally related to the calculated absolute difference in turnover between the present and the preceding year, in order to determine a share of that amount for each of the 22 types of reaction. The size of that share is related to the

<table>
<thead>
<tr>
<th>types of reaction</th>
<th>Parameter values</th>
<th>% expl. variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \alpha )</td>
<td>( \beta )</td>
</tr>
<tr>
<td>1 increase of total floor-space</td>
<td>1.17857</td>
<td>0.09659</td>
</tr>
<tr>
<td>2 decrease of total floor-space</td>
<td>0.94286</td>
<td>-0.15238</td>
</tr>
<tr>
<td>3 increase of sales floor-space</td>
<td>1.80000</td>
<td>0.15921</td>
</tr>
<tr>
<td>4 decrease of sales floor-space</td>
<td>1.11500</td>
<td>-0.19659</td>
</tr>
<tr>
<td>5 increase number of employees</td>
<td>0.69286</td>
<td>0.28183</td>
</tr>
<tr>
<td>6 decrease number of employees</td>
<td>4.16430</td>
<td>-0.97024</td>
</tr>
<tr>
<td>7 extension of assortment</td>
<td>6.48571</td>
<td>-0.20603</td>
</tr>
<tr>
<td>8 reduction of assortment</td>
<td>2.09286</td>
<td>-0.26532</td>
</tr>
<tr>
<td>9 start of shop elsewhere</td>
<td>1.05000</td>
<td>-0.05341</td>
</tr>
<tr>
<td>10 raise price level</td>
<td>0.70714</td>
<td>-0.01278</td>
</tr>
<tr>
<td>11 lower price level</td>
<td>2.02857</td>
<td>-0.31857</td>
</tr>
<tr>
<td>12 liquidation shop</td>
<td>0.20714</td>
<td>-0.05325</td>
</tr>
<tr>
<td>13 start of additional shop</td>
<td>1.31429</td>
<td>0.11286</td>
</tr>
<tr>
<td>14 more advertising</td>
<td>4.25710</td>
<td>-0.32000</td>
</tr>
<tr>
<td>15 less advertising</td>
<td>0.99286</td>
<td>-0.02278</td>
</tr>
<tr>
<td>16 invest in layout shop</td>
<td>5.25000</td>
<td>0.06429</td>
</tr>
<tr>
<td>17 cheaper employees</td>
<td>3.02857</td>
<td>-0.33357</td>
</tr>
<tr>
<td>18 selling more expensive goods</td>
<td>3.06429</td>
<td>0.05246</td>
</tr>
<tr>
<td>19 selling more cheap goods</td>
<td>3.65000</td>
<td>-0.47071</td>
</tr>
<tr>
<td>20 extending service</td>
<td>8.46428</td>
<td>-0.74595</td>
</tr>
<tr>
<td>21 reducing service</td>
<td>0.55714</td>
<td>-0.03540</td>
</tr>
<tr>
<td>22 doing nothing</td>
<td>46.43570</td>
<td>1.51675</td>
</tr>
</tbody>
</table>
standardized probability that the type of reaction will be conducted. After determining the financial space for each of the 22 types of reactions, by means of reaction-specific transfer-rules, a change in the level of attributes is reached. In this case interest will only be paid to the change in total floorspace for non-daily goods. Therefore, after calculating the financial share for this type of reaction for each shopping centre, only one transfer rule has to be specified. In the present model the change in the amount of floorspace is calculated by assuming a price of Dfl. 1200,-- for each square metre of extension and Dfl. 600,-- for each square metre of reduction. This rule is based on the level of mean rental costs of floorspace for retailing in the early eighties (as far as extension is concerned) (Van Deelen en Rompelman, 1986). The price of reduction is assumed to be considerably lower, though not zero, given previous investments.

The application of the fitted functions is tied down to some restrictions. First, the functions are only applicable on the level of the shopping centre, not at the level of the individual retailer. Secondly, one has to recognize that these reaction functions are fitted on data collected in Eindhoven and applied in Maastricht. This implies that it is assumed that the findings are spatially transferable. This assumption is based on the hypothetical setting of the measurement. This is also the reason for summarizing the answers of the retailers of different shopping centres. The assumption is that differences in the character of these shopping centres do not bias the answers of the retailers with regard to the hypothetical probability question. This assumption is to a certain degree empirically supported if the average probabilities per type of reaction for each of the four retail centres are calculated and mutually compared. Many similarities seem to exist among the patterns of scores on the 22 types of reaction, as is illustrated in Table 17. In Table 17 the correlation measure R and Robinson's agreement measure RAM are calculated to express the similarity in patterns of scores, while Theil's inequity coefficient expresses the degree of dissimilarity (with 0.0 as complete similarity and 1.0 as complete dissimilarity). The table indicates that the mean answers of respondents of shopping centre IV (Strijp) deviate relatively most from those of the other shopping centres, which is probably caused by the small number of respondents.
Table 17: Similarity among the average probability scores on 22 types of reaction to changes in turnover for the retailers of 4 shopping centres in Eindhoven

<table>
<thead>
<tr>
<th>Centre</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>I City (250 shops; 61 respondents)</td>
<td>-</td>
<td>a=.90</td>
<td>a=.92</td>
<td>a=.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b=.95</td>
<td>b=.96</td>
<td>b=.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c=.12</td>
<td>c=.10</td>
<td>c=.24</td>
</tr>
<tr>
<td>II Kruisstraat (90 shops; 36 respondents)</td>
<td>-</td>
<td></td>
<td>a=.92</td>
<td>a=.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b=.96</td>
<td>b=.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c=.10</td>
<td>c=.32</td>
</tr>
<tr>
<td>III Woensel (87 shops; 32 respondents)</td>
<td>-</td>
<td></td>
<td></td>
<td>a=.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b=.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>c=.34</td>
</tr>
<tr>
<td>IV Strijp (34 shops; 12 respondents)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a= coefficient of correlation  
b= Robinson's agreement measure  
c= Theil's inequity coefficient

Third, the functions are assumed to be constant during the period of forecasts. That is, the ratios of probabilities are assumed to be stable and independent of for instance more general economic processes. Fourthly, the functions are basically only validly applicable within the domain of -15% and +15% yearly change in turnover, as a consequence of the measurement. Since one is typically focusing on the autonomous yearly changes in a particular centre, this limit in domain might not be too restrictive. However, incidentally this might be the case. If a particular autonomous change in turnover exceeds the domain, the related probability can be calculated by assuming the functions to be applicable outside the domain. Evidently, given the available data and fits, the more the limits of the domain are exceeded, the less reliable the resulting outcomes are. In addition, it is noted that the fitted functions are only applicable in the context of yearly predictions.

Finally, it is necessary to recognize with respect to the applied retailers model that 22 predefined types of reaction are incorporated. There is no strict guarantee that some types of reaction are not relevant or particular options for reaction are excluded. Evidently,
the irrelevance of a type of reaction expresses itself, at least theoretically, in terms of zero probabilities, which is not the case in the present measurement. The possible exclusion of relevant reaction types is a more serious problem. Future research should be performed to test the validity of the assumption that the 22 types of reaction included in the present approach sufficiently express the range of likely types of reaction of retailers.

6.4.4 Results of the prediction of the trend for the region of Maastricht

Additional assumptions and data

The consumer spatial choice model and the retailer spatial reactive behaviour model are now applied simultaneously to predict the trend-developments in expenditure distribution, use and viability of the retail facilities in the region of Maastricht. The prediction is made for the period 1981-1990 and is aimed at improving the insight in the possible existence of retail planning problems. For the prediction some additional information is required and some assumptions have to be made.

First, a prediction of population development in the area is required. Data for 1985 and 1990 were available. However, as a consequence of the focus within the retailer's model on yearly changes in turnovers, the prediction of the retail system operations has to be on a year base as well. Therefore, yearly figures about the population for each residential zone were calculated by way of a linear interpolation between 1980 and 1985 respectively 1985 and 1990. It appears that the population in zone 1 will increase with 25% and in zone 2 with 30% in the first five years. In contrast, in zone 3 a decrease in population is calculated of almost 50% in the period 1980-1985. In the same period the population in zone 9 will increase with 63%, whereas in zone 10 an increase in population over that period is expected of almost 50%. In all other residential zones the size of the population will be largely unchanged.

The second additional type of information concerns the distance effects of an additional bridge crossing the river Maas just north of the city of Maastricht. This bridge was planned to be opened for
traffic in 1984. The implication is that for some residential zones the city of Maastricht and some other shopping centres on the west bank of the river would be easier to reach. These changes have been measured from the map focusing on the most likely route between the residential zone and the shopping centres. In the context of the prediction of the retail system operations, the impacts of these changes in distance are assumed to be effective from 1985 onwards.

The third additional type of information required for the prediction concerns assumptions regarding:

(a) changes in the individual spending power due to general economic developments;

(b) changes in the normative turnover-to-floorspace ratios;

(c) changes in the extra turnover resulting from the recreational function of the area;

(d) changes in the costs of extension and reduction of one square metre floorspace.

Evidently, for all of these aspects alternative scenarios might be formulated and applied, so that different scenarios for the trend development would result. The original retail planning team, for example, defined two scenarios based on different assumptions of the changes on the individual spendings: a scenario assuming no change in the total consumptive expenditures during the time period until the plan horizon and a scenario assuming 0.75% increase per year in the total consumptive expenditure. The first scenario implies a change in the individual spending power in the sector of non-daily goods of a yearly -3% for the period 1980-1985 and a yearly -2.6% for the second half of the eighties. The second scenario implies a change in individual spending power in the sector non-daily goods of -1.6% per year for the first half of the eighties and -1.3% per year in the period 1985-1990. The use of scenarios is, however, not essential for the meaning of this illustration. Therefore, only one assumption for each aspect has been defined and applied. These assumptions are based on the idea that since the end of the seventies, due to general economic processes, the level of individual spending power has slowly decreased. However, a recovery of economic growth was expected during the second half of the seventies. Therefore, the assumption in this illustration is that the total consumptive expenditure during the
first half of the period 1980-1990 will remain on the same level as in 1980, but that from the mid-eighties onwards a gradual recovery of total consumptive expenditure may be expected. The consequences of this scenario have been summarized in Table 18. Note that in the period 1984-1990 a gradual recovery has been assumed, up to a mean of approximately 1% over that period. The assumptions for the changes in normative turnover-to-floorspace ratios have been based on the quite general rule that approximately 75% of the growth in total consumptive expenditure is transferred into a growth in normative turnover-to-floorspace (PARTNERS, 1982, p. 58). On the other hand, an inflexibility in those norms in case of drops in turnover is assumed. Additionally, the changes are assumed to be derived of the changes on the total expenditure level. Hence, in the first years these changes are not as large as those of the spending power: individuals are less inclined to go abroad for their holidays when the level of expenditure decreases. Thus, they tend to expend relatively more in the region. Reversely, the recreational function of the region of Maastricht will not make a complete economic recovery, as a consequence of a tendency of relatively more holidays abroad.

Finally, the yearly change in costs of realization and elimination of one square metre of floorspace has been assumed to be zero during the complete period predicted. Moreover, it is necessary to recognize

<table>
<thead>
<tr>
<th>period</th>
<th>% change in spending power</th>
<th>% change in normative turnover-to-floorspace ratios</th>
<th>% change in recreational turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980 - 1981</td>
<td>-3.00</td>
<td>0.00</td>
<td>-2.25</td>
</tr>
<tr>
<td>1981 - 1982</td>
<td>-3.00</td>
<td>0.00</td>
<td>-2.25</td>
</tr>
<tr>
<td>1982 - 1983</td>
<td>-3.00</td>
<td>0.00</td>
<td>-2.25</td>
</tr>
<tr>
<td>1983 - 1984</td>
<td>-2.50</td>
<td>0.00</td>
<td>-2.00</td>
</tr>
<tr>
<td>1984 - 1985</td>
<td>-2.00</td>
<td>0.10</td>
<td>-2.00</td>
</tr>
<tr>
<td>1985 - 1986</td>
<td>-1.50</td>
<td>0.20</td>
<td>-2.00</td>
</tr>
<tr>
<td>1986 - 1987</td>
<td>-0.75</td>
<td>0.40</td>
<td>-1.00</td>
</tr>
<tr>
<td>1987 - 1988</td>
<td>0.00</td>
<td>0.70</td>
<td>-0.50</td>
</tr>
<tr>
<td>1988 - 1989</td>
<td>0.50</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1989 - 1990</td>
<td>1.00</td>
<td>1.30</td>
<td>0.00</td>
</tr>
</tbody>
</table>
that the application of the described models assumes stability of utility functions of consumers and retailer's reactive probability functions over time. Evidently, each application of a predictive model has to make such an assumption or, alternatively, to assume particular changes in such functions.

Predictions on the overall level

The findings of the trend prediction (Van der Heijden, 1985) have to be discussed selectively. A distinction can be made between economic aspects (aspects of retailer's interests) and aspects regarding consumer spatial behaviour. An overall picture of economic developments has been summarized in Figure 17. In that figure the overall developments of the size of the population, actual turnover for the sector non-daily goods and normative turnover for this sector have been displayed in terms of indexed figures. Table 19 shows that the index 100 in 1980 for the actual turnover implies the absolute level of Dfl. 564 million, while the index 100 in 1980 for the normative turnover implies the lower level of Dfl. 406 million. The figure shows that, overall, the turnover in the sector of non-daily goods drops considerably, but tends to recover from 1986/1987. Clearly, this drop is caused by the general economic developments expected. The growth in

<table>
<thead>
<tr>
<th>Year</th>
<th>total floor-space in m²</th>
<th>total turnover in million Dfl.</th>
<th>mean turnover-to-floorspace in Dfl.</th>
<th>% difference between actual and normative turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>actual normative</td>
<td>actual normative</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>143619</td>
<td>564.3</td>
<td>405.6</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>143619</td>
<td>550.0</td>
<td>405.6</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>143331</td>
<td>536.0</td>
<td>405.6</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>143024</td>
<td>522.5</td>
<td>405.6</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>142735</td>
<td>511.5</td>
<td>405.5</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>142504</td>
<td>502.6</td>
<td>405.9</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>142199</td>
<td>496.2</td>
<td>406.4</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>142094</td>
<td>493.8</td>
<td>407.8</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>142043</td>
<td>494.9</td>
<td>410.6</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>142008</td>
<td>498.5</td>
<td>414.7</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>141983</td>
<td>504.7</td>
<td>420.1</td>
<td></td>
</tr>
</tbody>
</table>
Figure 17: Index trend development for the region of Maastricht as a whole, for the period 1980-1990.

