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Supporting sustainable urban planning and development: three approaches

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Photo: Rob Huibers / Hollandse Hoogte

Cities are among the most complex of man-made systems. Interventions in these systems are never simple. The essential cooperation between all stakeholders can be improved by tools that clarify urban development processes and quantify impacts. TNO and its partners have developed three promising decision support systems.

The complexity of urban development will present us with one of our main challenges in the years to come. This complexity will increase further as new European directives come into force (e.g. on air quality) and the supply of land for greenfield development diminishes. Urban development will also increasingly be shaped by

transport infrastructure, as in the Transport Development Areas (TDA) concept. So what exactly is this complexity? We can break it down into three types: content-oriented complexity, political complexity and the complexity of urban systems. →

CRITERIA	ASSESSMENT OF THE TNO CITY APPROACH	SCORE
Integrative	TNO City in its basic form is primarily geared to financial assessments, but it can be extended to perform integrated assessments. It can be applied to different spatial levels and decision making levels.	++
Dynamic	TNO City is able to calculate the performance of alternatives. If specific indicators are needed, this could require additional modelling.	+
Interactive	The very communicative interface and real-time calculations make for a very interactive tool. The approach has been observed to act as a 'mediator' in multi-actor settings.	++
Transparent	The underlying models are transparent and relatively easy to demonstrate. The first sessions with the model are used to validate all the underlying models and data with the stakeholders.	++
Flexible and Reusable	The use of intelligent interfaces that link data and models to the GIS makes the approach very flexible and reusable. Default situations require no specific action.	++
Fast and easy	Experts should build the TNO City models. Experience is that non-experts can use the model with limited instruction, but expertise is required to use the software.	+
Communicative and educational	Because of the GIS background, the approach is very communicative. However, the approach does not contain a specifically educational element.	+
Authoritative	The basic databases and models are derived from expert models and databases used by TNO experts. TNO City easily handles financial data and can accommodate user specific data entered by stakeholders.	+

Sustainable development as a concept is far from unambiguous

CONTENT-ORIENTED COMPLEXITY

Sustainable development as a concept is far from unambiguous.¹ Many attempts have been made to provide definitions of sustainable development. Generic definitions suffer from the fact that they can be interpreted in many ways, whereas more specific definitions inevitably reflect the value judgments of the definer. Generally accepted definitions² leave room for interpretation and pose new questions which cannot be answered unequivocally. This ambiguity manifests itself on philosophical, political and operational levels.

It is fair to say that sustainable development is a concept that should be further defined and negotiated in a political context. If all the stakeholders involved want a sustainable and high quality public transport system, the trick is to bring together the rationality of the design process (making of design choices for the reorganisation of the urban system) and the political and administrative rationality (the acquisition of sufficient political and public support).

POLITICAL COMPLEXITY

Acquisition of sufficient political support for urban development and infrastructural projects typically involves a complex network of stakeholders, who strive to achieve their ambitions and protect their interests.³ Their activities are not governed by objective rationality, but determined by the perceptions and value systems of the actors

involved.⁴ They make competing assumptions about problems and solutions, means and ends, and cause and effect. From an actor network perspective, there is no single correct approach to policy problems and their solution. Decisions are made in a complex process of negotiation between actors and both the quality of the outcomes of these interactions and the level of support they enjoy are often suboptimal. Answers to this problem are sought in process management⁵ but this does not make urban development projects themselves any simpler.

COMPLEXITY OF URBAN SYSTEMS

Urban systems are extremely complicated and consist of many interdependent physical and social variables. Large projects typically require hundreds of major design decisions and many thousands of detailed choices have to be made. These decisions are often interdependent, and they contribute to a vast number of environmental, social and economic impacts, making the effects of decisions difficult to assess and complicating the design of alternatives.

Reductionist approaches to deal with this complexity tend towards monodisciplinary models which, while scientifically valid, lack an overall picture of the problem in a societal context. More pragmatic and holistic approaches, on the other hand, are often not transparent, and for that reason not acceptable for generic use.

