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A Tool For Economic Development Agencies For The Model-Based Business Consultation In Location Planning

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Abstract

Location planning is crucial to a company's long-term success. The increasing concentration of companies in urban areas poses new challenges for regional location planning. For companies to make good long-term location planning and development decisions, they must increasingly cooperate with Economic Development Agencies **(**EDAs). Against this background, a tool was developed in the DFG research project "TransferMetroPlant" that supports companies in regional location assessment and decision-making by comparing location requirements with assessed and stored locations. This tool makes it possible for EDAs to systematically and objectively carry out location consultancy and to derive development measures for the managed locations in the process. Company and municipal measures for the development of locations over time can be taken into account. This paper presents the structure of the tool and the corresponding workflow and provides insights into its development. In addition, essential findings of the workshop-based validation of the developed planning approach are described.

Keywords

Location Planning; Planning Tool, Factory Planning

1. Introduction

Location planning is confronted with far-reaching challenges at the regional level due to megatrends such as advancing urbanisation [1]. Location decisions bind spatial and financial resources, determining the long-term competitiveness of an organisation. The decision process can be viewed on multiple levels, beginning with a global view in case different countries are considered. After deciding on a country, companies must break down the location decision on a regional level. In regional location planning, companies have the most significant leverage to influence the location conditions, as the location has concrete geographical characteristics that are still unclear for most factors at the global level. Companies have to consider numerous quantitative and qualitative location factors in their regional facility location decisions, which significantly increases the situation's complexity. For example, the connection and distance to critical infrastructure (quantitative location factor) correlate with the attractiveness of a location (qualitative location factor), which is crucial for employees [2]. In the project "MetroPlant", an integrated planning approach for regional business location planning and development was developed by the Institute of Automotive Management and Industrial Production (AIP) at the Technische Universität Braunschweig and the Institute of Production Systems and Logistics (IFA) at the Leibniz University Hannover. A workshop-based validation showed that the developed planning approach provides realistic decision recommendations and offers clear advantages over conventional approaches in location planning by considering location developments[3]. At the regional

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level, it is often very efficient to enhance locations by initiating development measures. Since companies aim to choose the best location possible, not only companies themselves but also the Economic Development Agencies (EDAs) try to develop their location attractively in order to be able to bring companies to the region. The core objective of the project TransferMetroPlant is the further development of the existing planning approach for regional business location planning and development, resulting from the project "MetroPlant". The planning approach had so far been geared towards the requirements of companies and was to be expanded to include a municipal perspective as part of the project. With this extended approach, the focus is on the counselling of companies planning to relocate by EDAs, whose counselling process is to be systematised and objectified within the framework of the research project and tested under real conditions after transfer into an application-oriented tool. For this purpose, both the evaluation model and the decision model were to be adequately further developed. This article gives an overview of the project and presents the validation of the developed approach. After further describing the preliminary work and the municipals' role in regional facility location planning, the project's vision is presented. To describe the approach, a conceptual overview and system information are given, followed by information about workflow, the user interface and data management. The validation workshops are then summarised and findings are presented.

2. Regional Facility Location Planning and Development

The following chapter sets the base for further explanations, starting with a summary of the preliminary work. The municipal actors and their role in consulting companies looking for a new location are then described and lastly the project's vision is outlined.

2.1 Preliminary Work

This paper's content builds on fundamental research findings on regional facility location planning and development. As a joint preliminary work to this paper, the results have been obtained by the AIP and IFA as part of the DFG-funded research project *MetroPlant* (2018 - 2020). The overall aim of *MetroPlant* has been to develop an approach for assisting companies in regional facility location planning, whose novelty lied in the integrated decision support for the selection and strategic development of locations. By supporting these corporate decisions, development measures by different municipal actors at the potential locations can additionally be considered. The planning approach has been developed based on relevant findings concerning the following three research questions:

(1) How do companies and municipal actors assess their influence on regional location factors? [4,5]

(2) Which development measures can companies and municipal actors take to develop regional location factors? [5]

(3) What are the interdependencies between regional location factors? [5]

To answer the questions, broad empirical analyses have been conducted. Before this, relevant location factors on the regional level had been identified within a joint preliminary study (2014 - 2016) by the AIP and IFA [6,7]. Based on these findings and as the main result of the project *MetroPlant*, a prototypical planning approach for the integrated regional facility location planning and development was provided for companies. The approach was successfully validated in workshops with a company and municipal representatives [3].