- Population
- Normative turnover
- Total floorspace for non-daily goods
- Turnover
population is not large enough to compensate for the decrease in shopping expenditure. The reduction in floorspace is not as big as the drop in turnover. The first reason is the type of retailer reactive behaviour model applied; other types of reaction have been included since retailers tend to simultaneously apply different types of reaction. The second reason is that the overall development in floorspace is composed of very diverging developments on the level of the individual shopping centres. Figure 18 illustrates this by displaying the calculated trend development for four selected shopping centres. The main reason for the differences in the development of the economic operating of individual shopping centres is the unequal development in population size in the residential areas. In particular residential areas on the west bank of the river are confronted with a decreasing population, whereas on the east bank of the river new building programs will cause an increase of population in certain residential areas in Maastricht. Further, finishing the bridge implies changes in the accessibility to certain shopping centres.

An overall indication of the variety in the expected operating of individual shopping centres is given by some equity measures of realized turnover-to-floorspace ratios, summarized in Table 20. Clearly, Table 20 shows that in the period 1980-1990 the relative differences that appear to exist between shopping centres remain to exist. It also appears that in 1985, as compared to the preceding period, the effects of the new bridge north of the city of Maastricht become manifest in an increase of inequity. On the one hand this bridge has the effect that some small changes in the information

<table>
<thead>
<tr>
<th>Table 20: Development in turnover-to-floorspace in the sector of non-daily goods in the shopping centres in the region of Maastricht, according to the trend development, for the period 1980-1990 (in Dfl/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
</tr>
<tr>
<td>highest value</td>
</tr>
<tr>
<td>lowest value</td>
</tr>
</tbody>
</table>
Figure 18: Overview of index trend development in four selected shopping centres for non-daily goods, for the period 1980-1990

---

development in floorspace for non-daily goods
development in turnover for non-daily goods

---

development BRUSSELSE POORT
development HEER

development DAALHOF
development CITY

254
fields are introduced: particularly shopping centre 'Caberg' becomes more known to consumers in residential areas east of the river Maas because of the improved accessibility. Also some other shopping centres (Brusselse Poort, City, Mariaberg, Malberg) are more accessible because of the new bridge. Consequently, these centres can expect a positive effect of the opening of the bridge on their turnover. Evidently, some other shopping centres must expect a negative influence of finishing the bridge on their turnover (for instance Meerssen, Bunde, Nazareth, Borgharen, Itteren).

A further study of Table 19 shows that notwithstanding the overall drop in turnover and turnover-to-floorspace ratio, the difference between the overall normative and the actual level of economic operation of the retail system is on the whole positive, although this difference is decreasing from +40% to +20%. This might imply that a certain extension of floorspace is possible, though evidently only on specific locations.

With respect to consumer spatial shopping behaviour the following should be noted. First, as a consequence of the new bridge and the improving the accessibility to certain shopping centres in 1985, the average number of known shopping centres increases from 11.47 to 11.71, with a standard deviations of 2.20 and 2.40 respectively. Hence, consumers living in particular residential areas will get to know a few more shopping centres. Next, the accessibility to shopping facilities for buying non-daily goods has been measured in terms of the amount of floorspace for non-daily goods within a particular distance from the consumer's dwelling. The results are presented in Figure 19. A difference between the consumers living in Maastricht and those living in the adjacent municipalities becomes clear, as far as consumers have to travel to have access to a particular proportion of total floorspace is concerned. Consumers in Maastricht have a considerably better access to retail facilities where non-daily goods are sold than people living elsewhere in the Maastricht region. This is also illustrated by way of the average distance that consumers of each residential zone travel, as is indicated at the top of the figure. The overall picture of distance travelled is summarized in Table 21 in terms of a few equity measures. These measures clearly show that the
Table 21: Equity in average distance travelled by consumers of all residential areas for buying non-daily goods in region of Maastricht, according to the trend development, for the period 1980-1990

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean distance</td>
<td>4.249 km</td>
</tr>
<tr>
<td>Lowest distance</td>
<td>0.447 km</td>
</tr>
<tr>
<td>Highest distance</td>
<td>12.245 km</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>3.167 km</td>
</tr>
</tbody>
</table>

Inequity among the residential zones in terms of the average distance travelled for buying non-daily goods is rather large. Evidently, this situation is caused by the fact that the larger shopping centres, which have a larger choice range than the smaller shopping centres, are located within the town of Maastricht.

The degree of importance of the shopping centres in the Maastricht region in serving the consumers for buying non-daily goods is indicated by measuring the average shortest distance turnover proportion for each centre over the period 1980/1990. The shortest distance turnover proportion indicates the proportion of the total turnover of non-daily goods for a shopping centre based on the expenditure of consumers living in the geographically most near residential zone. Generally, this zone is termed as the primary service area of a shopping centre. The mean proportion for each category in the functional hierarchy as is indicated in Table 3, has been calculated. These proportions have been summarized in Table 22.

Table 22 shows that there exists a clear relationship for shopping centres between their level in the functional hierarchy and the

Table 22: Average shortest distance turnover proportion for each level of the functional hierarchy in the region of Maastricht, according to the trend development, for the period 1980-1990

<table>
<thead>
<tr>
<th>Level of the functional hierarchy</th>
<th>Shortest distance turnover proportion for non-daily goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.68</td>
</tr>
<tr>
<td>2</td>
<td>0.54</td>
</tr>
<tr>
<td>3</td>
<td>0.47</td>
</tr>
<tr>
<td>4</td>
<td>0.40</td>
</tr>
<tr>
<td>5</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Figure 19: Accessibility to retail facilities for non-daily goods, within the distance of 3 respectively 6 km. from the residence.

Average distance travelled in km:

<table>
<thead>
<tr>
<th></th>
<th>0.4</th>
<th>0.8</th>
<th>1.6</th>
<th>1.5</th>
<th>2.7</th>
<th>2.3</th>
<th>1.3</th>
<th>2.0</th>
<th>2.3</th>
<th>2.3</th>
<th>5.0</th>
<th>6.4</th>
<th>5.5</th>
<th>5.8</th>
<th>4.1</th>
<th>3.8</th>
<th>2.7</th>
<th>10.1</th>
<th>7.3</th>
<th>12.2</th>
<th>9.0</th>
</tr>
</thead>
</table>

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21.

--- Municipality of Maastricht ---

--- Remaining municipalities ---
geographical area they serve. The higher the level of the shopping centre, the more extended the service area, the lower the proportion of the total turnover that stems from the primary serving area. In addition, one has to acknowledge that consumers nowadays are very mobile, which causes many interrelationships to be possible within the retail system and also a much lower degree of expenditure of consumers in their so-called nearest distance shopping centres. The calculation of these figures resulted in the figures as summarized in Table 23.

Table 23 shows that particularly within the town of Maastricht only a minimum percentage of spending power of consumers in the sector of non-daily goods is spent in the nearest distance shopping centre. Evidently, the larger a shopping centre is, the more non-daily goods are sold, and the larger the expenditure in this nearest centre will be. The proportions for the residential zones outside Maastricht are higher than those within Maastricht because considerably less retail facilities are available within comparable distances (fewer opportunities). Consequently, the interrelationships between residential and shopping centres are less intensive compared to the municipality of Maastricht. Overall, one has to notice, however, that the calculated percentages, except for the residential zone closest to the city centre, are far lower than those often applied in a normative way in retail planning. The combination of Table 22 and Table 23 clearly indicates the relative meaning of the various types of shopping centres within the region of Maastricht for the spatial shopping behaviour of consumers who buy non-daily goods.

Table 23: Average proportion of expenditure for the sector of non-daily goods in the nearest distance shopping centres for the levels of the functional hierarchy in the region of Maastricht, for the period 1980-1990

<table>
<thead>
<tr>
<th>Level of the functional hierarchy of the nearest distance centre</th>
<th>average expenditure proportion for residential zones within the municipality of Maastricht</th>
<th>average expenditure proportion for residential zones outside Maastricht</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.03</td>
<td>0.10</td>
</tr>
<tr>
<td>2</td>
<td>0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>0.05</td>
<td>0.35</td>
</tr>
<tr>
<td>4</td>
<td>0.11</td>
<td>0.45</td>
</tr>
<tr>
<td>5</td>
<td>0.92</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Table 24: Economic trend development of the shopping centres City and Oud-Wyck for the sector of non-daily goods, for the period 1980-1990

<table>
<thead>
<tr>
<th></th>
<th>Turnover in million Dfl.</th>
<th>Floorspace in m²</th>
<th>Turnover-to-floorspace ratio actual (in Dfl.)</th>
<th>Turnover-to-floorspace ratio normative (in Dfl.)</th>
<th>% difference turnover-to-floorspace ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>356.8</td>
<td>80022</td>
<td>4458</td>
<td>2853</td>
<td>56.3%</td>
</tr>
<tr>
<td>1981</td>
<td>343.6</td>
<td>80022</td>
<td>4293</td>
<td>2853</td>
<td>50.5%</td>
</tr>
<tr>
<td>1982</td>
<td>329.8</td>
<td>79781</td>
<td>4134</td>
<td>2853</td>
<td>44.9%</td>
</tr>
<tr>
<td>1983</td>
<td>317.1</td>
<td>79517</td>
<td>3988</td>
<td>2853</td>
<td>39.8%</td>
</tr>
<tr>
<td>1984</td>
<td>306.2</td>
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<tr>
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<tr>
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<tr>
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<tr>
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<tr>
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</tr>
<tr>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>1990</td>
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<td>13358</td>
<td>1146</td>
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</table>

Predictions for the shopping centres in the central area of Maastricht

So far the findings of the trend prediction have been discussed on an overall level. Because of the specific aim of the research project, i.e. the development of a retail plan for the central area of Maastricht, special attention has to paid to to the shopping centre 'City' and 'Oud-Wyck', both located within that area. Table 24 presents the figures for both centres in respect of the trend development for
the trend development for turnover, the amount of floorspace and turnover-to-floorspace ratios. The table shows that the City of Maastricht will be confronted with a considerable drop in turnover during the first half of the eighties, whereas the turnover in Oud-Wyck will slightly increase in the same period. Differences in development of the size of the population in nearby located residential areas account for these differences in development in turnover. In accordance with the development in turnover, the amount of floorspace in the City centre tends to decrease with about 13%. In contrast, the amount of floorspace in Oud-Wyck remains approximately equal. The difference between both shopping centres is important as far as it concerns the difference between the actual turnover-to-floorspace ratio and the normative turnover-to-floorspace ratio. Throughout the predicted period the economic margin for the City remains positive, although it will decrease from 56% to 30% in 1990. For shopping centre Oud-Wyck, however, this margin is extremely negative. Oud-Wyck even has the most negative margin between normative turnover-to-floorspace ratio, given the amount of floorspace, and the actual turnover-to-floorspace ratio of all shopping centres in the town of Maastricht. These figures indicate that, notwithstanding the negative influences of the trend in the development of population and general economic variables, the City of Maastricht operates economically in a strong way. Even a certain extension of floorspace might be taken into consideration. In contrast, despite positive influences of population growth, the shopping centre Oud-Wyck cannot recover from the sub-optimal level of economic operation that was noted before. This does not necessarily imply an autonomous reduction of floorspace. However, it is very likely that a decline will become manifest in other ways: changes in branches, no upkeeping of buildings, relatively few employees and so on. Partly, these effects became already manifest during the second part of the seventies. Therefore, the planning team decided in 1980 to seek out a plan that could at least improve the operation of 'Oud-Wyck'. Hence this decision was made on the basis of the results of the model outcomes, illustrating the learning process associated with the decision support system use.
6.5 Retail plans for the central area of Maastricht

Relationship with the DSS

The second stage of the decision process model that underlies the DSS involves the identification of alternative retail plans. This section deals with that aspect for the planning of the retail functions in the central area of Maastricht.

EXPLORATION (6.3 & 6.4)
RETAIL PLANS (6.5)
IMPACT ASSESSMENTS (6.6)
MULTICRITERIA EVALUATION (6.7)
MONITORING

the retail system in the region of Maastricht were presented. Since the research project was initiated to develop a spatial structure plan for the central area, retail plans focus on the shopping centres within that limited area and not on the complete region of Maastricht. In this case study the thoughts of the original retail planning team on retail plans for the central area are accepted. The retail planning team decided to propose a number of alternative plans generated in a series of successive sessions in which the impacts of previous plans were discussed. The following 8 plans resulted from the feedbacks between plan definition and preliminary impact-assessments.

Plan 1: focuses on considerably improving the conditions of retailing in 'Oud-Wyck'. These improvements regard the accessibility for car-owners by creating better parking facilities (the index in Table 5 increases from 1.8 to 2.0) and the atmosphere (the index increases from 2.8 to 2.9). The total amount of floorspace is not deliberately changed.

Plan 2: pursues a reduction of floorspace for non-daily goods in 'Oud-Wyck'. In order to get an idea about the degree of reduction, the following simple calculation rule can be followed. The relatively 'worst' situation occurs in 1980. The acceptance of half of the normative turnover-to-floorspace ratio mentioned as a threshold implies, given the actual level of turnover, approximately 8200 viable square metres floorspace for non-daily goods. This in its turn means a remainder of about 5200 m² non-viable floorspace in the sector of non-daily goods. Given this simple calculation, the planning team decided to consider a reduction of floorspace with 4000 m², keeping the conditions for parking and atmosphere constant.

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Plan 3: Combines the policy measures regarding 'Oud-Wyck' proposed in plan 1 and plan 2.

Further considerations in the planning team concerned the position of the City centre of Maastricht. Although the turnover during the period 1980/1990 is expected to decrease, the city centre operates on a level that exceeds the norm of viability with at least 30%. This implies that a considerable extension of floorspace might be realized without threatening the viability of floorspace in the City centre. The planning team therefore also decided to consider the consequences of the following plans.

Plan 4: implies the extension of floorspace in the sector of non-daily goods in the City centre of Maastricht with 8000 m². All other conditions (accessibility, atmosphere) are assumed to be equal.

Plan 5: adds to plan 4 the full set of policy measures regarding shopping centre 'Oud-Wyck' (plan 3).

Finally, the planning team had to take into consideration claims on the extension of floorspace in the shopping centre 'Heer'. The trend development showed that an increase of turnover in Heer could be expected throughout the period 1908/1990, which is related to the growth in population in adjacent residential zones. Because of these claims the planning team also decided to reconsider the following plans.

Plan 6: implies an increase of floorspace for non-daily goods in 'Heer' of 1500 m², in combination with the policy measures regarding 'Oud-Wyck', proposed in plan 1.

Plan 7: proposes an increase of floorspace for non-daily goods in 'Heer' of 1500 m² and, additionally, all policy measures with regard to Oud-Wyck, namely: reduction of floorspace and improving conditions (plan 3).

Plan 8: implies the extension of floorspace in 'Heer' in the sector of non-daily goods with 1500 m² and the policy measures proposed for 'Oud-Wyck' in plan 3. In addition an extension of floorspace is proposed for the sector of non-daily goods in the City centre with 6000 m². Hence, the change in the City centre is not as considerable as in plan 4 and 5.