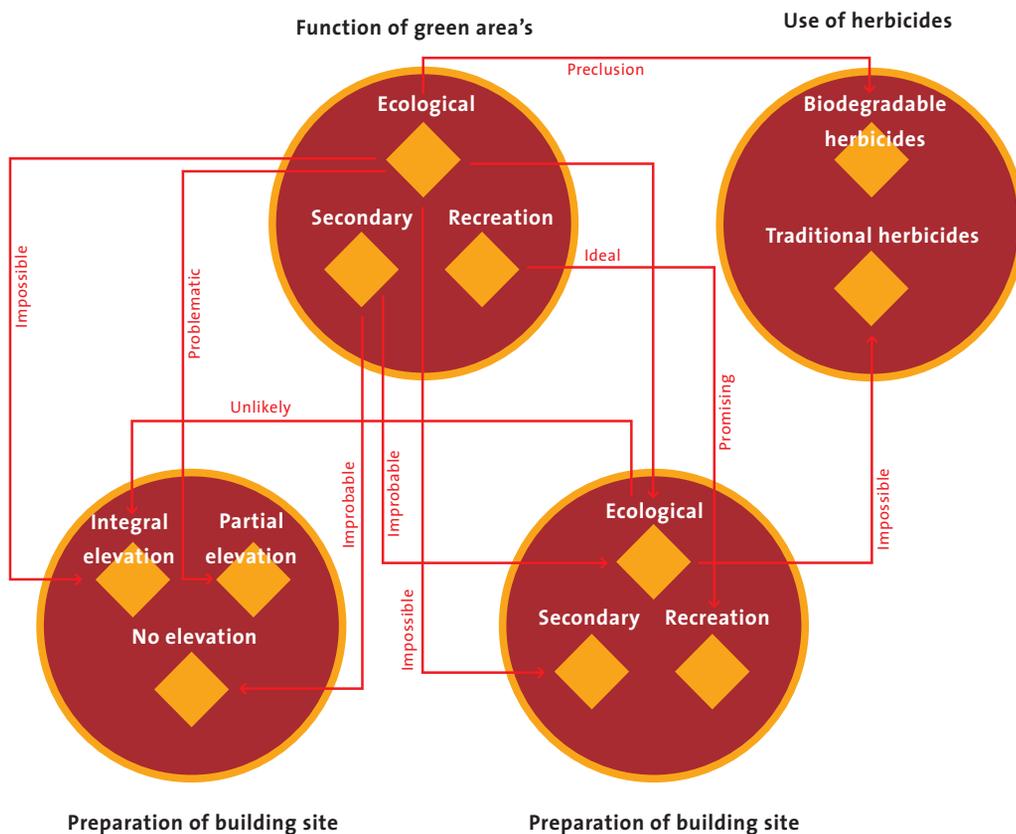


Figure 1: Interconnected decision areas.

Others have described this as the dilemma of the choice between scientific disciplinary rigour and practical relevance. What is needed is a balance between integration on the one hand and scientific validity and precision on the other.

SUSTAINABLE DECISION MAKING FOR URBAN DEVELOPMENT

System complexity, political complexity and the ambiguity of the concept of sustainable development make it difficult to manage sustainable urban development projects. What does 'sustainability' mean precisely to the various parties involved, and how can the goals of all the stakeholders be achieved?

System complexity alone could be addressed by modelling, focusing on the substantive issues. Unfortunately, many of these tools lack the transparency and flexibility required to accommodate the variety of perspectives on sustainability and the dynamics of political decision processes.

Political and administrative complexity alone could be addressed by a participatory planning approach or by process management.⁶ But without substantive knowledge, participatory decision-making processes are void. Participatory planning approaches, such as open forum discussions with residents, can easily degenerate into a rather one-sided venting of opinions at a time when the plans have already reached an advanced stage.⁷

What we need for sustainable urban development are decision support methods that cope with both the substantive (content) as well as the political (context) dimensions. Such methods and approaches should meet the following criteria:⁸

- Integrative: consider different aspects and levels of design and decision making in a holistic approach.
- Dynamic: show the 'performance' of various alternatives in relation to the preferences and the 'behaviour' of stakeholders.
- Interactive: support the negotiation process between stakeholders.
- Transparent: produce results that are clear and understandable to all stakeholders, i.e. no 'black box'.
- Flexible and reusable: usable for, or adaptable to, a range of similar situations.
- Fast and easy to use: relatively quick to implement by non-experts, e.g. residents and politicians.
- Communicative and educational: enlighten stakeholders about problem structure, alternatives and different perspectives.
- Authoritative: the process and the results meet analytical (e.g. validity) and political standards (e.g. safeguarding core values, timeliness) to increase the likelihood that the results are used.

