

18th CIRP Conference on Intelligent Computation in Manufacturing Engineering

Data assessment for effective regional factory location selection

Michael Riesener^a, Esben Schukat^a, Siyuan Wang^a, Carsten Engeln^{a*}^a*Laboratory for Machine Tools and Production Engineering (WZL)
of RWTH Aachen University, Aachen, Germany** Corresponding author. Tel.: +49-151-515-69705, E-mail address: c.engeln@wzl.rwth-aachen.de

Abstract

Factory location selection is complex, uncertain and time-consuming while it entails long-term consequences and high costs. To enable faster and less subjective decisions we aim to develop a data-driven decision support system. This system contains suitable data sets representing important location selection factors preselected in this paper. The focus and main contribution of this paper is the regional focus of the developed holistic overview of factors and data sets. Finally, we give an outlook on how to analyse this data in the decision support system to be developed. Thereby, we enable more objective and sustainable factory location decisions.

© 2025 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 18th CIRP Conference on Intelligent Computation in Manufacturing Engineering (CIRP ICME '24)

Keywords: Factory planning; location selection; site selection

1. Introduction

Factory location selection is a decision process entailing long-term consequences and high costs. It is complex, uncertain and time-consuming e.g. due to numerous factors to be considered especially if holistic, regional and sustainable. [1]

Our solution approach is to enable faster and less subjective decisions by developing a data-driven decision support system as outlined in previous publications [2, 1]. It focuses on regional location selection requiring the comparison of states or counties. The system will contain suitable data sets representing the most relevant location selection factors. Factors are considered most relevant if they are widely applicable to regional location comparisons regardless of case-specific context. In order to ensure manageable complexity for this first data selection the scope is limited to the USA as one of the most relevant locations for establishment of new factories. This was shown in 2024 by the German American Chambers of

Commerce where almost 96 % of 224 subsidiaries of german companies surveyed planned to expand their investments in the USA by 2026, 40 % exceeding five mill. USD and 30 % exceeding 10 mill. USD [3].

Our objective in this paper is to select data sets for integration in the decision support system. In chapter 2 relevant location selection factors from literature are summarized in a new holistic overview. In chapter 3 available data sets representing the most relevant location selection factors are identified.

2. Selection of relevant regional location selection factors

First, we present the objective of our selection of location selection factors as well as a limitation for their relevance in this context. Second, we present the approach and results of our literature review. Third, we present the identified location selection factors that are relevant in this context.

2.1. Objective and limitation of factor relevance

Regional limitation: In this publication a location selection factor is considered relevant if it is applicable to regional location selection. Global, regional and local are typically used scopes in location selection, where global means comparison of continents or countries; regional means comparison of states or counties; local means comparisons of cities or sites [4]. This excludes all factors exclusively relevant for global or local scopes. Figure 1 shows the described differentiation of location selection scope, compared objects and focus for this paper.

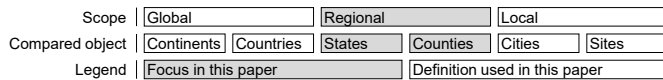


Figure 1: Typical scopes of location selection

Applicability limitation: In this paper a factor is considered relevant if it can be quantitatively represented for the intended development of a universally applicable decision support application. Therefore a factor is relevant if it can be represented by location-specific data independently of a specific use case. This excludes all factors dependent on the comparison of two specific locations or dependent on the consideration of use-case-specifics like specific sectors and firms. For instance income per capita is a relevant factor while distance to customers is not, since the latter cannot be represented via data considering only one location and depends on case-specific context like target customers, target customers location and production site location.