Given these plans, insights are needed in the conditional impacts of these plans in order to be able to evaluate each plan. Therefore, each plan has been subjected to a prediction, the results of which are discussed in the next subsection.
6.6 Assessments of the impacts of the retail plans

**Relationship with the DSS**

The third stage of the decision process model that underlies the DSS is focused on the prediction of the impacts of alternative plans. This section describes the results of such predictions in respect of plans for the retail system of Maastricht.

The models used for predicting the trend development are also used for the assessment of the impacts of the retail plans. The conditions of the calculations are set by defining each plan in terms of the independent planning variables of floorspace, distance, price, parking facilities and atmosphere. Evidently, the assumptions discussed in section 6.5 in the context of the prediction of the trend development of the retail system, as well as the opening of the bridge, are invariate in each run. The most interesting information now concerns the impacts of each plan relative to the expected trend development. Focusing on this type of information, the following insights result in respect of the economic operation of the shopping centres the retail plans apply to. First attention is paid to 'Oud-Wyck'. Next, aspects regarding the City centre are discussed and, finally, the aspects of the operation of Heer are considered.

Table 25 presents the indexed figures for the predicted development of the actual turnover-to-floorspace ratio in Oud-Wyck, in which context the trend development serves as a base for comparison. The impacts of each retail plan are assumed to become first manifest in 1983. Table 25 indicates that except for plan 4 (the extension of floorspace in the City centre, without policy measures in Oud-Wyck) all plans cause an improvement of the turnover-to-floorspace ratio for non-daily goods in Oud-Wyck. The least effect has plan 2, which pursues the mere reduction of floorspace in the sector of non-daily goods with about 1/3. In contrast, the improvement of the conditions of parking and atmosphere proposed in plan 1, has a considerably more positive influence on the turnover-to-floorspace ratio. In case of plan 1, the level of turnover-to-floorspace ratio improves from an average of
Table 25: Index development of turnover-to-floorspace ratio for the sector of non-daily goods in shopping centre Oud-Wyck for 8 retail plans, for the period 1980-1990

<table>
<thead>
<tr>
<th>years</th>
<th>trend</th>
<th>plans</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</tr>
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<td>1980</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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</tr>
<tr>
<td>1981</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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<td>255.2</td>
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<tr>
<td>1989</td>
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<td>1990</td>
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<td>mean</td>
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<td>226.1</td>
<td>104.6</td>
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approximately 67% below the calculated normative turnover-to-floorspace ratio for the trend up to approximately 16% below the norm. Plan 2 causes an improvement up to about 65% below the normative level, which is only marginal.

The effects of plan 3 and the plans 5 to 8 on the turnover-to-floorspace ratio for non-daily goods in Oud-Wyck are comparable. Plan 3, pursuing a reduction of floorspace in Oud-Wyck and the improvement of parking facilities and atmosphere, has the most positive effect on the turnover-to-floorspace ratio. Although the level remains approximately 10% below the normative turnover-to-floorspace ratio, it would mean a quite satisfactory result.

Plan 4 implies the extention of floorspace in the City centre of Maastricht in the sector of non-daily goods with about 10%, despite the tendency of loosing turnover during the period 1980-1990. The effects calculated for the City centre are displayed in Figure 20, in which the expected development in turnover is compared to the trend development, in terms of index figures (1980=100). As expected, the absolute level of turnover in the City centre increases considerably when the amount of floorspace increases with 8000 m², all other conditions being equal to those of the calculated trend. Moreover, the
level of actual turnover-to-floorspace ratio appears to be about 1.5% higher during the period 1983 to 1990 than in the case of the expected trend development. This indicates that the greater attractiveness has a relatively more positive effect than was expected. In other words: the relationship between the increase of floorspace and the patronage of consumers is not linear. The dominating effect of plan 4 is that the City centre strengthens its position in the functional hierarchy in the retailing system of the Maastricht region absolutely as well as relatively.

Evidently, these effects are somewhat less manifest, though obvious, in the case of plan 5. Plan 5 pursues, besides the increase of floorspace in the City centre, a reduction of floorspace in Oud-Wyck and the improvement of parking facilities and atmosphere in Oud-Wyck. In the case of this plan, the City centre realizes a higher level of

Figure 20: Turnover development in City Centre for plan 4, as compared to the trend, for the period 1980-1990

![Turnover Development](image-url)
turnover. This higher level also implies a relatively higher level of turnover-to-floorspace ratio, as compared to the trend. This is indicated in terms of the value 1.003 for the average shift in the turnover-to-floorspace ratio for the sector of non-daily goods, for the period 1980-1990, as compared to the trend. Calculated over the period 1983-1990, the average shift appears to be 1.004.

Plan 8 involves the extension of floorspace for non-daily goods in the City Centre to 86000 m² in combination with an extension of floorspace in Heer of 1500 m² in the same sector and all measures regarding Oud-Wyck proposed in plan 3. Under the conditions of this plan, the City centre also realizes a considerable higher level of turnover. However, the level of turnover-to-floorspace ratio is lower than the trend in this case, contrary to plans 4 and 5. The value of the average shift in turnover-to-floorspace ratio for the period 1980-1990 as compared to the trend is 0.996 (for the period 1983-1990: 0.995). Nevertheless, the difference between actual and norm turnover remains positive during the whole period.

Finally, the development of shopping centre Heer, given the conditions of the retail plans 6, 7 and 8, should be dealt with. As noted before, plan 6 implies the increase of floorspace for non-daily goods in Heer with 1500 m² plus the improvement of the conditions for parking and atmosphere in Oud-Wyck. Plan 7 adds to plan 6 the reduction of floorspace in Oud-Wyck with 4000 m² in the sector of non-daily goods. Lastly, plan 8 adds to plan 7 the increase in amount of floorspace for non-daily goods in the City centre with 6000 m². Hence, the planning measures for Heer involve an increase in the amount of floorspace for non-daily goods with more than 20% in all three plans. In Figure 21 the development of turnover for the three plans has been displayed in terms of index figures, the trend serving as a base. The affect of the plan is remarkable. Only plan 7 causes a higher level of turnover than the trend does. In the case of this plan, the attractiveness of Heer relative to Oud-Wyck, where floorspace is considerably reduced and parking and atmosphere are considerably improved, is seemingly increased. This is not the case in plan 6, where the attractiveness of Oud-Wyck is seemingly increased as the result of the improvements in the parking facilities and the
atmosphere, than the attractiveness of Heer. Evidently, this effect is even stronger in the case of plan 8.

These impacts on the development in turnover have their consequences on the turnover-to-floorspace ratios. The average proportional shift in turnover-to-floorspace ratio for the period 1980-1990 for Heer is in the case of plan 6: 0.886, in the case of plan 7: 0.906 and in the case of plan 8: 0.854. The value lower than 1.0 in case of plan 7 stems from the fact that the increase in turnover is not linearly related to the amount of floorspace. The lower levels of turnover-to-floorspace ratio in their turn imply that the difference between the actual turnover-to-floorspace and the norm turnover-to-floorspace for Heer changes. This is illustrated in Figure 22. The figure shows that the positive margin is reduced with 20 to 30%, but still remains positive on a lower level.

Figure 21: Index turnover development in shopping centre Heer for the plans 6, 7 and 8, as compared to the trend, for the period 1980-1990
The discussion above of the impacts of the 8 retail plans has been limited to the direct effect on the centres deliberately influenced in their operations. Evidently, these changes may also have consequences for the operation of the shopping centres not directly influenced by way of retail planning measures. Moreover, different effects may occur on consumer spatial choice behaviour and on aspects of general interest. Therefore, to elicit the most preferred retail plan, it is necessary to catch these secondary effects as well and also to take into consideration with regard to the taking of decisions. The next section deals with this dimension of the applied retail research approach.

Figure 22: Percentage difference between actual and normative-turnover-to-floorspace ratio for shopping centre Heer, for plan 6, 7 and 8
6.7 Multicriteria evaluation

The fourth stage of the decision process model that underlies the DSS involves the multicriteria evaluation of plans in respect of their impacts. This section describes the results of such an analysis for the retail system in the region of Maastricht.

A final step in this case study involves the multicriteria evaluation of the 8 alternative retail plans in order to get an idea of the relative overall value of each plan, given a variety of interests and weights attached to these interests. In section 5.4 it has been argued that three evaluation methods seems particularly suitable in the context of evaluating retail plans, namely the substracted summation technique, the substractive shifted interval technique and the additive interval technique. In this illustration all three methods will be applied in order to be able to compare the possible differences in outcomes of the methods. The evaluation of the 8 retail plans, given their effects on the operation of the retail system in the Maastricht region, requires the translation of the predicted impacts for the period 1980-1990 into a set of evaluation criteria. Normally, the selection of indicators is a matter of discussion for the participants in the planning group. In this case study the following set of criteria, each of them discussed in section 5.4, is arbitrarily selected.

With regard to the retailer interests:

1. the average yearly proportional shift in turnover-to-floorspace ratios for shopping centre 'City', as compared to the trend development;

2. the average yearly proportional shift in turnover-to-floorspace ratios for shopping centre 'Oud-Wyck', as compared to the trend development;

3. the average yearly proportional shift in turnover-to-floorspace ratios for shopping centre 'Heer', as compared to the trend development;
4. the average yearly proportional shift in turnover-to-floorspace ratios for the shopping centres not included in the plan, as compared to the trend development;
5. the average frequency of turnover-to-floorspace ratios for the shopping centres included in the plan that are lower than the trend turnover-to-floorspace ratios;
6. the average frequency of turnover-to-floorspace ratios for the shopping centres not included in the plan that are lower than the trend turnover-to-floorspace ratios;
7. the average frequency of turnover-to-floorspace ratios for the shopping centres included in the plan that are lower than their normative turnover-to-floorspace ratios;
8. the average frequency of turnover-to-floorspace ratios for the shopping centres not included in the plan that are lower than their normative turnover-to-floorspace ratios;
9. the average yearly proportional shift in expenditure of consumers living within the distance of 3.0 km from the shopping centres included in the plan, as compared to the trend development;
10. the average yearly proportional shift in expenditure of consumers living within the distance of 3.0 km from the shopping centres not included in the plan, as compared to the trend development;
11. the average yearly proportional shift in the shortest distance turnover proportion for shopping centres not included in the plan, as compared to the trend development;
12. the average yearly proportional shift in the shortest distance turnover proportion for shopping centres included in the plan, as compared to the trend development;
13. the average yearly proportional shift in the total floorspace for non-daily goods of shopping centres not included in the plan, as compared to the trend development.

Equity in the average difference between the actual and normative turnover-to-floorspace ratios for all shopping centres, for the development according to the plan, as compared to the trend development indicated by means of:
14. the mean;
15. the range function;
16. the standard deviation;
17. Pearson's coefficient of variance;
18. Niehans coefficient;
19. the variance of logarithms;
20. Weighted relative entropy index of inequality.

With regard to the consumer interests:
21. the average yearly proportional shift in familiarity with retailing floorspace, as compared to the trend development;
22. the average yearly proportional shift in the retailing floorspace consumers have access to within a distance of 3 km from the residential dwelling, as compared to the trend development;
23. the average yearly proportional shift in the retailing floorspace consumers have access to within a distance of 6 km from the residential dwelling, as compared to the trend development;
24. the average yearly proportional shift in the nearest centre expenditure proportion (excluding the residential zone nearest to the City centre) as compared to the trend development.

Equity in the average distance travelled from residential zones to the shopping centres in the situation conditioned by the plan, as compared to the trend development, indicated by means of:
25. the mean;
26. the range function;
27. the standard deviation;
28. Pearson's coefficient of variance;
29. Niehans coefficient;
30. the variance of logarithms;
31. Weighted relative entropy index of inequality.

With regard to public interests:
32. the average yearly proportional shift in total distance travelled, as compared to the trend development;
33. an index for the expected direct public costs of realizing the plan;
34. an index for the amount of space that becomes available for land use functions other than retailing, as the result of plan effectuation;
35. an index for the degree to which the inter-regional attractiveness for retailing in the central area of Maastricht as shopping area is increased.
The impacts of the plans defined, quantified by means of the values of the abovementioned indications/criteria, are summarized in Table 26. That table indicates that the values of almost all criteria vary over the 8 retail plans. The first three criteria have already been discussed in the previous section. Criterion 5 and 7 are directly related to each other. The values of criterion 4 indicate that, except for plan 2, the turnover-to-floorspace ratio of the centres not included in the plan are lower than their trend turnover-to-floorspace ratios. Criterion 6 and 8 are directly related to these impacts: criterion 6 measures the average yearly frequency of actual turnover-to-floorspace ratios lower than the trend turnover-to-floorspace ratios, and criterion 8 indicates that the average yearly frequency of the actual turnover-to-floorspace ratios are lower than the calculated norms. The values of criterion 9 indicate that the shopping centres included in the plan become more attractive to consumers living within a distance of 3.0 km from these centres, except for shopping centre Oud-Wyck under the conditions of plan 2. Criterion 10 renders the value for the remaining shopping centres, indicating that these shopping centres become relatively less attractive for consumers within a distance of 3.0 km from these centres except in the case of plan 2. In addition, criterion 11 and 12 measure the average yearly shift in local attractiveness of the shopping centres. A value greater than 1 indicates that generally a larger part of the turnover in the shopping centres stem from consumers living in the residential zone with the shortest distance to these shopping centres.

The values of criterion 12 indicate that the centres included in all plans, except plan 2, become relatively more attractive for consumers living at greater distances: a smaller part of their turnover stems from consumers living in the primary service area. The values of criterion 11 are the opposite of those of criterion 12, which implies that the centres not included in the plan become relatively less attractive for consumers at greater distances and, consequently, get a somewhat more local meaning. Criterion 13 measures the average yearly shift in autonomous changes in floorspace as a result of the plan, as compared to the trend. Its values are consistent with the values on the previous criteria: shopping centres not included in the plan have less financial margins to increase their amount of floorspace than in
the case of the trend development. The next 7 criteria are measures of the change in equity in turnover-to-floorspace ratio as compared to the trend. Overall, the plans cause a slight increase in inequity in turnover-to-floorspace ratios, except for plan 2.

As far as the criteria related to consumer interests are concerned, criterion 21 indicates the average proportional shift in familiarity with amounts of floorspace for non-daily goods. Some plans (4, 5, 6 and 8) cause a higher degree of familiarity, while the others cause a lower degree. This is quite consistent with the values of criteria 22 and 23, which denote the average proportional shift in accessibility to floorspace within a distance of 3.0 and 6.0 km respectively from the residential area. Criterion 24 gives an indication of the proportion of expenditure of consumers in their nearest distance shopping centre. Except again for plan 2, all other plans cause a lower degree of expenditure for non-daily goods in the shopping centre at the shortest distance. Hence, these centres become less meaningful for consumers, as compared to the trend. A consequence is that for most of the plans the mean travelled distance increases, which is indicated by means of the values of criteria 32. The changes in equity in the mean travelled distance from residential zones to the shopping centres are indicated by means of criteria 25 to 31. Overall, they indicate that the introduction of the plans slightly increases the inequity in this respect.