Three approaches developed by TNO and its partners are briefly described and discussed with reference to this list of criteria.

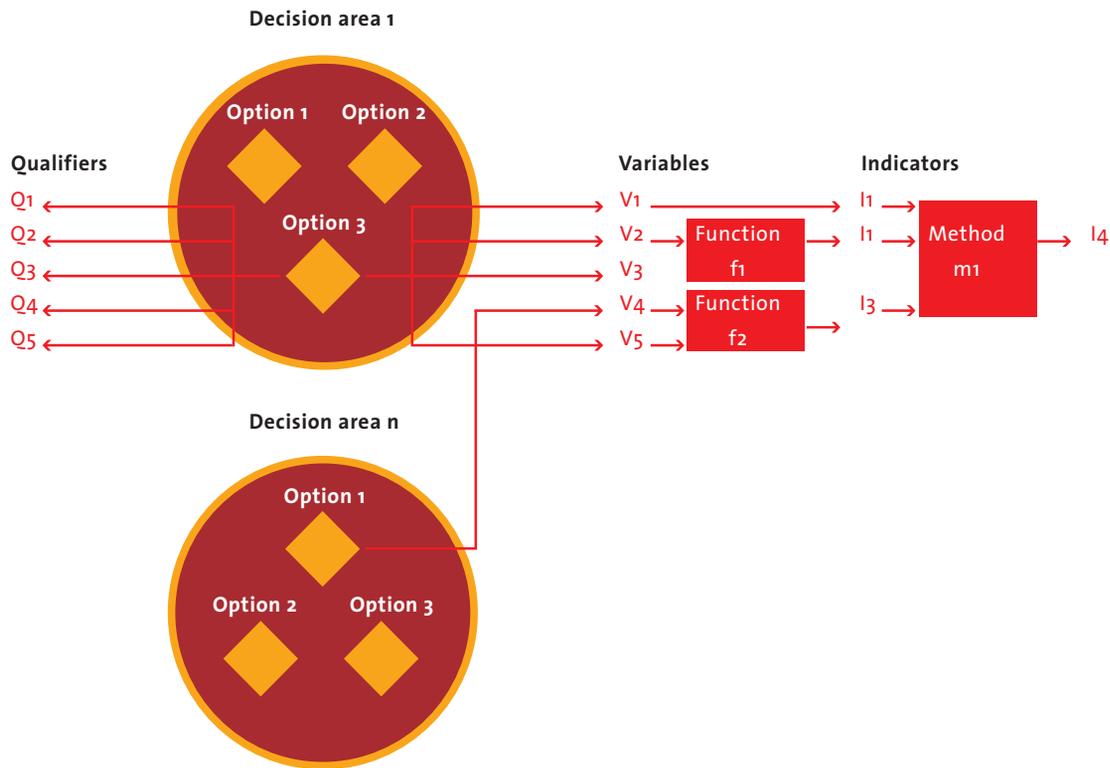


Figure 2: Impact assessment within MEDIA.

The DPL approach is very easy to use, also for non-experts

CODES

Codes stands for 'Consequences of Decision making in urban planning and infrastructure'. The approach has been developed within the Delft Cluster research programme by TNO Built Environment and Geosciences and the Delft University of Technology.⁹ It consists of an innovative and comprehensive decision support system – the software model MEDIA – in combination with gaming and simulation techniques.

Codes is aimed at supporting the early stages of urban planning (development brief and master planning). It can be used for plans at different spatial levels, from individual dwellings to cities and regions, although presently it is mainly used for districts. It has been designed to deal with both the complexity of urban systems and the political complexity.