2.2. Literature review for identification of factors

A systematic literature search was conducted based on the method by vom Brocke et al. [5]. The objective was to find holistic overviews of location selection factors for the latter identification of the most relevant factors. The topic included site selection, also called location selection, for factories also called manufacturing or industrial facilities. The approach was documented according to the STARLITE method by Booth [6]. The sampling strategy was selective, attempting to identify relevant studies within specified limits. The type of studies searched for were reviews, expert studies and meta-analysis. The approach was to search in databases. The range of years was unlimited. Limitations were set to English and German language. Included studies had to focus on factory location selection. The search string was (("location selection" OR "site selection") AND ("factory" OR "factories" OR "manufacturing" OR "industry" OR "industrial")) OR ("Standortauswahl" OR "Standortentscheidung") AND ("Fabrik" OR "Fabriken" OR "Produktion" OR "Industrie" OR "industriell"). The sources were IEEE Xplore, Scopus and Web of Science. In nine steps following the method by vom Brocke [5] and the PRISMA statement by Moher [7] 4,141 publications were found and filtered. The exclusions contained 310 anthologies and proceedings, none too old publications, 650 duplicates, 1,163 off-topic publication mediums, 480 off-

topic keywords, 1,455 titles, 56 abstracts and 12 full texts. The following three studies were finally considered relevant. Arunyanart et al. identified 30 factors by reviewing 33 publications on the topic [8]. Badri identified 95 factors by meta-analysis of theoretical and empirical publications from 1875 to 2006 and verified them with 2,125 industrial executives from 23 countries [9]. MacCarthy et al. identified 80 factors by delphi study with 17 international experts experienced in the topic [10]. This resulted in a total of 205 partially redundant location selection factors.

2.3. Relevant regional location selection factors

Relevant factors were identified by excluding 13 factors according to the regional limitation and 66 factors according to the applicability limitation from section 2.1. The remaining 126 factors were summarized into 71 new factors and ordered into twelve new categories. A category e.g. market potential, may contain multiple factors. This standardization was necessary since the original factors were ordered in different categories and had different levels of abstraction spanning from what we consider measurable indicators to what we consider criteria or factors. Figure 2 shows the resulting regional location selection categories and factors.

Category	Factor
C01: Market potential	Customers number Customers purchase power Market size Market size development
C02: Supply infrastructure	Electricity supply Fuel supply Gas supply Infrastructure overall Water supply
C03: Freedom of trade	Trade openness
C04: Labor market and workforce	Labor costs Labor rights Language Living conditions attractiveness Workforce availability Workforce education Workforce overall Workforce productivity Working time
C05: Taxes and transfers	Taxation Transfers and subsidies
C06: Legal system and certainty	Regulatory business friendliness
C07: Political stability	Crime Political stability
C08: Macroeconomic stability	Access to capital Economic freedom Economy overall Financial stability
C09: Simplicity of business establishment	Attractiveness for foreign investments Ease of doing business
C10: Transport and telecom infrastructure	Airway transportation Highway transportation Railroad transportation Telecommunication systems Transportation and warehousing Water transportation
C11: Industrial infrastructure	Industrial facility establishment Suppliers Technology and innovation
C12: Environmental sustainability	Pollution Renewable energy availability Risk of natural disaster Sustainability development

Figure 2: Regional location selection categories and factors

3. Selection of data sets

The data research approach aimed to find suitable data sets representing the relevant regional location selection factors. First, for each category and for each factor therein suitable measurable indicators were collected. These indicators were collected from the twelve full texts that were analysed as described in section 2.2. Some were specified using the authors experience from factory location selection projects carried out by the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University in Germany [11]. Where it seems suitable to increase order, a factor was split up into multiple criteria, where each criterion summarized multiple measurable indicators. For every measurable indicator a separate online search was conducted.

The data research results are shown in figure 3. In column 1, each row has an ID and represents one acquired data set. In columns 2 and 3, the categories and factors are identical to those presented in section 2.3. Columns 4 and 5 contain the criterions and measurable indicators as described in the previous paragraph. Column 6 contains the unit of the measurable indicator, where “#” represents a number without a unit. Column 7 contains the scope representing the granularity of the data. For the scope “county” the data distinguishes separate counties, while not necessarily all counties. For the scope “metropolitan” the data distinguishes a few selected metropolitan areas. For the scope “multi-state” the data distinguishes a few regions containing multiple states e.g. as “west coast”. The considered data sets regarding energy supply distinguish five PADD regions by the Petroleum Administration for Defense and Districts [12]. Column 8 contains the abbreviated sources that the data set was directly acquired from as explained and cited in the next paragraph. Column 9 contains the actuality representing the latest year consistently represented in the data set and therefore not representing the publication date of the data set.