Finally, criteria 33 to 35 are introduced to indicate differences in some aspects that might be relevant for public spatial policies. Criteria 33 gives an index for the direct investments expected related to the effectuation of the plans. Plan 8 and plan 3 are assumed to score highest in this point. Further, criterion 34 indicates the amount of land that becomes available for other purposes as a consequence of plan implementation. In this respect, plan 2 has the highest value, since in this plan a reduction of floorspace with 4000 m² in Oud-Wyck is pursued. Finally, the values of criterion 35 indicate to which degree each plan is assumed to contribute to the increase of the inter-regional attractiveness of the shops located in the central area of Maastricht. Plan 5 and plan 8 have received the highest values, because they on the one hand improve the attractiveness of Oud-Wyck by means of better parking facilities and an improved
Table 26: Impacts of 8 retail plans for the central area of Maastricht in terms of the values of 35 evaluation scores

<table>
<thead>
<tr>
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<th>Plans</th>
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</tr>
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<td>2</td>
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</tr>
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<tr>
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</tr>
<tr>
<td>14</td>
<td>0.999</td>
</tr>
<tr>
<td>15</td>
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</tr>
<tr>
<td>16</td>
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<td>20</td>
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<td>21</td>
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<tr>
<td>22</td>
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</tr>
<tr>
<td>35</td>
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</tbody>
</table>

atmosphere and on the other hand pursue a considerable extension of floorspace for non-daily goods in the City centre.

The variety in criteria and criteria values makes it difficult to get a complete picture of the effects of the retail plans. The application of multicriteria evaluation methods has been argued to be helpful in this respect. Qualitative and quantitative variables are mixed up in the evaluation phase. In the case of the set of criteria
mentioned above, criteria 5, 6, 7, 8, 33, 34 and 35 are considered to be of a qualitative nature. This assumption might be subject of discussion with regard to the first four of these criteria, because their values have been calculated in such a way that they could be used as cardinal data. However, their values are considerably dependent upon the number of years in the period for prediction. Therefore, the values of these four indicators are preferably considered as ordinal values. The multi-criteria evaluation of the 8 retail plans now involves three steps:

- the standardization of the evaluation scores;
- the definition of a weight for each criterion accepted in the multi-criteria evaluation; and
- the multicriteria evaluation analysis.

With respect to the first step the standardization of the values should take place according to equation (5.3.4). Next, the standardized scores have to be directed in the same way, since a higher value of one criterion might imply a better score, whereas a higher value of another criterion implies a worse score. In Table 27 the direction of each criterion has been indicated by a + or -, the first sign implying that a higher score must be interpreted as being better. Evidently, the second score has the reverse meaning. With respect to the second step, i.e. the definition of weights to attach to each of the included criteria, several approaches are possible. Again it is stressed that this depends upon political considerations. Hence, these weights have to be put forward by the participants in the planning group. In this illustration 4 strategies are chosen:

- no extra weight is put on criteria related to whatever interest group;
- extra weight is put on criteria related to retailer's interest (criterion 1-20);
- extra weight is put on criteria related to consumer interests (criterion 21-31);
- extra weight is put on criteria related to public interests (criterion 32-35).

Further, in all plans an extra weight is given to criterion 2, denoting the average yearly proportional shift in turnover-to-floorspace ratios in shopping centre Oud-Wyck. For determining the weights for each criterion, the following procedure is followed. Assume that the sum of
Table 27: Directions and weights of the criteria included in the multicriteria evaluation of the 8 retail plans

<table>
<thead>
<tr>
<th>Criteria</th>
<th>direction</th>
<th>weight sets</th>
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<tr>
<td></td>
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<td>I</td>
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<tr>
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<td>7.69</td>
</tr>
<tr>
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<tr>
<td>35</td>
<td>+</td>
<td>25.00</td>
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</table>

the weights for the criteria related to a particular interest is equal to 100. In addition, for each group of criteria this total weight is equally distributed over the criteria. In this context, it is relevant to note that for the consumer interest the group of criteria which measures the (in)equity in distance travelled is considered as one criteria. The same is applied to the measurement of (in)equity in turnover-to-floorspace ratios. Further, criterion 2 is considered as a
special group with the total weight of 25.00. Finally, within the
group of criteria for consumer interests, criterion 24 and criterion
23 partly measure the same effect. Consequently, criterion 24 is
considered to be of less relevance in respect of the other criteria.
Applying these rules for the determination of the weight for each
criteria results in the weights summarized in Table 26 for each weight
set. The special emphasis on one of the three groups is indicated by
doubling the weights of the criteria within that group.

The final step involves the application of the three multicriteria
evaluation methods (Timmermans, 1983). The result of these methods is a
rank ordering of the plans, given the evaluation values and the weights
attached to the included criteria. In Table 27 these rank orders for
each of the 3 applied methods and each of the 4 weights sets are
summarized.

The table shows that when no special emphasis is put on whatever
interest group (weight set 1), plan 5 is the most preferred plan. In
the case of special weight put on retailer interests (weight set 2),
the most preferred plan appears to be plan 3, which implies the
reduction of floorspace in Oud-Wyck plus the improvement of the
conditions for parking and atmosphere. The emphasis on consumer
interests (weight set 3) causes a preference for plan 5, while the
extra weight put on public interests makes plan 1 the most preferred
plan (implying improvement of the conditions in Oud-Wyck). The most
remarkable difference between interest groups seems overall to exist
between consumer and retailer interests. Note for instance the
difference in the rank order of plans 1, 3 and 8. The rank order
according to the extra weight on public interests is more similar to
the rank order related to extra weight on retailer interests. Finally,
it is interesting to note that the application of the three multi-
criteria evaluation methods render highly similar results.

6.8 Conclusions
In this chapter some main elements of the proposed retail planning
decision support system have been illustrated in relation to the
retail system of the Maastricht region. The illustration involved the
exploration of the retail system, the prediction of the trend
development, the identification of problems, the assessment of impacts
Table 28: Results of multicriteria evaluation in terms of rank order figures

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<th>Multicriteria evaluation methods:</th>
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<td>subtractive interval method</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Weight set 1: no special emphasis</td>
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</tr>
<tr>
<td>plan 1</td>
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</tr>
<tr>
<td>&quot; 2</td>
<td>7</td>
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<td>Weight set 2: special emphasis on retailer interests</td>
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<td>Weight set 4: special emphasis on public interests</td>
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278
of retail plans and the multicriteria evaluation of these plans. A number of analyses distinguish this approach from currently applied retail research for the support of structural retail planning:

- the use of an individual multiattribute preference model based on conjoint measurement, for the description and prediction of consumer spatial choices;
- within the context of that model: the application of a model for predicting the information fields of consumers;
- the use of a retailer reactive behaviour model to determine autonomous changes in floorspace of retail facilities;
- the evaluation of the impacts of retail plans on the basis of the predicted trend development of the retail system;
- the quantification of these impacts in a large number of indicators related to consumer-, retailer- and public interests; and
- the application of multicriteria evaluation methods to select the most preferred plan.

Generally, the approach turned out to work satisfactorily. One main characteristic of the approach is the elaboration of the consumer spatial choice model. It was shown that the applied model rendered a satisfactory description of observed patterns of consumer spatial choice behaviour in the context of buying non-daily goods. Further the application of a logit-model to predict the information fields of consumers, the parameters of which have been estimated in another spatial context (i.e. Eindhoven), turned out to be promising. The retailer model has been estimated on data collected in Eindhoven. Its use did not cause remarkable changes in the operation of the retail system, but on the other hand gave insight in the tendencies of some consequences of the economic operation of individual shopping centres. As such, it is a worthwhile extension of modelling consumer spatial choices only. In order to improve the comparison of different retail plans, the choice for the trend development as the fundament of this comparison seems a better one than one which compares impacts in terms of absolute norms. Much more insight in the dynamics of the retail system is gained. Moreover, for many of the criteria used to indicate the impacts of different plans, norms are simply not available. In this case study, some possibilities for a more balanced approach have been illustrated. Evidently, further elaboration is possible and, in
practice, dependent upon the wishes of the decision makers. The use of the multicriteria evaluation methods is a pleasant way for coping with the resulting body of knowledge of the impacts of a set of plans according to the various emphases on different interest groups. It underlines the possibilities argued to establish a more balanced approach to support retail planning.
CHAPTER 7: DISCUSSION

7.1 Introduction
This chapter intends to give a short critical evaluation of some main elements of the study described in the previous chapters. The evaluation starts from the awareness that the findings of this study are certainly not the only and definitive answer to the problems of applied retail research. The study pretends to improve the coping with problems of retail planning and applied retail research on a structure planning level. In this chapter attention will be first paid to some aspects of the substantive toolkit for the DSS that has been suggested (section 7.2). Next, attention will be paid to some main assumptions and aspects of the theoretical notions underlying the operational part of the DSS (section 7.3). Finally, the evaluation focuses on the DSS approach in relation to the nature of retail planning (section 7.4). Again, these sections correspond to the three levels of analysis chosen in this study. The issues to be discussed concern basic elements of the suggested approach on these levels.

7.2 Evaluation of some aspects of the methodology
The substantive toolkit of methods, models and indices for the DSS suggested in chapter 5 of this study is to a considerable degree based on the cognitive-behavioural approach of individual actors in the retail system. With respect to that approach the following aspects will be dealt with:
- the measurement of preferences for simulating consumer spatial choices (7.2.1);
- the costs of data collection (7.2.2);
- the retailer reactive behaviour model (7.2.3);
- the number and types of indices (7.2.4).

7.2.1 The measurement of utilities
The direct measurement of preferences of consumers for shopping centres, using experimental designs, is essential for the (de-) compositional multiattribute preference approach. Sometimes doubts
are expressed on the validity of these types of measurements and it is argued that people cannot subjectively evaluate a number of hypothetical choice alternatives in terms of preferences. Consequently, these critics doubt the reliability of evaluation data. Clearly, the measurement of preferences is more complex than the measurement of, for example, overt choice patterns which is typical for modelling in currently applied retail research. However, the complexity is not an argument for not performing such measurements, given the obvious advantages for the development and application of more sophisticated spatial choice models. Since spatial shopping behaviour on the level of the shopping centre is generally hardly influenced by social standards, its underlying evaluation and decision making process is quite reasonably recognizable. And consumers are themselves quite aware of that process. The question, therefore, is not whether preferences are measurable but rather how they can be measured and under which circumstances the reliability of measurements is reduced or increased. In the past, the surveys described in literature with a focus on the measurement of preferences by applying experimental designs, have paid special attention to tests on the internal and external validity of measured preferences (compare e.g. Timmermans, 1985; Timmermans, Van der Heijden and Westerveld, 1983, 1984b; Veldhuisen and Timmermans, 1984). Also comparative empirical studies focused on the effects of different measurement methods. The findings of such studies are quite promising; they suggest that the results of preference measurements do not vary systematically with the type of measurement method applied, that respondents are generally consistent in their answers and that subjective preferences for different types of choice alternatives are systematically related to the different natures of real-world choice alternatives on one hand and overt choice behaviour on the other.

7.2.2 Costs of data collection
A problem related to the issue discussed in 7.2.1 is the trade-off between the costs of data collection and the richness of data. Currently a very cost demanding aspect of the use of expenditure models in applied retail research is the collection of data to estimate the parameter(s) of the model in use. The typical feature of the estimation
of the gravity, entropy-maximizing and discrete choice models is that reliable choice probabilities related to each choice alternative are needed. These probabilities are calculated on the basis of observed origin-destination interaction flows. In order to construct a reliable origin-destination interaction matrix a relatively large number of observations is necessary to improve the reliability. In the past, these observations were generally based on personal interviews at home. Alternatively, Borchert, Doorn and Floor (1984) have proposed a method based on interviewing individuals by telephone so as to reduce the costs of research. This approach has also been suggested in the context of the present DSS proposals for monitoring. This method might possibly yield unreliable data on choice patterns because of the inherent limits of measurement by telephone and problems of motivating respondents. Future research should analyze the validity of this criticism. Hence, the definition of a reliable origin-destination interaction matrix remains a crucial and cost-demanding measurement problem in the context of the application of the aforementioned model types.

A problem of the (de)compositional multiattribute preference models is that the collection of data for estimating the parameters is a considerably more complex task than the data collection problem discussed above. According to Timmermans (1984c), the reliability and validity of the measurements may be relatively weak, if, for example, the respondents cannot be motivated, the experimental task is unrealistic, respondents are not able to respond consistently because they do not understand the question, or when respondents have not developed a stable preference structure. The only possibility to collect reliable data, therefore, is to use the method of personal interviews, performed by trained interviewers. Moreover, several internal and external consistency tests are needed to check the reliability of the data. Hence, the approach might cause relatively high costs for data collection. On the other hand, a relatively small number of respondents might be sufficient because of the stepwise modelling of the individual's decision making process. Depending upon the complexity of the model specification this might compensate for the measurement complexity. Moreover, since the model is defined in terms of a set of successive submodels, data collection might be subdivided over the samples: subgroups of respondents give answer to different
questions within the questionnaire. Of course, in that case not all validity tests may be performed on the individual level. Aggregation is performed afterwards. On the one hand the advantage is that the data collection might be restricted to what is statistically needed in the context of every modelling step, whereas on the other hand the external validity (generalizability of the model) is increased because the data used for particular model steps stem from different samples.

Therefore, it is difficult to give a general statement for the trade-off between costs and measurement complexity. The evaluation of that trade-off should also be embedded in considerations about the usability and richness of the data. The richness of the data collected in the context of research based on the described theoretical framework can be significantly higher than the data currently collected in the context of applied retail research. As to the aspect of usability, it is assumed that a model specified on the basis of data gathered in experimental measurement settings has a high degree of spatial generalizability, which implies that it may be sufficient to measure preferences at one point in time and apply them in other spatial contexts. Hence, in applied retail research the data collection problem is embedded in the trade-off between the difficulty of the respondent's evaluation task and the advantages of various methods of parameter estimation. Clearly, it is an issue of further basic retail research to empirically test the (dis)advantages of various measurement designs and improve the applicability of the multiattribute preference model in the context of applied retail research. Meanwhile, however, no theoretical or practical reasons related to the measurement of preferences using experimental designs are known to reject this type of model for application in the context of applied retail research.