At the core of Codes is the MEDIA software model, based on the Analysis of Interconnected Decision Areas (AIDA) concept.¹⁰ AIDA makes major design challenges transparent and manageable. Design challenges are described as a set of decision areas, with two or more decision options. Relations between decision areas and options are formalised, creating transparency and insight into the direct and indirect consequences of one specific decision or comprehensive set of decisions (scenario). Four typical decision areas are presented as an example in Figure 1.

Originally, AIDA identified only preclusions (between a decision option and a decision area) and exclusions (between decision options of different decision areas). This has been implemented in MEDIA, with some adaptations. First, MEDIA differentiates between the severity of exclusions, distinguishing impossible, problematic and unlikely relationships. Second, the concept of positive relationships between options has been introduced (ideal, favourable, promising).

Another addition is the impact assessment functionality of MEDIA, which is closely related to the problem regarding the ambiguity of sustainable development. It is through the choice of indicators and impact assessment models that we, implicitly or explicitly, implement our views about what sustainability is. Any attempt to develop a generic set of indicators and calculation models can be regarded as 'yet another interpretation' of this concept. To deal with this problem, MEDIA has been designed to accommodate different definitions. MEDIA uses three major elements in dealing with impact assessment: variables and functions, methods, and qualifiers.

Variables are the direct effects (impacts) caused by decision options (e.g. more parking space means increasing the area of hard surfacing). Variables can be combined by more or less complicated functions to give aggregated and/or comprehensive variables



CRITERIA	ASSESSMENT OF THE DPL APPROACH	SCORE
Integrative	DPL is integrative as far as substantive aspects concerns.	+
Dynamic	DPL is suitable for calculating the performance of alternatives; however it does not link such results to the preferences of the stakeholders. It does facilitate discussion however.	++
Interactive	A large amount of data is required for the model to work. Generation and interactive processing of alternatives is limited.	o
Transparent	The model is very transparent to the user. All the underlying calculation methods are easily accessible and transparent.	++
Flexible and reusable	Through the use of references, the model is applicable to a range of similar applications. First however, a reference database must be generated, which is rather time consuming.	+
Fast and easy	The model is easy to use for everybody with some basic computer skills. However, gathering the information needed can take considerable time.	o/+
Communicative and educational	The model can be a useful communication tool within the policy process of a local authority. The model is not aimed at facilitating communication in dynamic multi-actor settings.	o
Authoritative	Where possible the indicators are based on existing and validated methods. Public support for other indicators can be obtained through the inclusion of stakeholders in the development of the model. The Dutch Ministry of Housing, Spatial Planning and the Environment supports the method. Nevertheless, the choice of the indicators remains subjective.	+



MEDIA is used in interactive gaming and simulation exercises that condense the decision-making process into a few sessions in which stakeholders can discuss alternative plans. The decision areas help to structure the agenda and MEDIA gives immediate feedback on the impacts of the choices, distinguishing between financial impacts (e.g. life cycle costs), environmental impacts (e.g. CO₂ emissions) and social impacts (e.g. access to services).¹² This application can also be used in training.