2.2 Role Of Municipal Actors And Need For Action

Municipal actors pursue different goals and concepts for attracting companies [8]. In general, municipalities and especially EDAs play a central role in a company's regional location planning and development. Economic development is conducted at different levels (i. e., from a municipal up to a federal level), and thus EDAs have a broad spectrum of tasks [9,10]. The tasks differ both between and within regions [11].

There are, however, some core tasks like ongoing improvement of economy-related infrastructures as a critical prerequisite for long-term corporate success and support for (re)location requests of companies [12,10]. EDAs usually bring together relevant information on locations of interest in a systematic manner and thus are a central source of data for companies. Many EDAs, for example, maintain web-based databases as publicly available sources for companies to acquire location-relevant data. Also, EDAs are generally well-networked with further municipal actors and relevant third-party actors. Against the background, for location-seeking companies, EDAs are an unavoidable point of contact in their decision-making process [13]. This is particularly true when potential locations are to be identified and assessed by companies. In this phase of the corporate decision-making process, EDAs often have a supporting role. Concretely, they identify vacant locations for companies and try to filter out the individually most suitable one(s). For this, they acquire a company's specific location requirements based on multiple criteria, for example, by using simple checklists. The location recommendations are usually derived heuristically, i. e., based on an EDA's employees' individual experiences and intuitions. Although intuitive recommendations do not necessarily need to be wrong, location decisions should be well-considered and aided methodologically to avoid strategic missteps. So far, in both literature and practice, no decision-making tool exists that supports an EDA's management consultation process in regional facility location planning and development. This need for action has been identified through numerous expert interviews with representatives of EDAs and municipalities in different German regions in the context of *MetroPlant*.

2.3 TransferMetroPlant – The Project's Vision

The need for action was addressed by the DFG-funded project *TransferMetroPlant* (2021 - 2022) of the AIP and IFA, which built on the results of *MetroPlant*. The project aim was to enhance further the already developed prototypical planning approach towards an application-oriented tool for EDAs for the model-based systematic consultation of companies in regional location planning and development. For this, cooperation has been entered with the EDAs of the Hanover region and the Hanover state capital as project application partners. For both EDAs, the consultation of companies in location planning is a highly repetitive and relevant task. Annually they receive about 200 inquiries from companies seeking for locations. The staff of EDAs consult companies often based on their individual experience and in varying duration. However, location recommendations for the same company are unlikely reproducible across employees, as they highly depend on an employee's subjective perception. Therefore, from the tool developed in *TransferMetroPlant*, the EDAs expect a considerable increase in objectivity through process standardization and methodological foundation in the location consultancy for companies. To achieve the project aim, a work program consisting of the work packages (WPs) 1–5 has been defined, as shown in Figure 1.