7.2.3 The retailer reactive behaviour model
The extension of the cognitive-behavioural approach to the domain of reactions of retailers in shopping centres to changes in their business environment, is a progress relative to accepted theories in current applied retail research. It is, however, obvious that the suggestions at this point in this study are only a first step to linking more systematically and on comparative levels the supply and demand side of the retail system in order to catch some dimensions of the system's
operations theoretically as well as in terms of an operational methodology. Evidently, the present proposals lack a body of basic knowledge of retailer behaviour from the perspective that is described in this study. That knowledge has to be developed in the future so as to arrive at more elaborated and sophisticated approaches.

The model used to illustrate the region of Maastricht is to a large degree influenced by the type of data available. As mentioned before, these data were collected with the primary aim to arrive at some basic insights in these issues and, secondly, to enable a preliminary inductive modelling. The results of the analyses of these data make it easier to perform more and more focused measurements in order to transfer the general insights in cognitive-behavioural aspects of retailer reactive behaviour into useful models of decision making on the level of the individual. In particular, insights in retailer preferences are needed in order to be able to analyse types of reaction and the conditions influencing these preferences. This need is related to a problem that occurred in the context of the application in the Maastricht region of the present model.

In the case study the tendency to increase floorspace was found to be present whenever the turnover grew, irrespective of the fact whether the actual level of the turnover was far below the calculated norm in the shopping centre or not. This is not a very likely development, although it should be recognized that within a shopping centre and on the level of individual retailers the economic operation might deviate considerably from the average development for the centre as a whole. In terms of modelling at the level of the shopping centre, however, it is more likely to assume, in case of an increase of turnover, that when the actual level remains far below the norm turnover level, the increase in turnover is in no way used for extension of floorspace. Rather, retailers use the extra turnover for recovering their economic operation up to a level that is closer to the norm. This might, for instance, be reached by improving sales formula, selling other goods, more advertising and the like; hence, increasing attractiveness through image changes. Retailers who are in a situation that evidently operates on a level far below the norm will most likely have other priorities regarding the set of reactions than retailers have who find themselves located in a shopping centre that
operates on a level that to a considerable degree exceeds the norm level. For this last mentioned group of retailers the present model calculates a reduction in floorspace when the turnover level drops. Again, for some individuals this might be true. However, in all this effect is most unlikely. Retailers in such conditions primarily focus on limiting the number of employees, on advertising less and the like. These considerations regarding the modelling of retailer's reactions can be summarized in terms of Figure 23.

In Figure 23 the margin $X_1 - X_2$ is defined in terms of a percentage of $X_0$, the normative turnover for sector $z$ for a particular shopping centre $j$. In case of an increasing turnover level extension of floorspace is likely to be realized when the actual turnover is at least $X_1$, whereas in case of a drop in turnover, reduction of floorspace is assumed to be possible when the actual turnover is not higher than $X_2$. Evidently, the extension of the applied retailer's reactive behaviour model to the above suggested mechanism and perhaps other mechanisms as well first requires additional empirical research. Additional research is also required in order to test the assumption that the probability functions fitted to the answers of 140 retailers are systematically related to their real-world choices. This would in

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**Figure 23: Hypothetical conditions of modelling changes in floorspace**

<table>
<thead>
<tr>
<th>$X_1$</th>
<th>$X_0$</th>
<th>$X_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>turnover = $a%$ of normative turnover for sector $z$</td>
<td>normative turnover for sector $z$</td>
<td>turnover = $b%$ of normative turnover for sector $z$</td>
</tr>
</tbody>
</table>

- EXTENSION OF FLOORSPACE IS LIKELY IF TURNOVER GROWS
- REDUCTION OF FLOORSPACE IS LIKELY IF TURNOVER DECREASES

$0 < a < 100\%$ $b > 100\%$
fact require data on actual changes in the shopping centre in which the respondents are located, in relation to the developments in actual turnover over a number of years. The collection of these data is a complex and time consuming process. The measurement of actual turnover developments particularly is very difficult because retailers are not inclined to publish these figures. Consequently, the researcher has to build up a very good relationship with the retailers, a relationship which is based on mutual trust. Jansen and Koopman (1983), for instance, have shown that this is not impossible. Further, a careful registration of all types of mutations is needed, preferably on the level of each shop in the shopping centre. The total amount of data can be used to test the expressed assumptions.

Critics might ask themselves whether the knowledge resulting from studying such issues is necessary for improving applied retail research. The answer to such criticism has several aspects. On a theoretical level the answer is clearly yes. In the last decade considerable progress has been made in understanding and modelling consumer spatial choices. Far less attention has been paid to retailer behaviour, especially with the aim of improving applied retail research. Such research pretends to provide balanced insights in the retail system dynamics and, hence, it is curious that basic processes on the supply-side are neglected in that context. A more practical reason for paying increasingly attention to changing processes on the supply-side and their underlying mechanisms in the context of supporting planning and policy is put forward by the fact that retail planning and applied retail research deal with the problems of retail facilities in the context of the urban management of present structures. The construction of new shopping centres is no longer the central point of retail planning, but instead of this the careful dealing with spatial supplies of retail facilities has become very important. This shift in attention is of a general nature and appeals to all fields of physical planning. Consequently, the nature of the supply-side deserves more attention and a more balanced approach in research and physical planning relative to the current attention for aspects of demand. The above suggested issues for study are suited to such a more balanced approach, implying that they are not a luxury but rather an increasing necessity for understanding the retail system.
operations in a reliable way.

7.2.4 The number and type of indicators
In this study a number of indicators has been suggested, but the retail planning DSS has in principle the capability of including additional or alternative indicators and, consequently, enabling the decision makers to make a choice among these indicators in order to define the set of ultimate evaluation criteria. The illustration in chapter 6 for instance showed that indicators can be added to the set of evaluation criteria, the values of which are determined external to the DSS. This flexibility is particularly relevant for the inclusion of information not directly related to the impact assessments but might be considered relevant for the evaluation of alternative plans. In so far as the suggestion is concerned to relate impact values to the trend values for the same indicators, this approach is considered to be very worthwhile and transferable to other subfields of physical planning. The illustration of the DSS for the region of Maastricht clearly underlined the relevance of this approach. The development of turnover in Oud-Wyck, for instance, appeared to be very positive given the conditions of almost every planning option, as compared to the predicted trend. Nevertheless, the normative turnover level was never exceeded. Yet currently applied retail research is dominated by the evaluation of retail system performances on the basis of absolute norms. In the case of Oud-Wyck this would imply findings that deviate from the present one.

Evidently, for a comparison of actual developments with the trend, also alternative indices might be elaborated. Generally, one has to avoid the measuring with different indicators that have the same effect on the system. A way of dealing with this problem is the integration of the values of such indicators into one (weighted) multi-criteria evaluation value. Another way is to attach shared weights to such indicators as is illustrated in chapter 6.

7.3 Assumptions of the retail planning-orientated theory
In this section, attention will be paid to some aspects of the planning orientated theory described in chapter 4. First, attention will be paid to the issue of transferability of some submodels (7.3.1). Next, the
flexibility of the individual approach for coping with variety in personal conditions is dealt with (7.3.2). Also, attention will be paid to assumptions regarding retailer reactive behaviour (7.3.3) and finally to the theoretical notions underlying consumer, retailer and public interests. Clearly, these assumptions are very relevant to the nature of the theory.

7.3.1 Transferability of submodels

A basic reason for applying conjoint measurement to the identification of the individual's utility function refers to the assumption that such measurements increase the spatial transferability of the multi-attribute preference model. Evidently, the greater the spatial transferability of the spatial choice model is, the less the need for data collection associated with the specification of such models will be. The consequence for applied retail research might be that at a particular moment a fully specified model is accepted and applied in the context of a particular research situation different from the context in which the model is specified, assuming that some of the measurements related to the model (like the relevant attributes, the (part-worth) utility functions and the combination rule) are transferable. A limited data set on actual choice behaviour might in addition be used to test the outcomes of the simulation. This would mean a very relevant, even revolutionary, step in the context of the development of a DSS methodology, particularly when a quick insight is needed in the operations of the retail system, for instance with regard to the problem diagnosing phase. In fact the use of a fully specified model is in such a context a completely hypothetical prediction and is, of course, only reliable when enough empirical research has established a firm empirical basis in relation to the transferability of the (de)compositional multiattribute preference model used. As such, the legitimacy of the completely hypothetical simulation heavily depends on the progress in basic research that fits to the described theoretical framework. This implies that a great deal of basic research has to be performed in order to test the transferability of decompositional multiattribute preference models and related submodels. Some empirical analyses was found in a test concerning the predictive value of the decompositional multiattribute
preference model defined in this study on basis of the consumer questionnaire in the Maastricht region in the context of buying non-daily goods in Eindhoven (Van der Heijden and Timmermans, 1986). Given the objective levels of 13 shopping centres in the area, the model appeared to explain the observed proportions of choice of these shopping centres quite satisfactorily, indicated by way of a coefficient of determination ($R^2$) of 0.99 and a proportion of 0.96 for correctly predicted levels of turnover. Notwithstanding these findings it is necessary to perform more of such analyses in the future.

This also applies to the spatial transferability of other submodels, like the model for predicting consumer information fields and the model for predicting retailer reactive behaviour. With regard to the first mentioned model, some tests on the spatial transferability have been described in Van der Heijden and Timmermans (1984). Also in the present case study some evidence has been provided, although the test itself is handicapped because of the lack of direct measurement of consumer information fields. Evidently, since the retailer reactive behaviour model is new, no empirical tests on its spatial transferability have yet been performed, although the analysis of similarities in expressed probability scores in the present study approximates such a test. However, in the present situation the reliability of the test might be biased by the fact that the retailers interviewed were all located within the retail system of Eindhoven.

Both the applicability of the theory underlying applied retail research and the issue of the costs of related measurements require the systematical performance of studies on the spatial transferability of different types of context independent types of models as well as on the question whether preferences can be measured properly on abstract attribute levels. If the answer to this last mentioned question is yes, then the preference measures are transferable. Very recently some authors have advocated context dependency of the modelled choice process in the sense that the composition of the choice set (number and type of choice elements) may influence the utility function. In order to tackle these problems, Borgers and Timmermans (1984, 1986) have analysed these ideas and have elaborated options to include the effects of the spatial arrangement of choice alternatives in a systematic way in (de)compositional multiattribute
preference models. The path of research constitutes an important and stimulating contribution to the improvement of the predictive ability of these models. However, since the majority of this research is of a very recent date, these developments have not yet been incorporated in the suggested DSS models. There is, however, no reason to believe that in the very near future such a step cannot be made.

7.3.2 Flexibility of individual approach
The definition of the theory on consumer spatial choices and retailer reactive behaviour on an individual level has been judged as an advantage of this theory compared with other theoretical approaches. The reason for this judgement is the fact that measurements and model building on the individual level increases the flexibility in the theoretical explanation of observed behaviour and in building models on such behaviour. More options are available for including individual specific characteristics. Three examples will be given.

Socio-economic characteristics of the consumers have not been used as independent variables influencing spatial choices in a discriminatory way. This deviates from most types of approaches in currently applied retail research. Such variables have not been included because it has not been sufficiently proved that these variables affect consumer choice behaviour significantly (on the level of shopping centres). However, in specific situations and for specific groups of consumers this might be the case, for example because of the cultural background of consumers or their mobility. An analysis of individual decision making which focuses on perception, evaluation and preferences make it possible to incorporate such influences more easily than modelling which uses data on aggregate levels.

The same considerations apply to differences among consumers in the weight they attach to attributes of shopping centres in their evaluation of these alternatives and their decision where to shop. Such an analysis is for instance described by Timmermans, Van der Heijden and Westerveld (1984b). Consequently, utility functions used to arrive at an overall utility of choice alternatives might differ significantly among consumers. In that way a distinction in the analyses could be made between, for instance, consumers characterized by a 'social shopping' approach and consumers characterized by a more 'economic
shopping' approach. Such a distinction might even occur on the level of a particular consumer buying non-daily goods or daily goods.

A third illustration of the advantage of the individual approach concerns the possibility to uncover the type of combination rule people apply to integrate part-worth utilities related to the levels of attributes of choice alternatives into an overall utility. Timmermans, Van der Heijden and Westerveld (1983), for instance, analysed whether individuals differ in the application of an additive or a multiplicative combination rule.

Although the advantages of an individual approach to arrive at analyses of consumer decision making seem to be obvious, the question may arise what the advantage of this flexibility for modelling in applied retail research actually is. Clearly, the incorporation of individual differences can result in more reliable predictions of choice probabilities, provided that the distribution of these differences over the population of the area (proportional and spatial) are known. This is, at least at this moment, very difficult, because little knowledge exists of the relationships between for example differences in additive and multiplicative combination rules and characteristics of the individual. Hendriks (1983), for example, suggests that such differences are related to personal constraints (the structural position) of individuals. Unless the incorporation of individual determinants significantly increases the predictive value of the applied model, these extensions seem only to be of relevance when there exists some relationship between these variables and the opportunity of influencing the levels of these variables by means of planning. Again the trade-off between extra costs that are most likely related to this increase of sophistication of individual choice models and the increased relevance for planning must be subject to future research, and in the same context: the trade-off between the speed of DSS and complexity of models. Similar considerations apply to the more sophisticated modelling of retailer decision making.

7.3.3 Assumptions regarding retailer behaviour
The basic assumptions in the approach of the (reactive) behaviour of retailers can be considered as the outcome of individual decision making processes. That the nature of the bounded rationality in
retailers' decision making is explored is typical for the approach; 'bounded' in the sense that perception and evaluation processes on the individual level influence the decision making in such a way that decision making is based on the retailers' subjective cognitive images of situations. The relevant question in the context of this evaluation is whether it is sufficient to focus on reactive behaviour of retailers when trying to catch the retail system's dynamics. Clearly, the behaviour of retailers is multidimensional, as has been argued in chapter 4. Therefore, it is necessary to encode this multidimensionality in the context of modelling. This implies that the reactive behaviour as it is understood in this study is reactive behaviour by definition: reactions to developments in turnover. Inevitably, this is a reductive approach. The question may arise whether this approach still deals with the central issues of retailer behaviour. If not, the present understanding is too limited and may even be inadequate for dealing with retailing dynamics. It seems, however, a valid assumption that any kind of retailer is directly or indirectly associated with developments in turnover, whether this concerns future expectations or past experiences. Moreover, in the context of applied retail research and retail planning, the economic dimension is the most appropriate link between consumer shopping behaviour and retailing dynamics. In this view, initiating behaviour and (re)allocative behaviour are in a certain way kinds of reactive behaviour such as reactions to opportunities at the individual level. Clearly, in order to deal with such an extended view of retailer reactive behaviour, it is necessary to explore and define the nature of opportunities in more detail. In addition, measurements may be adjusted to this view.