This paragraph alphabetically explains the abbreviated sources. CNBC stands for CNBC LLC. and is source of 11 data sets [13]. DHS FEMA stands for U.S. Department of Homeland Security - Federal Emergency Management Agency and is source of 2 data sets [14]. DOC BEA stands for U.S. Department of Commerce - U.S. Bureau of Economic Analysis and is source of 16 data sets [15]. DOC ITA stands for U.S. Department of Commerce - International Trade Administration and is source of 1 data set [16]. DOC USCB stands for U.S. Department of Commerce - U.S. Census Bureau and is source of 26 data sets [17]. DOE EIA stands for U.S. Department of Energy - U.S. Energy Information Administration and is source of 11 data sets [18]. DOE NREL stands for U.S. Department of Energy - National Renewable Energy Laboratory and is source of 5 data sets [19]. DOJ FBI stands for U.S. Department of Justice - Federal Bureau of Investigation and is source of 1 data set [20]. DOL BLS stands for U.S. Department of Labor - U.S. Bureau of labor statistics and is source of 4 data sets [21]. DOL WHD stands for U.S. Department of Labor - Wage and Hour

Division and is source of 1 data set [22]. DOT BTS stands for U.S. Department of Transportation - Bureau of Transportation Statistics and is source of 10 data sets [23]. DOT FHWA stands for U.S. Department of Transportation - Federal Highway Administration and is source of 1 data set [24]. FCC stands for Federal Communications Commission and is source of 1 data set [25]. Fdi Markets is source of 3 data sets [26]. FHFA stands for Federal Housing Finance Agency and is source of 1 data set [27]. Forbes advisor stands for Forbes advisor and is source of 1 data set [28]. Fraser institute is source of 9 data sets [29]. NOAA stands for National Oceanic and Atmospheric Administration and is source of 8 data sets [30]. NVCA stands for National Venture Capital Association and is source of 3 data sets [31]. SDSN stands for UN Sustainable Development Solutions Network and is source of 1 data set [32]. Tax-Rates.org is source of 4 data sets [33]. U.S. Courts is source of 1 data set [34]. UIC stands for University of Illinois Chicago and is source of 1 data set [35]. USDA NASS stands for U.S. Department of Agriculture - National Agricultural Statistics Service and is source of 1 data set [36]. USGS WSC stands for U.S. Geological Survey - MD-DE-DC Water Science Center and is source of 1 data set [37].

4. Discussion

Many factors to be considered in regional location selection can be analysed with publicly accessible data sets. On the other hand some data sets do not seem to allow for gathering the desired insights and therefore require further analysis. The following discussion follows the data assessment outlined in a previous publication [1]. The relevance of the data sets vastly differs, meaning that they describe differently suitable quantitative measures for representation of the respective regional location selection factor. The trustworthiness of most sources appears reliable, since they are published by governmental departments of the United States of America. The trustworthiness of the contained information depending on the data creation method disclosed is not always high since some of the data is modelled and provided with warnings regarding its low reliability. The comprehensiveness of the data is sometimes limited since not all entities in the desired scope are contained e.g. not all counties of the USA. The granularity of the data sets revealed that for some factors and criterions locations cannot be meaningfully broken down into states, counties, or other classes, since the factor or criterion cannot or is not usually assessed on a sub-national level e.g. regarding the legal system. The data precision is also often limited when data is not intuitively comprehensible e.g. because it is represented by relative measures, indices or rankings. The actuality describing what year is represented in the data is mostly less than two years old but only very few data sets are from the current year. Some seemingly interesting data sets were for now disregarded since they were neither freely accessible nor currently accessible by the authors.