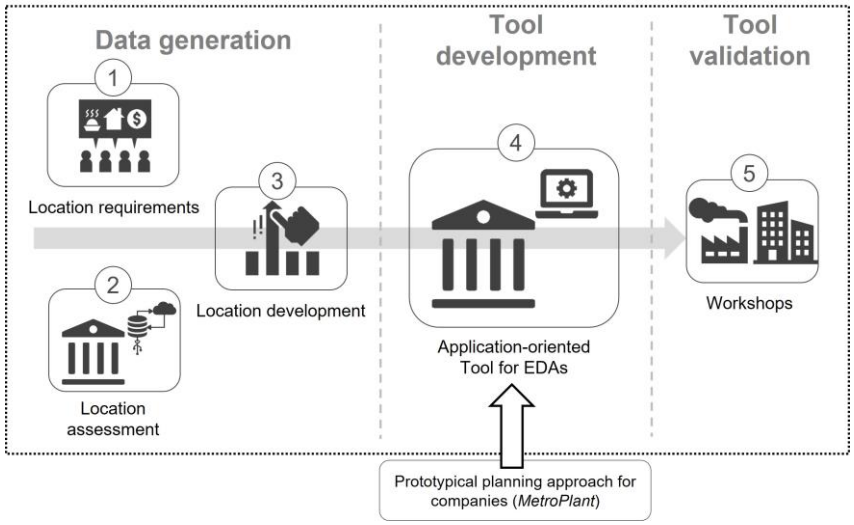

Figure 1: Work program of the project *TransferMetroPlant*

Relevant data for the new tool has been generated within WPs 1 - 3. In the context of **WP 1**, the location requirements of companies currently seeking and companies already located within the Hanover region have been identified. To ensure heterogeneity, a total of 726 online questionnaires (return rate of 11.6 %) have been sent to companies of different branches and sizes. Within **WP 2**, locations (e.g., business parks or real estate) within the Hanover region have been assessed by the participating EDAs. Based on the comparison of the evaluated location characteristics (WP 2) with the surveyed location requirements (WP 1), needs for action and municipal measures for location development have been identified in **WP 3**. These results from WP 1 - 3 made up for the initial data framework. The project's core was the tool, which development took place within **WP 4**. Here, the prototypical planning approach resulting from the preceding project *MetroPlant* served as the primary input. The focus was on the transformation of the formerly operational approach towards a municipal planning tool that had to meet the requirements of business advisory EDAs. Finally, the developed tool was validated within **WP 5** by putting it into real-life applications by the EDAs. For this purpose, workshops were held with companies of different sectors and sizes that were looking for a location within the Hanover region. In the following, this article focuses on WP 4 and 5.

3. Planning tool

In this Section, the planning tool is presented by giving an overview of the concept and system implementation followed by a description of the workflow, as well as an insight into the user interface and data management.

3.1 Conceptual Overview and system implementation

The tool aims to support companies' decision-making regarding selecting the most suitable location and its optimal development over time. To do so, a comprehensive set of data is needed, which can be divided into master data and planning data [14]. The master data contain information about the number of potential locations, relevant location factors, or measures for location development. The planning data specify parameters on the location assessment, location requirements, location development, and general conditions. The process can be divided into three steps: (1) data collection; (2) generating results; (3) interpreting results. In the first step, the necessary master and planning data is generated using the tool, structured in a two-staged process starting with a pre-selection followed by request for additional planning data. Initially, a pre-selection takes place, possibly reducing the number of considered locations by gathering information about budget, utilisation category and development status (property or real estate). After pre-selection, the user states his targets for specific location factors and then prioritises them by completing a pairwise comparison. In the second step, the results for a planning company regarding the selection and development of a location are generated using the tool. The decision-making is based on mathematical optimization methods. Concretely, the Weighted Goal Programming approach from the field of Multi-Objective Decision Making (MODM) is used to address the planning problem adequately [14].
Step 3 takes the user to a dashboard which presents a variety of data, including the mathematical optimisation results. The results can later be influenced by adding different development measures from the perspective of the seeking company to improve certain aspects regarding one or several locations.
To ensure accessibility, the tool is operated in MS Excel, which is not open source but can be seen as an elementary and widespread office program. The tool is run on different Excel sheets starting on the dashboard. The background components of the tool responsible for the optimization are open source to allow for unrestricted access and use. The optimization model is implemented through Pyomo (Python-based), whereas the tool in Excel is based on visual basic for applications (vba). Message boxes and instructions support the whole process to ensure input is made correctly.

3.2 Workflow and user interface

The workflow is divided into two different loops. The first loop lets the user put in the data for generating initial results regarding a facility location decision. The second loop is optional and offers the chance to include the influence of development measures in the decision process. Figure 2 shows the overall process, displaying the first loop at the top and the second loop in the lower part of the image. The workflow regarding both loops is described in the following.