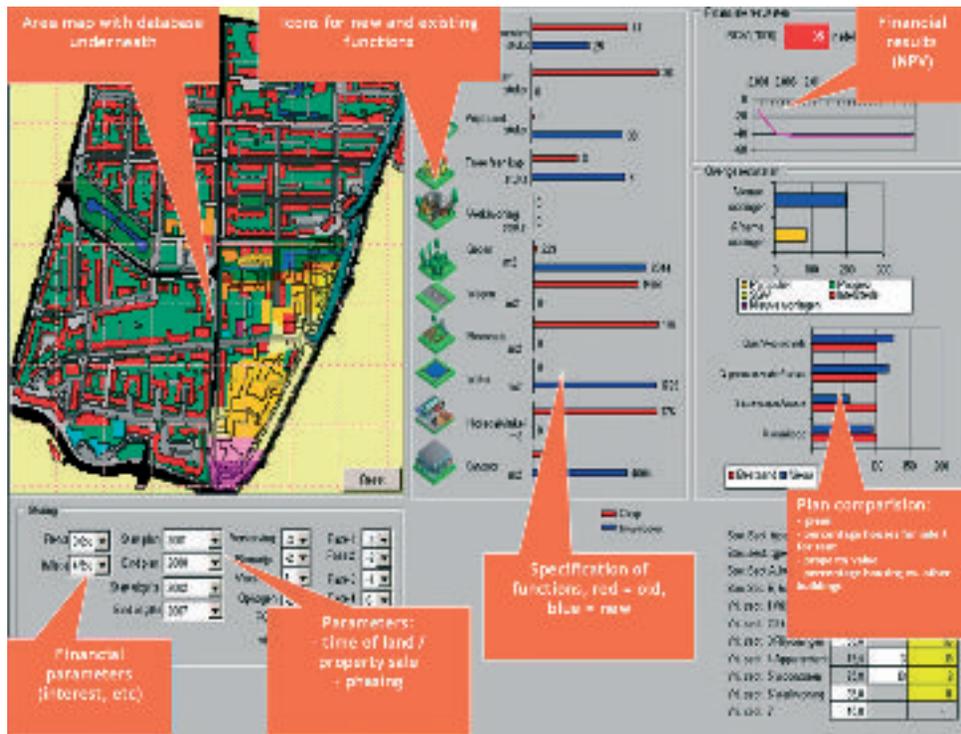
DPL can be used to set targets in advance and verify them later

(e.g. modal split in a district is calculated by combining variables for type of dwelling, quality of public transport, available parking space and so on). In addition, more sophisticated models can be linked to MEDIA using the concept 'Methods', and qualitative labels can be assigned to decision options using the concept 'Qualifiers'.¹¹ The benefits of this flexible structure (no approaches are precluded or forced upon actors) outweigh the drawbacks (no 'easy' answers are provided). Figure 2 depicts the impact assessment structure of MEDIA, which at the moment can calculate approximately 850 variables. Additional functionality within MEDIA includes linking stakeholders' goals specific variables and defining coherent sets of decisions (e.g. all the decisions regarding high quality public transport).

TNO CITY

TNO City is an approach developed by TNO Environment and Geosciences. The approach is all about interactively drawing and calculating urban development plans.¹³ The method improves trust and understanding in complex projects with numerous stakeholders. Just like Codes, it should be used in the early stages of decision making, but with an emphasis on land and site planning and financial feasibility. It is designed for use with professional stakeholders.





'TNO City' improves trust and understanding in complex projects with numerous stakeholders

TNO City interface.

TNO City consists of a sophisticated geographical information system (GIS) for use in interactive settings. Plans can be drawn up interactively using a visual and communicative interface, with the financial and other consequences of alternatives immediately calculated and fed back into the process. The TNO-City model consists of four major conceptual components:

- 1 **Maps.** The starting point for all analyses using TNO City is a set of topographical or functional maps of the area. Several types of maps can be used as a basic map. Older versions (TNO RasterGis) used only raster maps, but presently all common formats are compatible. Based on this map alone, preliminary analysis can be performed, such as average distances to public transport stops.
- 2 **Databases.** All kinds of geographical databases can be added as 'layers' to the system: land and real estate ownership, real estate prices, soil conditions, demographical data, legal information, etc. These databases provide input to a great diversity of analyses, for example the financial impact of acquiring and demolishing a specific area.
- 3 **Functions:** The third component is a database, in which urban functions (infrastructure, dwellings, offices, parks, shopping centres, etc.) have been broken down into their logical components and related to surface area. For each square metre of a land use the area of road, pavement, green space, parking space, sewers and so on is known. This enables the user to draw plans based solely on the surface area of the land uses; it is not necessary to make an actual architectural design.
- 4 **Calculation models.** Several impact assessment models are linked to the system, such as models to make financial assessments and environmental, demographical and sociological models. The model also allows for comparative and integrated assessment of scenarios and for assessment of the development over time. Typically, calculation models are Excel-spreadsheets.