7.3.4 The quantification of retail system performance
The retail planning-orientated theory also contained theoretical notions to quantify the retail system performances. These notions are related to consumer-, retailer- and public interests. Two questions might be relevant. The first question is: do these three categories sufficiently cover the substantive foci of decision makers' evaluations of retail system performances? The answer is confirmative, given the accepted definition of retail planning. This does, however, not imply that retail planning practices actually pay more or less equal
attention to these interest groups. Therefore, the acceptance of these three fields has some normative meaning for retail planning practices. At the same time it is fully recognized that the pursued impacts on retail planning practices are, again, very dependent upon the operationalization: the degree to which one succeeds in translating these interests in terms of clearly understandable and effective performance indicators. Therefore the substance of the theoretical notions and the additional translation into indicators are crucial. Consequently, the second question is: is the understanding of each of the three categories in the present theory adequate towards retail planning on the one hand and the involved interests on the other hand?

This question is difficult to answer, for such an answer in fact requires a higher level framework of reference. Nevertheless a few additional considerations can be given. The consumer and public interests have more explicitly been elaborated in this present theory than in common practices of applied retail research. Whether specific notions or indices should be added to the presently suggested set or not has to be learned from the confrontation of their operationalization with decision makers in retail planning. Yet, it is felt beforehand that the understanding of public interests lacks a more explicit link with other fields of spatial planning, but on the other hand the nature of such a link might be too diverse or fuzzy to be incorporated as an explicit notion in the retail planning-orientated theory. Therefore, these links should be understood and operationalized within the conditions of specific planning projects. When, for instance, the distribution of population and, consequently, the program of building dwellings are not fixed, the costs of various building programs as far as these programs are used as instruments to influence the operations of the retail system, can be included in the evaluation matrix. Similar approaches to variable options for infrastructure planning are possible. With respect to retailer interests it is recognized that (normative) turnover-to-floorspace ratios still have an important meaning as criterion for evaluating the retailer's position. The dominance of the absolute value of these variables is considerably reduced by referring to the trend development. On the other hand, this focus on turnover (-to-floorspace ratios) can be justified because it refers to one of the few possibilities which links consumer spatial
choices systematically to the position of retailers. Moreover, it is a fact that the turnover (relative to the cost level) plays a very important role in retailing. In addition to the economic aspect, future studies of retailer behaviour should focus on whether it is also necessary to formulate retailer interests in terms of opportunities for retailer behaviour (reaction, (re-)allocation). These opportunities might be linked to the perceived turnover developments in various shopping centres or to the position of these shopping centres with respect to the ideal point on the preference scale. This could be a point of departure for a re-allocation model. Further, more detailed insights in retailer behaviour might suggest still other relevant behavioural notions that might be linked to the modelling of retail system dynamics. In that way, the influence of the unidimensional understanding of retailer interests common in currently applied retail research and retail planning can be minimized.

7.4 DSS and its relationship with retail planning
The DSS approach for elaborating an applied retail research methodology is a means for integrating all requirements formulated with respect to the substance and organization of applied retail research. The appropriateness of the DSS approach for bridging the gap between applied retail research and retail planning in real-world practices depends, to a large degree, upon the increased adequacy of its methodology to produce required data. The possible problems concerning the measurements and assumptions related to the proposed methodology have been sufficiently discussed in the previous two sections. Other factors possibly influencing the appropriateness of the DSS approach in a negative way are related to the contextual dimensions of DSS use.

By means of the use of the retail planning DSS an improved awareness with regard to the decision making context is pursued: who takes what decision and why and at what moment and with what aim? What is the body of knowledge he/she relies on in taking the decision? These aspects require decision makers to be very explicit in aims, views, responsibilities and interests. Differences between decision makers in this respect might be dealt with in decision making processes presuming that these conditions are satisfied. The question is however whether decision makers are happy with this kind of openness. This
needs not necessarily be the case. Many examples are known of decision makers who consider a particular degree of fuzziness with respect to the abovementioned aspects necessary to establish an idea of freedom. This might influence the willingness to accept a possible substantive and procedural ordering of DSS with regard to decision making. The ordering effect is caused by elaborating the DSS on the basis of a normative and comprehensive decision process model. This choice is based on the assumption that when the procedural and substantive character of retail planning processes are structured in agreement with such models these processes are ordered adequately so that they can solve semi-structured problems. Further, the assumption is made that different retail planning processes on a structural planning level are largely similar in their procedural and substantive structure, although they deal with retail systems for different study areas. Many reports suggest that the majority of stages that are considered to be important for retail planning are included in the accepted decision process model and that this model merely explicates these stages. Of course, these reports might a posteriori rationalize decision processes and, consequently, actual decision making might deviate from these rationalizations. On the other hand, empirical descriptions of decision making aimed at defining an alternative decision process model would also have to rationalize in order to serve DSS building. This rationalization implies a search for similarities between various studied processes and the a posteriori interpretation of these similarities in terms of a sequence of substantively different stages. These considerations underline the plea for not establishing direct interaction. They enable a reformulation of the DSS to be realized easier in terms of using models in another sequence and/or adding new elements to the DSS.

Another problem in the context of DSS use is that decision makers might experience the DSS as a kind of 'black box'. The probability that this problem will occur depends upon the degree to which the researcher accepts his/her responsibility. Currently applied retail research which applies quantitative expenditure distribution models has often been conceived of as a black box, simply because the researcher has failed to explain the nature of the models, the included variables and particularly the underlying assumptions to the people who depend on the
produced information. This situation may also occur in the case of DSS use. The researcher is obliged to explicate and illustrate the research approach irrespective of the type of research performed or the methodology applied. Although this issue is not of relevance for DSS building as such it can influence the willingness to accept DSS outcomes and to use these findings in decision making.

A final point of discussion is whether the suggested approach re-establishes an important position of applied retail research relative to retail planning and whether it brings about a more heavy weight of research on the outcomes of retail planning. In fact, this refers to the impact of professional knowledge on decision making, as is discussed by for instance Knott (1984). From another perspective this refers to the following question: what makes applied retail research (in the way suggested in this study) a retail planning DSS? To summarize, applied retail research is linked permanently to retail planning in an organizationally as well as a substantively adequate communication framework. Further, the decision makers use the information generated by the DSS to come to their decisions in an iterative process. There are several possibilities for influencing data-processing, summarized in previous chapters. Evidently, it is necessary that the decision makers are made aware of the options for influencing data-processing and feedbacks in terms of models and measurements. This is the task of the researcher. Moreover, although no direct interaction has been pursued, the system of software and data-storage should enable a reasonably quick and efficient answering of expressed information needs. Hence, the probability of a recovery of research dominated retail planning is not very likely, given the ordering effect of the research methodology captured in the retail planning DSS on retail planning. Of course, such an effect would conflict with the aims of DSS development and its use (no replacement of decision making; support of decision makers; improving the understanding of decision problems, the quality of the decision approach and the quality of the ultimate decision). An important distinction has to be made in this respect. A retail planning process not research dominated does not necessarily imply that the production of necessary information might not be improved and the utilization of research findings might not be increased. Both effects are pursued by
means of DSS development. It does, however, imply that the outcomes of decision making in retail planning are not deterministically based on the findings of research. The degree of freedom for decision makers to deal with produced information is therefore crucial. The DSS approach does not limit the degree of freedom in decision making that currently characterizes retail planning. On the contrary, a higher degree of freedom might even be established, since the substantive and technical elaboration of the DSS focuses on creating a greater responsiveness and interactiveness between research and retail planning and, consequently, on realizing a greater influence of retail planning decision makers on activities of applied retail research. Examples are the impact assessment for various options, the various possibilities to attach weights to criteria in the context of multicriteria evaluation of options, the inclusion of new or alternative impact indicators related to specific interests, and so on. But, of course, when freedom in decision making is based on encouraging fuzziness and on behaviour which is non-compromising, the support of decision making by means of a retail planning DSS might imply a reduction of freedom. The loss of that dimension of freedom is, however, not necessarily bad for the quality of the outcomes of retail planning.
CHAPTER 8: SUMMARY AND CONCLUSIONS

The aim of this study was to formulate and illustrate the principles of a decision support system for the planning of retail facilities on a structural plan level. This study was initiated by reviewing existing criticisms on applied retail research (chapter 1). Analyses of the body of criticism of three levels resulted in the following insights.

On an ideo-structural level criticisms stress the insufficient support of retail planning by means of applied retail research due to less adequate organizational contexts and the substantive separation between retail planning and applied retail research. Until recently research and planning were mostly organized separately, which caused the situation that research often preceded planning. Consequently, the experience is that researchers often may focus research on scientifically relevant problems, that need not necessarily correspond with planning relevant problems. Moreover, applied retail research is criticized for paying insufficient attention to the efficiency of the transfer of research findings to the assumed users of these findings. The attention of researchers, critics argue, is insufficient in respect of the conditions of information production and the conditions of information handling derived from the nature of information needs and information use in retail planning processes.

On a super-structural level criticisms of applied retail research focus on the type of theoretical understanding of the retail system's dynamics. Theory building is necessary for deriving substantive foci of applied retail research. Three requirements for theory building have been formulated. First, the operations of the retail system on a specific level should be interpretable in terms of measurable regularities and patterns. Hence, theory building is aimed at formulating an abstract and generalized representation of the basic elements of the retail system being consumer spatial choice behaviour (demand-side) and retailer reactive behaviour (supply-side) and their dynamic relationships in terms of a set of axioms and empirically
testable assumptions. Secondly, the theory should be planning-orientated, which implies a power to answer 'what' as well as 'what-if' questions. The first type of questions asks for a careful definition of variables and data in terms of a checklist for exploration and description. The second type of questions requires, in addition, that the relationships between these variables are interpretable in terms of causalities, with (the values of) planning variables as input and impact assessments as output. The focus on the theoretical validity and practical reliability of these assessments emphasizes the need for transferability of the applied models. Thirdly, the theory should be formulated in terms of dimensions of individual behaviour. The cognitive-behavioural approach is preferred, given its focus on causalities underlying individual acting and its flexibility for inductive modelling. The evaluation of currently applied theories in relation to their main operational forms resulted in the conclusion that none of these theories, and of these especially the second and third, can sufficiently meet these requirements.

On the infra-structural level the criticisms of applied retail research emphasize the insufficient understanding and operationalization of consumer-, retailer- and public interests associated with retail planning. Further, the trade-off between costs of data collection and the richness of produced information is felt to be unfavourable. On the one hand, this is caused by not using available data efficiently enough and on the other hand by the low degree of spatial transferability of applied models that require new data collection each time they are used for other study areas. Moreover, the estimation methods associated to currently applied methods tend to be data consuming.

Notwithstanding existing criticisms, applied retail research is generally appreciated as an important source of information for retail planning. There exists, however, an obvious need for a reformulation of (aspects of) its methodology in relationship with its organization. The reformulation starts with the development of an ideo-structural view of applied retail research (chapter 2). First, it was noted that there exists a tendency to organize applied retail research and retail planning in terms of projects. This tendency is judged positively because of the formal establishment of more or less continuous
opportunities for communication between both activities. Research in that context has a supportive task extended to all stages of the planning process. An iterative-participative approach of a sequence of limited decisions is typical for the retail planning process. These decisions are taken on the basis of imperfect information associated to uncertainties about future developments and impacts and various interests of several participants. This makes the retail planning process a typical situation of semi-structured decision making. The primary task of applied retail research is to reduce uncertainties at every step which involves decision making. Requirements for this task were derived from the 'utilization of knowledge' movement. It was concluded that applied retail research needs to be based on a careful analysis of the information needs associated to the supported decision making process. Next, the substantive nature of applied retail research is based on a planning-orientated theory, which systematically describes the dynamic operations of the retail system and indicates the way these operations are quantified. The set of quality criteria accepted in the context of the operationalization of the theory (and hence the nature of data processing) is a combination of classical scientific quality criteria for research and additional transfer criteria. The organization of the methodology has to enable a flexible and quick use to be realized on behalf of a focused answering of information needs.

In addition, the information needs of structural retail planning processes have been analysed (chapter 3). The purpose of that analysis was to identify the role of research with respect to different stages of decision making and the nature of specified methods and techniques applied. The analysis showed that the researcher plays various roles with regard to the group of decision making. Further, it was concluded that the development of the methodology for applied retail research should be focused on the mainlines of decision making that require the production of (empirical) information about the operations of the retail system using specialized methods and techniques. This implies a focus on the support of:
- descriptive exploration of present and future retail system's performance to identify problems and opportunities;
- the exploration of the margins of retail planning;
- the assessment of impacts of alternative retail plans;
- the multicriteria evaluation of these plans;
- monitoring and early warning.

The nature of the required and produced information with respect to these stages of decision making and the conditions of decision support typically refer to the philosophy of decision support systems (DSS). A DSS is a computer based system that is aimed at supporting semi-structured decision making by collecting information needs and data processing parameters of decision makers and, reversely, by providing decision makers with information tailored to their decision problem. In the context of the elaboration of the retail planning DSS the responsiveness of the system (the power to substantively answer the information needs) is considered to be of greater importance than the direct interactiveness of the system (the possibility to directly communicate between system and decision maker). Interaction through the researcher, who functions as an intermediate, is considered to be sufficiently efficient and effective.

The first requirement for the elaboration of the DSS was the formulation of a retail planning-orientated theory (chapter 4). In that theory both consumer and retailer choices are understood as being the results of a cognitive-behavioural decision making process in which subjective perception, evaluation and preferences with regard to choice alternatives are key notions. The approach is based on work of Timmermans that has been specifically focused on consumer spatial choices. In the context of this thesis several components of the model of consumer spatial choice behaviour that existed when this project was started have been further elaborated and, in addition, the approach has been extended to the domain of retailer spatial reactive behaviour in the perspective of the dynamic relationship with consumer patronage of shopping centres. The emphasis in the cognitive-behavioural theory on the decision making of individual actors in regard of their (spatial) behaviour proved to be useful for the understanding of retailer behaviour, although a number of conditions are different from those of consumer shopping behaviour. This implied that an adjusted interpretation was needed.

In addition to the theoretical understanding of the supply-demand dynamics within the retail system a theoretical base has been provided
for quantifying these dynamics in a planning relevant way. This part of the theory focused on describing the nature of consumer, retailer and public interests to be reckoned with in the context of retail planning. The performance indicators used in the information production context are derived from these interests.

Next, the study focused, in chapter 5, on elaborating the methodology of applied retail research on behalf of the support of the five stages mentioned above, which are based on the outlined retail planning-orientated theory. The operational elaboration in terms of data-collection methods used to fill the data bank of the DSS and several data-processing models used to generate the required information are inherent to the DSS nature of the methodology. These models constitute the so-called model bank of the DSS.

As far as the static descriptive analyses are concerned, the extension of data collection might be considerable or, in contrast, be limited to some aspects of retail facilities. The nature of data-processing in the context of the DSS can therefore not be clearly identified. A plea was held for paying more attention to cognitive-behavioural aspects of consumer and retailer behaviour. In the context of static descriptions this could for example be the analysis of consumer information and usage fields, consumer perception and evaluation of retail facilities and consumer wishes with respect to the retail structure. Further, more attention might be paid to retailers' perception and evaluation of retail facilities and their intentions with respect to retailing. Some options for measurements and analyses were discussed.