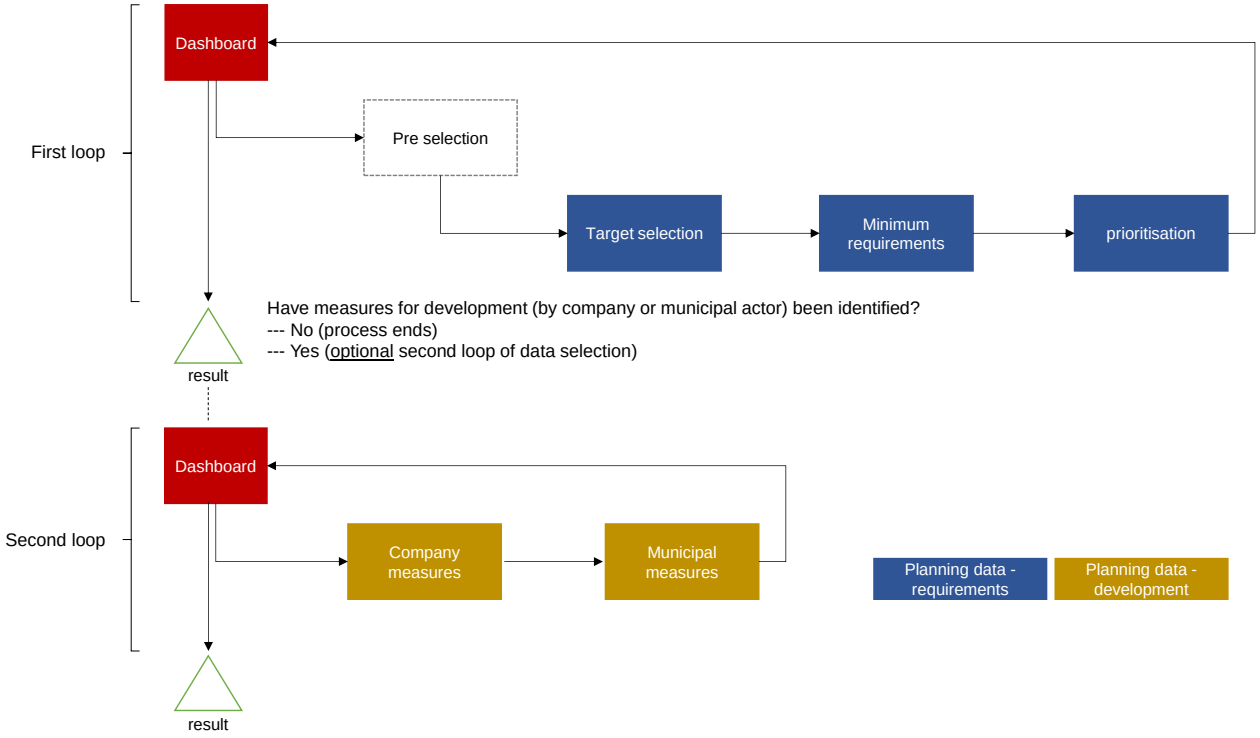

Figure 2: Overall workflow of the planning tool

The **dashboard** can be seen as the system's centrepiece, as it is set up as the starting point for each decision-making process and optimisation, as well as an overview of the results. Starting from the dashboard, the user is guided through the tool by answering different questions and rating certain factors in a given order. Therefore, the dashboard has also been the starting point for most workflow test runs during the implementation. The **pre-selection** is being addressed first and contains three questions to exclude location options that do not meet these criteria for further consideration. In this context, information about the budget and potential utilisation category (different options for residential, mixed, commercial, and special building areas) are derived. The user can also decide for the tool, whether to take only open building area, existing real estate or both into consideration, setting the base for either greenfield or brownfield factory planning.

After completing the pre-selection, the tool leads to the **target selection** regarding 18 location factors clustered into six categories. Each factor is rated regarding the importance of the current location planning project. The factors are rated on a scale of maturity levels reaching from 1 to 4 to make a comparison between them possible. After completing the rating, the same factors can be further specified by submitting **minimum requirements** for each factor. This step is only valid for those criteria that have not been rated irrelevant before. The selection of minimum requirements can lead to the exclusion of specific locations similar to the pre-selection. A **prioritisation** of the factors ensures receiving legitimate results. A pairwise comparison is used to rule out subjectivity as far as possible, allowing for a prioritisation based on several considerations.