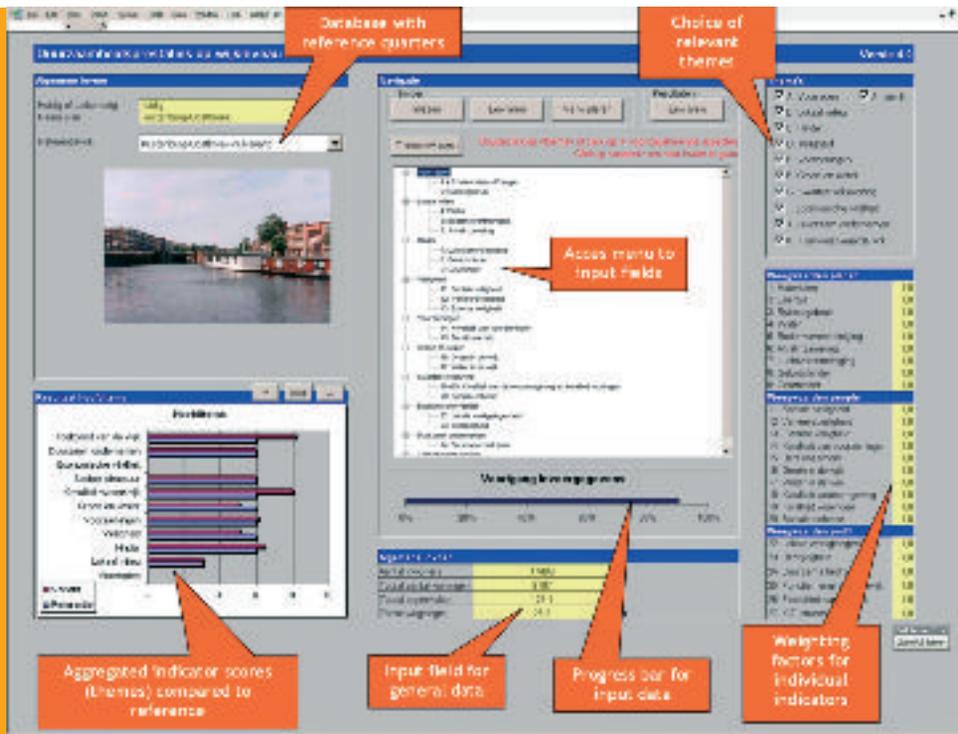
The input and output to the geographical information system is managed by the flexible programmable interface Visual Basic. The model has been applied numerous times and has proven to be of added value, and a version aimed specifically at land and real estate planning is used commercially by the consultancy firm StrateGis Groep.

MEASURING SUSTAINABILITY OF A DISTRICT WITH DPL

DPL is an approach for sustainable urban planning that quantitatively measures the sustainability of urban areas (districts) based on 25 environmental, social and economic indicators (People, Planet, Profit). DPL was developed by IVAM in cooperation with TNO Environment and Geosciences and with financial support from the Dutch Ministry of Housing Spatial Planning and the Environment (VROM).

DPL can be used by local authorities, urban planners and project developers to inform discussions of sustainability in urban planning. DPL can be used to set targets in advance and verify them later. Pilot projects have been carried out in the cities of Amsterdam, Delft, The Hague, Den Helder, Heerlen, Nieuwegein and Velsen.

Central to the DPL approach is a spreadsheet model with a user-friendly interface. Users of the model first have to gather information regarding numerous aspects of an existing or newly planned district. This information is used to calculate the 25 indicators. The resulting indicator scores can be compared with a database of reference plans, typical for the most common types of Dutch urban districts. The complexity and depth of the isolated indicators is limited; the strength of DPL lies in the breadth of the range of ecological, social and economic indicators (see Sustainability profile of a district). DPL is currently available as a



The DPL interface.

DPL – SUSTAINABILITY PROFILE OF A DISTRICT

‘PLANET’ INDICATORS

- STOCKS
- 1 Material use
- 2 Energy use
- 3 Land use
- LOCAL ENVIRONMENT
- 4 Water management
- 5 Soil contamination
- 6 Waste management
- 7 Air pollution
- 8 Noise
- 9 Smells

‘PEOPLE’ INDICATORS

- SAFETY
- 10 Social safety
- 11 Traffic safety
- 12 External safety
- SERVICES
- 13 Quality of services
- 14 Access to services
- GREEN SPACE AND WATER
- 15 Local green space
- 16 Local water
- QUALITY
- 17 Quality of the district
- 18 Quality of the dwellings
- 19 Social cohesion

‘PROFIT’ INDICATORS

- ECONOMIC VITALITY
- 20 Local employment
- 21 Local economic activity
- SUSTAINABLE BUSINESSES
- 22 SUSTAINABLE BUSINESSES
- CAPACITY TO CHANGE
- 23 Flexibility
- 24 Mixed use
- 25 ICT infrastructure

commercial software program through IVAM and TNO Environment and Geosciences.