A static description that links consumer patronage of shopping centres to measurements regarding the nature of these centres can give insight in currently existing problems. However, the determination of new problems that might become manifest during the future period the retail planning project focuses on, requires more than a static description. Insight in this future, not-planning intervened, trend development of the retail system is considered to be necessary. The use of a consumer spatial choice model in conjunction with a retailer spatial reactive behaviour model is needed in this context in order to predict the future system dynamics. Therefore, options for the definition of an expenditure distribution model and a model for
retailer reactive behaviour have been presented. A variety of questions related to the specification of these models are discussed.

The expenditure distribution model is subdivided into a model that predicts information fields of consumers and a multiattribute preference model for consumer spatial choices among shopping centres they are familiar with. With respect to the multiattribute preference models the principles of measurement of relevant attributes and of decompositional and compositional utility measurement models are discussed. Decompositional models are preferred. The typical feature of the related measurement (known as conjoint measurement) is that the preferences for choice alternatives are measured by using experimental designs in which individuals are requested to evaluate hypothetical choice alternatives. The approach influences the transferability of the model positively. Further advantages and disadvantages of these approaches with regard to applied retail research are discussed too. In addition, four different decision rules are discussed so as to link individual preferences to actual choice.

With respect to retailer reactive behaviour two routes have been chosen. The first one is the definition of a pragmatic model for applied retail research. Secondly, some options for a more sophisticated measurement and modelling approach were discussed. The reason is the general lack of insights in cognitive-behavioural aspects of retailer reactive behaviour. In the pragmatic model the link between the consumer patronage of shopping centres and the retailer reaction model is basically established in terms of expenditures in shopping centres. For retail planning the interest is particularly on changes in floorspace as the result of changes in turnover. Consequently the model focuses on this aspect.

The models outlined are also used for the assessment of the impacts of defined retail plans. In order to support the definition of these plans an operational approach is suggested in order to explore the 'planning space'. The approach focuses on defining scenarios for independent planning variables and on the evaluation of them in an explicit and systematic way. By means of this approach, which results in the elimination of scenarios, the directions of feasible plans are clarified. The plans are defined in terms of the values of the independent variables of the model, while the impacts are calculated
by making conditional predictions of the consumer patronage of the shopping centres. These impacts are expressed in terms of a number of indices related to consumer-, retailer- and public interests. The theoretical aspects of these interests have been elaborated in the planning-orientated theory. Indices for accessibility to facilities, aspects of travel and familiarity with facilities are defined for consumer interests. The indices for retailer interests mainly express aspects of the economic operation of retail facilities. Finally, aspects of land use, distributional justice and public costs are indicated by means of some indices for public interests. Most indices pay special attention to the shift in effect as compared with the hypothetical trend development. The assumption is that in the case of evaluating alternative retail plans the absolute effects are not only of relevance but also and rather the effects relative to the trend. Such an approach is not common in currently applied retail research.

Trying to quantify the impacts of alternative plans in terms of this set of indices demands for the additional application of multi-criteria evaluation methods in order to support the ultimate integrated decision making with regard to these plans. Since the indices are of a qualitative as well as a quantitative nature, the use of three multi-criteria evaluation methods for mixed data sets is advocated by Voogd. These methods are outlined and incorporated in the DSS.

Finally, some approaches for monitoring the retail system operations after retail planning measures have been taken are suggested. An early warning approach is linked with these principles of monitoring. With regard to monitoring emphasis is laid on the measurement of the actual development of some key-indicators of the retail system's operations. These developments are compared with previous expectations on the one hand and goals on the other hand. In the context of early warning the outlined forecast approach is used for (possibly new) forecasts and these are compared with and related to planning goals.

The measurement- and data-processing models are used in the context of the decision support in various ways. A typical characteristic of DSS is an interactive communication between information production and the decision makers. Decision makers basically determine the outcomes. Such an interactive communication has been established
on at least three levels. Overall, the choice of the most preferred plan is based on an iterative communication with the DSS in terms of trial and error. On the level of the separate stages of decision making, the definition of planning problems, the definition of various plans to be evaluated, the number and type of indicators included and the number and type of criteria included in the multicriteria evaluation and their weights are basically determined by decision makers. The necessary choices are, in practice, supported in interaction with data-processing. Finally, interactive communication is necessary with regard to all the moments in the information production process that require some normative parameter value associated with the political value system of the decision makers (for example normative turnover-to-floorspace ratios, threshold values for criteria, political goals).

In chapter 6, parts of the elaborated DSS are illustrated in relation to the region of Maastricht. Attention is paid to some explorative-descriptive analyses, impact assessments and multicriteria evaluations. Overall, the approach produces many interesting and relevant information for retail planning decision making. Specifically, the following main aspects may be memorized.

First, the logit-model for the prediction of information fields, the parameters of which have been estimated in the context of a study in Eindhoven, was found to be applicable in the context of the Maastricht region. The model showed to have a satisfactory predictive ability, which implies a satisfactory level of spatial transferability.

Secondly, the illustration focused on the operation of the retail system as far as the sector of non-daily goods is concerned. A decompositional multiattribute preference model was defined on the basis of five selected attributes of shopping centres: choice range, distance to the consumer's dwelling, price, atmosphere and parking facilities. A trade-off design was applied in order to measure the part-worth utilities of consumers. Data of 678 respondents were used. A decompositional approach, based on the linear additive combination rule was applied in order to calculate the part-worth utilities of levels of hypothetical choice alternatives. After defining real-world choice alternatives in terms of the selected variables and after relating the utility functions to these objective alternatives,
individual preference functions were defined for the shopping centres included in the information fields of these individuals. The explained variance in observed expenditure distribution over the shopping centres was found to be 99% and the model explained 75% of the variance in observed expenditure flows. These figures indicate a quite satisfactory predictive ability of the consumer spatial choice model for the sector non-daily goods.

Thirdly, the calculations within the applied retailer reaction model were based on data collected by means of a questionnaire among retailers of four different shopping centres in Eindhoven. The answers of 140 respondents to the question of what the probability of choice would be for 22 prespecified types of reaction to 6 hypothetical changes in turnover level showed a high degree of correspondance in the four groups of retailers. These answers were used to estimate probability functions for daily and non-daily goods for each type of reaction. These functions establish the essential part of the present (pragmatic) retailer reaction model for the Maastricht region. For every year it transfers changes in turnover into reductions or extentions in the amount of floorspace for a particular retailing sector in all shopping centres in the study area. By means of this approach some of the autonomous changes within the retail system are simulated.

Finally, the models were then used to make a prediction of the trend development of the retail system in the Maastricht region and to assess the likely impacts of 8 retail planning options. The impacts were described in terms of a number of indicators of the type discussed above. In addition, preference orderings of these options were derived by means of multicriteria evaluation with regard to these options by attaching various weight sets to the impact indicators.

The study ends with a discussion of some basic aspects of the suggested DSS. In particular further applications of the DSS and the development of models that can be included in the DSS are required. Especially more basic insights should be gained in the cognitive-behavioural aspects of retailer behaviour.
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SAMENVATTING

Het onderzoek ten behoeve van de ruimtelijke planning van winkelvoorzieningen, het zogenaamde distributieplanologisch onderzoek (DPO), heeft in het afgelopen decennium in Nederland sterk onder kritiek gestaan. Winkelplanning richt zich op het formuleren van plannen op basis waarvan ruimtelijk beleid gevoerd wordt ten aanzien van winkelvoorzieningen in een (plan)gebied. Daarbij wordt beoogd een set van beleidsmatige doelen te bereiken. Het DPO heeft als primaire taak de planvorming te ondersteunen door het aanleveren van gewenste en geschikte informatie. Het DPO is onder kritiek komen te staan vanwege de relatief hoge kosten ervan in verhouding tot de gebleken beperkte ondersteuning van winkelplanning. In deze studie wordt dit probleem nader geanalyseerd en worden alternatieven voor de onderzoeksaanpak gesuggereerd welke rekening houden met bestaande kritiek op het DPO. Daarbij wordt met name gerefereerd aan het DPO ten behoeve van winkelplanning op het zogenaamde structuurplanniveau. De alternatieve voorstellen zijn gekoppeld aan de organisatie van het DPO in de vorm van een 'decision support system' (DSS). Een deel van dit DSS wordt geïllustreerd in de context van een project van winkelplanning in de regio van Maastricht.

De studie start met een overzicht van de belangrijkste kenmerken en problemen van winkelplanning en gangbaar DPO. Het ontstaan van perifere winkelvestigingen en grootschalige verkoopvormen in het begin van de zeventiger jaren heeft een sterke impuls gegeven aan de wens tot regulering van de dynamiek in winkelsystemen door middel van winkelplanning en -beleid vanuit overheden. Dit werd expliciet gemaakt in de wijziging van het Besluit op de Ruimtelijke Ordening in 1976, waarbij de aandacht voor winkelvoorzieningen in een plangebied in de context van de voorbereiding van ruimtelijke plannen werd toegevoegd aan de bestaande voorgeschreven velden van aandacht. De economische recessie van de laatste jaren en het toenemend belang van vraagstukken van ruimtelijk beheer hebben het karakter van winkelplanning veranderd. Tevens zijn de voorschriften ten aanzien van het karakter van
planvoorbereiding verzacht. De relevantie van vormen van winkelplanning en derhalve van vormen van DPO is evenwel gebleven.

Parallel aan de ontwikkeling van winkelplanning heeft zich een DPO-traditie ontwikkeld. Daarin tekenen zich twee typen van onderzoek af: beschrijvend-analytisch onderzoek en modelmatig onderzoek. Het eerste type onderzoek is vooral bruikbaar in de context van de beantwoording van 'wat' vragen; het tweede type onderzoek is met name verbonden aan 'wat...als' planningsvragen. De modelmatige studies hebben aan belang gewonnen als gevolg van verschuivingen in planning waardoor meer nadruk is komen te liggen op besluitvorming over alternatieve planoplossingen. Bovendien hebben rapporten van adviesorganen met betrekking tot het DPO (RARO, Werkgroep Hazelhoff) deze ontwikkeling gestimuleerd. Beide typen van onderzoek zijn evenwel in toenemende mate bekritiseerd ten aanzien van verschillende aspecten. Deze kritiek wordt beschreven uitgaande van drie niveaus. Op het eerste (ideo-structurele) niveau gaat het om de inhoudelijke en organisatorische positie van DPO. Het tweede (superstructurele) niveau betreft de in DPO gehanteerde theoretische concepten ten behoeve van de productie van gewenste informatie. Tenslotte gaat het bij het derde (infra-structurele) niveau om de methoden en technieken die gebruikt worden.

Op het eerstgenoemde niveau blijkt DPO vaak onvoldoende te zijn ingepast in een organisatorische structuur die een goede communicatie met winkelplanning mogelijk maakt. Het gevolg is dat dikwijls onvoldoende aandacht bestaat voor de verscheidenheid in informatiebehoeften. De kritiek ten aanzien van de theoretische concepten binnen DPO, het tweede niveau, betreft vooral het feit dat doorgaans uitgegaan wordt van theoretische noties van ruimtelijke gedragingen van actoren, die hetzij in het verleden sterk zijn bekritiseerd, danwel niet interpreteerbaar zijn in termen van individuele beslissingsprocessen waarvan het gedrag de resultante is. Bovendien wordt te weinig aandacht geschonken aan gedrag van winkeliers in een dynamische verhouding tot ruimtelijk consumentengedrag. Kritiek op DPO op het derde niveau richt zich enerzijds op de relatief hoge kosten van dataverzameling. Daarnaast is de geproduceerde informatie te vaak eenzijdig gericht op de economische belangen van winkeliers.

De formulering van alternatieven voor het DPO gaat eveneens uit van de genoemde drie niveaus. In de hoofdstukken 2 en 3 van deze studie
wordt een kader aangegeven voor het eerstgenoemde niveau van DPO. In hoofdstuk 4 volgt de uitwerking van een alternatief theoretisch kader, waarna hoofdstuk 5 operationele methoden van dataverzameling en -analyse presenteert.

Hoofdstuk 2 beoogt de formulering van wezenlijke ideo-structurele eisen aan DPO, afgeleid van de ondersteunende rol die DPO heeft ten aanzien van het proces van winkelplanning op structuurplanniveau. Karakteristiek voor dit proces is de in toenemende mate plaats vindende organisatie in projectkaders. Dit impliceert dat de planvorming door een groep van belanghebbenden, planners en onderzoekers wordt uitgevoerd. Kenmerkend voor deze participatieve context is een verscheidenheid in doelen. Het planningsproces wordt voorts begrepen als een proces van iteratieve besluitvorming over subproblemen, gegeven onvolledige informatie, onzekerheden en onderlinge samenhangen in besluiten. Dit maakt het proces van winkelplanning tot een semi-gestructureerd besluitvormingsproces. De positie van DPO ten opzichte van dit proces wordt geduid vanuit de zogenaamde 'utilization of knowledge' beweging. Vanuit deze traditie van gedachtenvorming over gebruiksgericht onderzoek komen vier themata naar voren waaraan eisen aan DPO ontleend worden. Allereerst dient DPO gekoppeld te worden aan de breedheid van informatiebehoefte van het planvormingsproces. In het kader van de onderhavige studie impliceert dat een zorgvuldige analyse van de hoofdlijnen van informatiebehoefte bij planvorming. Voorts dient de informatieproductie te worden gebaseerd op een planninggerichte theorie, welke de dynamiek in het winkelgebeuren systematisch beschrijft in voor planning relevante variabelen en aangeeft op welke wijze de dynamiek in termen van indicatoren tot uiting wordt gebracht. Als derde geldt dat criteria van informatie-overdracht en -nut toegevoegd worden aan klassieke criteria aan onderzoek (met name betrouwbaarheid en validiteit). Enerzijds impliceert dit dat theorie en analyses antwoorden mogelijk maken op 'wat' en 'wat als' vragen, alsmede op problemen van verschillende fasen van besluitvorming. Onder andere leidt dit ertoe dat verklarende variabelen tevens manipuleerbaar dienen te zijn. Anderzijds impliceert de cumulatieve set van kwaliteitscriteria dat de cq. informatieproductie wordt geformeerd naar de aard van de verschillende informatiebehoefte. Tenslotte geldt als eis aan DPO dat het wordt georganiseerd in een structuur die een flexibele, snelle en intensieve communicatie met de besluitvormers
mogelijk maakt.