The dashboard offers a button which gives the opportunity of introducing planning data for development measures to the location planning project by starting a second loop. A company can then consider activities to improve one or several locations in certain aspects. This step is not mandatory since results have already been created. Companies have opportunities to influence locations through **company measures**. These

measures can include any actions companies can take on their own, aiming to improve one or several location factors, possibly already referring to specific deficits after reflecting the results of the first loop. Similarly, EDAs can take **municipal measures** to improve the rating of a location factor. After completing the second loop, the user is brought back to the dashboard.

3.3 User Interface

One main target of the tool is to make the decision process for companies easier and more transparent while enabling the EDAs to improve their consultation service. The tool is therefore set up to be intuitively useable, giving only relevant information and options to click on. As described before, the dashboard is the centrepiece of the tool, being the starting point of new consultations as well as the base for further considerations of development measures. The different sheets are always automatically accessed by various commands in vba triggered by completing a message box or command, so the user cannot accidentally take a wrong turn. The message boxes give a selection of possible choices or offer a blank space to type in the request. Another way input can be entered is by double-clicking certain areas of the screen. In that case, the shown information already contains the parameters that can be selected. A message box containing information on how and where to select the needed information is shown in that case. An example of this kind of interface is the target selection, as shown in Figure 3.

Location factors	Maturity levels	1	2	3	4
Price level of commercial and industrial areas	not relevant	… >300 €/m²	… 100 - 300 €/m²	… 40 - 99 €/m²	… <40 €/m²
Business taxes	not relevant	… >470 %	… 450 - 470 %	… 400 - 449 %	… <400 %
Availability of properties	not relevant	… <1.000 m² zur Verfügung	… 1.000 - 4.999 m² zur Verfügung	… 5.000 - 10.000 m² zur Verfügung	… >10.000 m² zur Verfügung

Target selection Minimum requirements

Figure 3: Target selection process

All input data is stored in a separate sheet to make the data accessible for optimisation while ensuring the user will not accidentally change the input in the consultation process. After optimisation, the user returns to the dashboard, and the results are presented. The dashboard then offers particular possibilities to refresh the input data, adapt it, or start a new consultation process. Figure 4 shows the dashboard.