ID	Category	Factor	Criterion	Measurable indicator	Unit	Scope	Source	Actuality
01.01	C01: Market potential	Customers number	Population	People	[#]	County	DOC BEA	2022
01.02	C01: Market potential	Customers number	Population	People development over 3 years	[#]	County	DOC BEA	2022
01.03	C01: Market potential	Customers purchase power	Income per capita	Personal income per capita	[USD]	County	DOC BEA	2022
01.04	C01: Market potential	Customers purchase power	Income per capita development	Personal income per capita change over past 10 years	[%]	County	DOC BEA	2022
01.05	C01: Market potential	Market size	Gross domestic product	Inflation-adjusted or real GDP	[USD]	County	DOC BEA	2022
01.06	C01: Market potential	Market size development	Gross domestic product	Change over past 3 years	[USD]	County	DOC BEA	2022
01.07	C01: Market potential	Market size	Gross domestic product	Inflation-adjusted or real GDP by industrial sector	[USD]	County	DOC BEA	2022
01.08	C01: Market potential	Market size development	Gross domestic product	Change over past 3 years by industrial sector	[USD]	County	DOC BEA	2022
01.09	C01: Market potential	Market size	Consumer spending	Consumer spending by industrial sector	[USD]	County	DOC BEA	2022
02.01	C02: Supply infrastructure	Infrastructure overall	Infrastructure overall ranking	Infrastructure overall ranking	[#]	State	CNBC LLC.	2022
02.02	C02: Supply infrastructure	Electricity supply	Electricity availability	Electricity consumption	[Btu]	County	DOE NREL	2016
02.03	C02: Supply infrastructure	Electricity supply	Electricity availability	Electricity consumption	[Btu]	Multi-state	DOE EIA	2022
02.04	C02: Supply infrastructure	Electricity supply	Electricity costs	Electricity costs per Btu	[USD]	County	DOE NREL	2016
02.05	C02: Supply infrastructure	Electricity supply	Electricity costs	Electricity costs per Btu	[USD]	Multi-state	DOE EIA	2022
02.06	C02: Supply infrastructure	Gas supply	Natural gas availability	Natural gas consumption	[Btu]	County	DOE NREL	2016
02.07	C02: Supply infrastructure	Gas supply	Natural gas availability	Natural gas consumption	[Btu]	Multi-state	DOE EIA	2022
02.08	C02: Supply infrastructure	Gas supply	Natural gas costs	Natural gas costs per Btu	[USD]	County	DOE NREL	2016
02.09	C02: Supply infrastructure	Gas supply	Natural gas costs	Natural gas costs per Btu	[USD]	Multi-state	DOE EIA	2022
02.10	C02: Supply infrastructure	Fuel supply	Fuel availability	Fuel consumption incl. gasoline and diesel	[gal]	County	DOE NREL	2016
02.11	C02: Supply infrastructure	Fuel supply	Fuel availability	Fuel consumption incl. gasoline and diesel	[Btu]	Multi-state	DOE EIA	2022
02.12	C02: Supply infrastructure	Fuel supply	Fuel costs	Fuel costs per gallon for diesel	[USD]	Multi-state	DOE EIA	2024
02.13	C02: Supply infrastructure	Fuel supply	Fuel costs	Fuel costs per gallon for gasoline	[USD]	Multi-state	DOE EIA	2024
02.14	C02: Supply infrastructure	Fuel supply	Fuel availability	Coal consumption	[Btu]	Multi-state	DOE EIA	2022
02.15	C02: Supply infrastructure	Fuel supply	Fuel costs	Coal costs per Btu	[USD]	Multi-state	DOE EIA	2022
02.16	C02: Supply infrastructure	Water supply	Water availability	Water consumption	[USGS WSC]	County	USGS WSC	2015
03.01	C03: Freedom of trade	Trade openness	Foreign trade	Export volume by origin	[USD]	State	DOC USCB	2023
03.02	C03: Freedom of trade	Trade openness	Foreign trade	Export volume by zip code	[USD]	State	DOC USCB	2023
03.03	C03: Freedom of trade	Trade openness	Foreign trade	Export volume	[USD]	Metropolitan	DOC USCB	2023
03.04	C03: Freedom of trade	Trade openness	Foreign trade	Import volume	[USD]	State	DOC USCB	2023
03.05	C03: Freedom of trade	Trade openness	Foreign trade	Exporting businesses by size by industry	[#]	State	DOC ITA	2021
04.01	C04: Labor market and workforce	Workforce overall	Workforce overall ranking	Workforce overall ranking	[#]	State	CNBC LLC.	2022
04.02	C04: Labor market and workforce	Labor costs	Wage average	Employee compensation per year average	[USD]	County	DOC BEA	2022
04.03	C04: Labor market and workforce	Labor costs	Wage average	Employee compensation per hour average in manufacturing	[USD]	State	DOL BLS	2023