In hoofdstuk 3 wordt allereerst een analyse gegeven van de hoofdlijnen van informatiebehoeften. Daartoe wordt gekozen voor een benadering van het planningsproces vanuit een abstract en normatief besluitvormingsschema. Aan de hand van dit schema wordt het winkelplanningsproces uiteengelegd in een aantal begrensde besluitvormingsfasen. Op grond van het karakter van deze fasen kunnen de hoofdlijnen van informatiebehoeften worden geïdentificeerd. De onderzoeker heeft wisselende taken ten opzichte van deze informatiebehoeften: initiërend, toelichtend, structurerend. In de volgende fasen blijkt de toepassing van gespecialiseerde operationele informatieproductie methoden gewenst: de identificatie van planningsproblemen, de exploratie van de planningsruimte c.q. de identificatie van alternatieve plannen, de effecten-schattingen, de ex ante multicriteria evaluatie van alternatieve plannen en de monitoring van planningsmaatregelen. De in deze fasen geproduceerde informatie is voornamelijk kwantitatief-empirisch van aard.

De ten behoeve van deze fasen wenselijk geachte onderzoeksmethoden worden in deze studie georganiseerd volgens de kenmerken van DSS'en. Het bepleite doel en karakter van DPO corresponderen met de uitgangspunten en het karakter van dergelijke systemen. Kenmerkend voor DSS'en is dat zij een ondersteuning van semi-gestructureerde besluitvormingsprocessen nastreven op basis van een gecomputeriseerde informatieproductie. De inhoudelijke en procedurele structuur van het ondersteunde besluitvormingsproces bepaalt de architectuur van het DSS. Daarbij wordt een zekere normerende (ordenende) invloed op de besluitvorming nagestreefd. Voor de relatie tussen het planvormingsproces en DPO is directe interactie minder relevant dan het inhoudelijke vermogen om op informatiebehoeften antwoord te kunnen geven. Daarom richt deze studie zich met name op de inhoudelijke kant van het DSS. Karakteristiek voor DSS is de inhoudelijke organisatie van modellen en data in de vorm van gestandaardiseerde software modulen en data-opslag eenheden (modelbank en databank). Derhalve is de beschrijving van de beoogde DSS gesteld in samenhangende, maar onderling duidelijk onderscheidbare modellen en technieken voor data-verzameling en data-verwerking.

De uitwerking van de DSS start in hoofdstuk 4 met de presentatie van een op winkelplanning gerichte theorie. In de theorie wordt
enerzijds een abstracte benadering gegeven van ruimtelijk consumentengezag en de dynamische relatie met reactief gedrag van winkeliers. Anderzijds wordt een set van theoretische noties gepresenteerd op basis waarvan de toestanden van het onderzochte en geplande winkelsysteem op voor planning relevante wijze tot uitdrukking kunnen worden gebracht. De benadering van consumentengedrag en winkeliersgedrag is gebaseerd op de door Timmermans uitgebouwde cognitieve-behaviouristische benadering van ruimtelijk keuzegedrag van consumenten. Kenmerkend voor de benadering is dat individueel keuzegedrag wordt gezien als de resultante van processen van subjectieve perceptie en evaluatie van keuzemogelijkheden en condities van keuze. Doordat de theorie op individueel niveau is gedefinieerd is de flexibiliteit voor metingen en modelvorming groot. Het ruimtelijk gedrag van consumenten en het reactief gedrag van winkeliers worden allereerst kwalitatief ingeleid, waarna de theorie in termen van axioma's en assumpties geformaliseerd wordt teneinde kwantitatieve modellerings mogelijk te maken.

De uitwerking van de theoretische noties ten behoeve van het indiceren van de aard van de dynamische processen in het winkelsysteem vindt plaats per belangencategorie verbonden aan winkelplanning. Drie categorieën zijn onderscheiden: belangen van winkeliers, belangen van consumenten en algemene belangen. Het eerstgenoemde belang wordt geduid in termen van de economische efficiëntie van distributie. Bij de belangen van consumenten wordt de nadruk gelegd op aspecten van toegankelijkheid en beschikbaarheid van winkelvoorzieningen van verschillende aard. Tenslotte worden algemene belangen met name begrepen in termen van grondgebruik en algemene kosten.

In hoofdstuk 5 worden modellen en technieken voor meting en dataprocessing beschreven ten behoeve van de productie van informatie die geschikt is voor de beantwoording van vragen gerelateerd aan de vijf bovengenoemde fasen van planvorming. De op winkelplanning gerichte theorie vormt de substantiële basis voor deze uitwerking. Een onderdeel van het bij exploratieve beschrijvingen en effecten-schattingen benodigd geachte vooruitberekeningsmodel betreft de beschrijving van opties voor de definitie van (de)compositionele multi-attribuut preferentie modellen voor ruimtelijk keuzegedrag van consumenten. Kenmerkend voor de benadering is de meting van nutsfuncties met behulp
van experimentele designs op individuele basis. De parameters van het model worden derhalve niet geschat door relatering van het model aan waargenomen gedrag maar op basis van experimentele metingen. Eerstgenoemde methode is gangbaar bij de momenteel in DPO toegepaste modellen (discrete keuzemodellen, ruimtelijke interactiemodellen). De langs de tweede weg bepaalde parameters zijn relatief onafhankelijk van de specifieke ruimtelijke structuur van het detailhandelsapparaat. Dit vergroot de ruimtelijke transferabiliteit van het model, hetgeen een grotere betrouwbaarheid van de toepassing met zich meebrengt in de context van de voorspelling van effecten van verschillende alternative plannen die een verandering in de ruimtelijke structuur van het plangebied veroorzaken. De simulatie van ruimtelijke keuzen van consumenten tussen verschillende winkelcentra wordt vooraf gegaan door de toepassing van een submodel voor de voorspelling van de keuze set van consumenten. Daarnaast worden enkele opties besproken voor de modellering van reactief gedrag van winkeliers, gericht op het genereren van autonome veranderingen in de niveaus van de kenmerken van winkelcentra.

Ten behoeve van de kwantificering van gesimuleerde toekomstige ontwikkelingen in het winkelsysteem onder verschillende plancondities wordt een set van indices gepresenteerd als operationalisatie van het theoretisch begrip van de bovengenoemde drie categorieën van belangen. Daarbij wordt de nadruk gelegd op de relatieve verschuiving in de waarde van de indices onder de conditie van een bepaald planalternatief ten opzichte van de onbeinvloede trend-ontwikkeling. De simultane vergelijking van de effecten van verscheidene planalternatieven wordt vergemakkelijkt door de toepassing van multicriteria evaluatie methoden. In deze studie worden drie methoden gememoreerd, voorgesteld door Voogd, ten behoeve van de evaluatie van gemengde data-sets. Typisch voor dergelijke gemengde data-sets is dat de informatie zowel van kwalitatieve als van kwantitatieve aard is.

Vervolgens worden een benadering gegeven voor een onderzoeksmatige ondersteuning van het zoeken naar opties voor de oplossing van planningsproblemen. Het accent ligt daarbij op een iteratieve benadering van het probleem gericht op de inperking van de oorspronkelijke breedte van de planningsruimte. Tenslotte worden mogelijkheden geschetst voor het realiseren van een operationele 'monitoring' en
'early warning' benadering ten behoeve van het evalueren van genomen planningsmaatregelen, respectievelijk de verkenning van toekomstige ontwikkelingen.

In hoofdstuk 6 worden enkele modellen in de voorgestelde DSS getoetst en geïllustreerd voor de regio Maastricht. De context van deze illustratie vormt de ontwikkeling in 1981/1982 van een binnenstadsplan voor Maastricht. Met name wordt aandacht besteed aan enkele exploratieve-beschrijvende analyses, effecten schattingen en multicriteria evaluaties. In het kader van de beschrijvende analyses wordt een bestedingen-verdelingsmodel gedefinieerd in combinatie met een pragmatisch winkeliersmodel voor het verkrijgen van inzicht in de te verwachten trend in de sector niet-dagelijkse goederen. Het bestedingen-verdelingsmodel bestaat uit (a) een model voor voorspellingen van keuzesets van consumenten en (b) een decompositioneel multi-attribuut keuzemodel. Het eerste submodel betreft een logitmodel zoals dat is vastgesteld in een studie in Eindhoven. De parameters van het (aggregate) model werden geschat op basis van waarnemingen in 1980 van informatieveelden van 192 consumenten. Het model blijkt goed toepasbaar voor de Maastrichtse regio, hetgeen zeggen dat op bevredigende wijze de informatieveelden van consumenten kunnen worden geïdentificeerd. Voorts wordt het decompositioneel multi-attribuut preferentie model voor de voorspelling van ruimtelijke keuzen van consumenten gedefinieerd op basis van de verklarende variabelen prijs, sfeer, afstand, parkeren en keuze. De gebruikte (individuele) data zijn gebaseerd op een enquete in 1981 onder 725 respondenten. De voorspelling van ruimtelijke kooipatronen in de sector niet-dagelijkse goederen in de regio Maastricht op basis van het individuele preferentiëmodel blijkt bevredigend, gemeten naar de overeenstemming met waargenomen kooipatronen. De verklaarde variantie in waargenomen besteding in de 38 winkelcentra in het gebied bedraagt 75%. In totaal wordt 94% van de waargenomen bestedingsniveaus in de winkelcentra correct voorspeld. Het gebruik van dit model ten behoeve van de voorspelling van de toekomstige trend is gekoppeld aan een pragmatisch winkeliers-reactie model. Dit model voorspelt de autonome veranderingen in vloeroppervlak in winkelcentra op grond van de omzetontwikkeling en de kans op verschillende reacties van winkeliers. Het model is gedefinieerd op basis van data die verzameld is als
onderdeel van een in 1984 gehouden enquête onder 141 winkeliers in Eindhoven.

In de illustratie worden de resultaten van de trend-simulatie besproken voor de Maastrichtse binnenstad en de Maastrichtse winkelcentra Oud-wyck en Heer. Voorts zijn in totaal 8 plannen voor de oplossing van de geconstateerde planningsvragen geaccepteerd. Deze plannen zijn ontleend aan de besluitvorming in 1982 door het Maastrichtse planningsteam. De effecten van de plannen worden geschat met behulp van het bovengenoemde model. De effecten worden gekwantificeerd in termen van in totaal 35 indicatoren voor consumenten-, winkeliers- en algemene belangen. Gegeven deze effecten zijn de 8 plannen vervolgens geëvalueerd met behulp van multicriteria evaluatie methoden onder de veronderstelling van verschillende gewichten-sets voor de in beschouwing genomen criteria, teneinde te komen tot een prioritering van de planalternatieven.

Ofschoon de illustratie van de DSS beperkt is, kan worden vastgesteld dat de benadering een bredere hoeveelheid informatie oplevert ten opzichte van gangbaar DPO, echter zonder kostenverhogingen. Zelfs wordt in het zevende hoofdstuk, waarin enkele discussiepunten worden genoemd, betoogd dat het gehanteerde model mogelijk dusdanig ruimtelijk transferabel kan worden gemaakt dat volstaan kan worden met een beperktere dataverzamelings-inspanning. Dit is kostendrukkend. In het hoofdstuk wordt evenwel ook vastgesteld dat de metingen verbonden aan de huidige benadering wat ingewikkelder zijn dan bij gangbaar DPO. Nader onderzoek naar de relatie tussen kosten en bruikbaarheid van onderzoek is daarom gewenst. Tevens wordt gepleit voor meer aandacht voor de ontwikkeling van individuele winkeliersmodellen teneinde een betere benadering van de dynamiek van het winkelsysteem mogelijk te maken.
STELLINGEN

behorend bij het proefschrift
A decision support system for the planning of retail facilities.
Theory, methodology and application.
R.E.C.M. van der Heijden

1. (Distributie)planologisch overleg is geen vervanging van (distributie)planologisch onderzoek.

2. Het door Borchert, Doorn en Floor (1984) gehanteerde etiket nieuwe stijl voor het door hen voorgestelde type distributieplanologisch onderzoek is in zoverre misleidend, dat er ten aanzien van de inhoudelijke kant van dat onderzoek weinig nieuws onder de zon is.

3. Het gebruik van decompositionele multiattribuut-preferentie modellen in distributieplanologisch onderzoek verdient aanmoediging, ondanks de kritische kanttekeningen die Van der Smagt (1985, H5) plaatst bij de bijdrage van deze modellen aan het causaal verklaren van individueel keuzegedrag. De aanmoediging stoelt op de relatieve theoretische en operationele rijkdom die met genoemde modellen samengaat, vergeleken met het huidig modelgebruik in distributieplanologisch onderzoek.
(A.G.M. van der Smagt, Definieren en relateren in sociaal-wetenschappelijk onderzoek, Proefschrift Katholieke Universiteit Nijmegen, 1985; verschenen in de serie Nijmeegse Geografische Cahiers, nr. 29)

4. De efficiëntie en de effectiviteit van modelgebruik in de context van distributieplanologisch onderzoek is gediend met de ontwikkeling van kwantitatieve modellen inzake aspecten van de dynamiek van winkelsystemen, die algemeen toepasbaar zijn zonder specifieke (kostenverhogende) data-verzamelingen.

5. De dynamische wisselwerking tussen aanbod en vraag in het winkel-distributiesysteem impliceert dat de thans in het distributieplanologisch onderzoek gangbare inventarisatie van bestaande winkelvoorzieningen onvoldoende is voor het verkrijgen van inzicht in de toekomstige veranderingen in winkelvoorzieningen. Dit impliceert tevens dat een ruimere aandacht voor onderzoek ten aanzien van het gedrag van winkeliers zowel theoretisch als vanuit het oogpunt van verbetering van winkelplanning gewenst is.

6. De Decision Support System benadering, welke in dit proefschrift is toegepast op distributieplanologisch onderzoek, kan, indien toegepast op andere velden van planologisch onderzoek, een positieve invloed hebben op de theoretische en methodisch-technische ontwikkeling van die onderzoeksvedlen.
7. De jaarlijkse stroom van reparatiewerkzaamheden aan (met name de daken) van diverse gebouwen van de Technische Universiteit Eindhoven is een schoolvoorbeeld van enerzijds de continuïteit in de bouwopgave en anderzijds de accentverschuiving in de bouwopgave van nieuwbouw naar beheer.

8. Gelet op de herstructurering van het wetenschappelijk onderwijs en onderzoek in de bouwkunde, vertonen sommige binnen die bouwwereld opererende personen een attitude jegens het bouwen welke meer overeenkomsten vertoont met kaalslag-denken dan met beheerdenken.

9. Het (recentelijk) accentueren van de praktische onmogelijkheid dat een kernramp in westere kerncentrales zou kunnen optreden met effecten als die in Tsjernobyl, is ten diepste een uiting van het geloof in de realiseerbaarheid van menselijke techniek die de grenzen van het menselijk denken en handelen overstijgt.


11. De huidige vloed van inbraken brengt het *my home is my castle* voor velen tot een eiqentijdse realiteit.