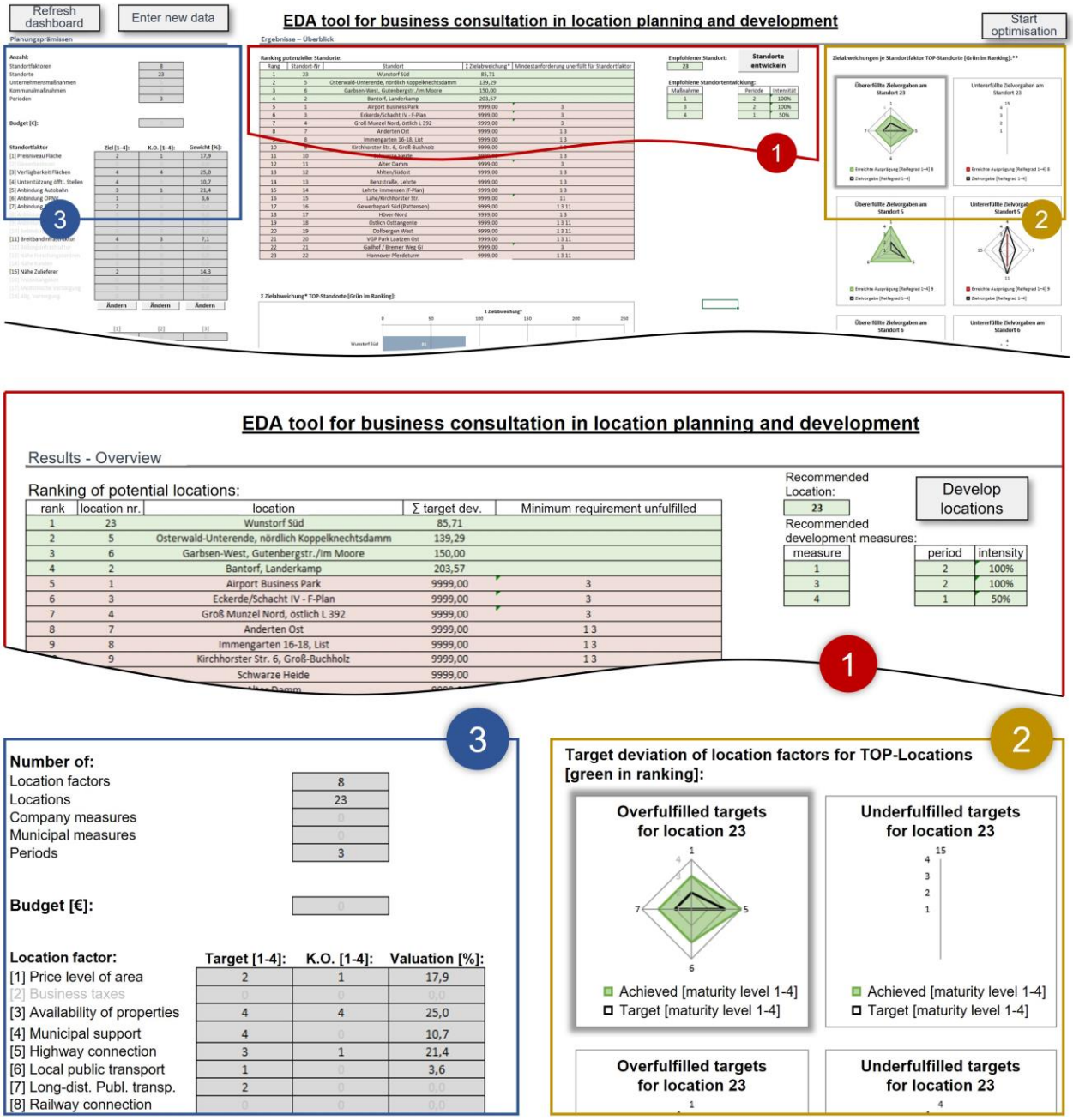

Figure 4: Dashboard of the planning tool

In the middle of the dashboard (1) the potential locations are shown in a ranking that already considers the factors' prioritisation. The minimum sum of deviations from the company-specific targets with regard to the relevant regional location factors determines the first-placed location in the ranking. Locations that meet all company-specific minimum requirements are considered suitable and are shown in green. In contrast, locations that do not meet one or more minimum requirements are thus unsuitable and are shown in red. The values derived from the mathematical optimisation of suitable locations are also shown in bar charts. In addition to this evaluation, a decision recommendation is given, including the choice of location and its optimal development. On the right-hand side of the dashboard (2) the positive and negative deviations from the targets for each relevant location factor are shown in radar charts for the suitable locations. This way, the abstract target function values are visualised for the user. Potential levers for development measures can thus be quickly derived from undesirable deviations. On the left-hand side (3) the planning data the results are based on are also displayed in the dashboard. Among other things, the number of relevant location factors,

potential locations, and the available budget of the advised company is displayed. In addition, the recorded targets and minimum requirements, as well as their prioritisation, are shown.

3.4 Master Data Management

An essential aspect of the tool was setting it up to allow for adaption and permanent use in the future. To ensure that the EDAs can benefit from the tool in the long term, it was essential to enable them to change the master data regarding the different locations filed in the tool. It must be possible to add new locations, delete locations that are no longer available, and change certain aspects of locations already filed. These options are considered in an area on the dashboard that addresses data management. From there, it is possible to intuitively add new locations, delete existing locations or make specific modifications to existing locations (or their characteristics concerning the 18 regional location factors). By keeping the master data updated, it is ensured that the consulting EDAs always take current (and vacant) locations into account when making decision recommendations on location selection and development for companies.