THREE PARALLEL APPROACHES

A brief assessment of the three approaches, using the criteria identified earlier, is presented in tables 2a, 2b, and 2c. Each of the approaches has its specific advantages and disadvantages.

The Codes approach is integrative in many ways and pays a lot of attention to the link between performance of design alternatives and the preferences of the stakeholders. The model is transparent, but also very complex. This complexity limits its use, since experts are always needed to apply the approach.

The TNO City approach is very communicative and interactive and has no real weaknesses. Further improvements should focus on making the interface more usable for non-experts and on adding more substantive aspects (indicators) to the default calculations.

The DPL approach is very easy to use, also for non-experts. It is also a very transparent approach. The main disadvantage is that it takes time to generate the input for the calculations, which makes the approach unsuitable for interactive and dynamic applications.

The ideal method would have the integrative and actor-focused qualities of Codes, the GIS interface and speed of TNO City and the transparency and ease of use of DPL. Such hybrid approaches will be →

CRITERIA	ASSESSMENT OF THE CODES APPROACH	SCORE
Integrative	MEDIA integrates different spatial levels, substantive aspects and decision making in one systematic approach.	++
Dynamic	MEDIA is able to calculate the performance of alternatives. The simulation game relates these results to stakeholders' preferences. Stakeholders can choose the indicators they consider important.	++
Interactive	MEDIA itself does not directly support negotiation between stakeholders, this is however the primary function of the simulation game.	++
Transparent	From evaluations of the combined use of MEDIA and simulation game, it can be concluded that the approach in principle is clear and understandable to all stakeholders, although the complexity of the model requires a certain degree of expertise and experience with computer models.	+
Flexible and Reusable	The concepts behind MEDIA are generic, and therefore can be used or adapted for a wide range of applications. Considerable effort is required to construct a specific database, so this is only feasible if the method is applied often, or on very large projects.	o
Fast and easy	MEDIA databases should be built by experts. Experience is that non-experts can use the model with instruction, but only for the most basic functions. For sophisticated analysis an expert is needed. It is also clear the software interface still has a lot room for improvement.	o
Communicative and educational	This is not directly the purpose of MEDIA, but again one of the main objectives of the simulation game. Within the game, MEDIA clarifies the structure of the problem and possible alternative solutions. The game is designed to allow for different perspectives. The interface of the model itself is not specifically communicative.	+
Authoritative	Many of the indicators calculated by MEDIA are based on established and validated methods, but this not necessarily the case, nor is it clear in the model. Specific care has to be taken in advance to demonstrate this to the users. Within the simulation game, political standards are incorporated through the ambitions and goals of the participants.	+

examined in the future within research programmes such as Delft Cluster. However, past experiences have shown that visions of omnipotent supermodels have the tendency to become a goal in themselves. Accordingly, the approaches described in this paper will be developed primarily in parallel with one another, focusing on their specific strengths and applications.

Notes

- See Hajer M., The politics of environmental performance review: choices in design, Working paper 38, Recht and Beleid, Rijksuniversiteit Leiden, 1992, and Roe E., Taking complexity seriously: policy analysis, triangulation and sustainable development, Kluwer, Boston, 1998.
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- This functionality has been described more detailed in earlier papers. See, for example, Bots P. and Seijdel R., MEDIA – A decision support tool for urban development, Conference proceedings Sustainable Building 2002, Oslo, 2002.
- These sessions are described in Mayer I., van Bueren E., Bots P., van der Voort H. and Seijdel R., Collaborative decision making for sustainable urban renewal projects: a simulation – gaming approach. Environment and Planning B: Planning and Design 32:403-423, 2005.
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