4. Validation of the tool through Workshops

Since the project findings and the developed tool are meant to support EDAs in their daily consultation process, a validation was intended to verify that the tool is performing well and the results given out are legitimate. To do so, a workshop concept was created that existed of three following meetings. Each meeting was held with the research institutes involved, representatives of the participating EDAs and a person in charge of the location planning process of a seeking company. The first meeting aimed to identify the company's needs by selecting and rating the relevant location factors. The institutes then monitored the input data collected there, and the tool calculated a result. This result was taken into the second meeting as a base for further discussion and a starting point for possible future development measures. Those were implemented, and the new result was calculated for the third meeting. The results with and without development measures were then discussed. In total, the tool could be tested in workshops with three different companies. Heterogeneity was achieved concerning their industry affiliation, company size and intended location use. The location-seeking companies came from the building services sector, manufacturing and IT/communication. The latter was a small company ($\leq$ 49 MA), and the other two were large companies ($\geq$ 250 MA). Two companies were looking for a location for research & development. One intended location use was logistics/warehousing.

5. Findings

The validation workshops demonstrated that the application of the tool brought significant benefits to both the consulted company and the consulting EDA. The three companies consulted attested that the EDA's application of the planning approach during the consultation process contributed to a considerable increase in transparency in their decision-making. The companies highlighted the structured recording of their location requirements. In addition, they benefited from the systematic derivation of objective decision recommendations in that they were free from subjectivity on their part or the part of the EDA representatives consulting them. One managing director noted that the tool's great potential lies in communicating location decisions within a company since the high degree of transparency makes it easy for people involved to understand and accept specific measures. Another manager said that some of the results of the target selection were surprising, giving an ideal starting point for future development measures. For the EDA's staff, applying the tool in the consultation process goes hand in hand with a considerable gain in efficiency and standardisation of the process. The EDAs attested that the time usually spent (on average) on business consultancy for location planning can be minimised by up to 40 % with the application of the planning approach using the tool. By standardising the process, the approach can ensure that the quality of advice is

consistently high, regardless of the level of knowledge and experience of the EDA staff providing it. The validation of the tool showed that it is practical and advantageous compared to previous approaches of management consultancy for location planning and development by EDAs. The validation workshops also proved the legitimacy of the results created and could further demonstrate the acceptance of data-supported recommendations by the consultation-seeking companies.

6. Conclusion

The introduced tool is a beneficial and innovative instrument for EDAs to systematically and methodically consult companies on the selection and development of locations at the regional level. EDAs are enabled by its use to support companies in finding suitable locations systematically and according to their needs. The data-based approach reduces the risk of wrong decisions in strategic location planning on the part of companies. In addition, with the help of the tool, municipal and company development measures can be derived in a targeted manner and evaluated in advance. Systematic cooperation between EDAs and companies makes it possible to identify synergy potentials early and leverage them purposefully. The tool developed was piloted for the application partners in Hanover and made available to the participating EDAs with immediate readiness for use in advising location-seeking companies. The planning tool can, in principle, be rolled out without restriction within the economic area examined and beyond (Germany-wide) for use by other EDAs.

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Biography

Justin Hook (*1994) studied industrial engineering with a focus on production technology at Leibniz University Hannover and University of Southern Denmark. He works as a research associate in the field of production management at the Institute of Production Systems and Logistics (IFA) at the Leibniz University Hannover since 2020.

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Prof. Dr. Thomas Stefan Spengler (*1963) is Professor of Production and Logistics Management since 1998 and head of the Institute of Automotive Management and Industrial Production (AIP) at the Technische Universität Braunschweig. Within his research, he focuses on quantitative methods for decision support in operations and , and supply chain management. He studied Industrial Engineering and received his PhD and Habilitation in Business Economics from the Karlsruhe Institute of Technology (KIT).

Prof. Dr.-Ing. habil. Peter Nyhuis (*1957) studied mechanical engineering at Leibniz University Hannover and subsequently worked as a research assistant at IFA. After completing his doctorate in engineering, he received his habilitation before working as a manager in the field of supply chain management in the electronics and mechanical engineering industry. He is heading the IFA since 2003.