04.04	C04: Labor market and workforce	Labor costs	Wage average development	Employee compensation per year average development over 10 years	[%]	County	DOC BEA	2022
04.05	C04: Labor market and workforce	Labor costs	Wage minimum	Employee compensation per hour minimum	[USD]	State	DOL WHD	2024
04.06	C04: Labor market and workforce	Labor rights	Full-time minimum wage income	Score for full-time minimum wage income as percentage of per capita income	[#]	State	Fraser institute	2021
04.07	C04: Labor market and workforce	Labor rights	Labor union existence	Score for labor union density	[#]	State	Fraser institute	2021
04.08	C04: Labor market and workforce	Language	English speakers	English speakers at level "very well"	[%]	County	DOC USCB	2013
04.09	C04: Labor market and workforce	Living conditions attractiveness	Life, health and inclusion ranking	Life, health and inclusion ranking	[#]	State	CNBC LLC.	2023
04.10	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual average	[F]	County	NOAA	2023
04.11	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual average change compared to 1901 - 2000 average	[F]	County	NOAA	2023
04.12	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual maximum	[F]	County	NOAA	2023
04.13	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual maximum change compared to 1901 - 2000 average	[F]	County	NOAA	2023
04.14	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual minimum	[F]	County	NOAA	2023
04.15	C04: Labor market and workforce	Living conditions attractiveness	Climate	Temperature annual minimum change compared to 1901 - 2000 average	[F]	County	NOAA	2023
04.16	C04: Labor market and workforce	Living conditions attractiveness	Climate	Precipitation	[Inches]	County	NOAA	2023
04.17	C04: Labor market and workforce	Living conditions attractiveness	Climate	Precipitation change compared to 1901 - 2000 average	[Inches]	County	NOAA	2023
04.18	C04: Labor market and workforce	Living conditions attractiveness	Cost of living	Cost of living ranking	[#]	State	CNBC LLC.	2022
04.19	C04: Labor market and workforce	Living conditions attractiveness	Education	Number of educational services	[#]	County	DOC USCB	2017
04.20	C04: Labor market and workforce	Living conditions attractiveness	Health care	Population with health insurance coverage	[#]	County	DOC USCB	2022
04.21	C04: Labor market and workforce	Living conditions attractiveness	Health care	Number of health care services	[#]	County	DOC USCB	2017
04.22	C04: Labor market and workforce	Workforce availability	Workforce size by industry sector	Total jobs per industry sector	[#]	County	DOC BEA	2022
04.23	C04: Labor market and workforce	Workforce availability	Workforce participation	People in workforce	[#]	County	DOC USCB	2022
04.24	C04: Labor market and workforce	Workforce availability	Workforce participation female	People in workforce female	[#]	County	DOC USCB	2022
04.25	C04: Labor market and workforce	Workforce availability	Workforce participation male	People in workforce male	[#]	County	DOC USCB	2022
04.26	C04: Labor market and workforce	Workforce availability	Workforce total	Employed and unemployed people	[#]	County	DOL BLS	2022
04.27	C04: Labor market and workforce	Workforce availability	Workforce unemployed	Unemployed rate as share of the total workforce	[%]	County	DOL BLS	2022
04.28	C04: Labor market and workforce	Workforce education	Workforce education ranking	Workforce education ranking	[#]	State	CNBC LLC.	2022
04.29	C04: Labor market and workforce	Workforce education	Workforce with less than high school degree	Population share with less than high school degree	[%]	County	DOC USCB	2022
04.30	C04: Labor market and workforce	Workforce education	Workforce with bachelor degree	Population share with bachelor degree	[%]	County	DOC USCB	2022
04.31	C04: Labor market and workforce	Workforce education	Workforce with bachelor degree	Population share with bachelor degree by field of education	[%]	County	DOC USCB	2022
04.32	C04: Labor market and workforce	Workforce education	Workforce with high school degree	Population share with high school degree	[%]	County	DOC USCB	2022
04.33	C04: Labor market and workforce	Workforce productivity	Workforce productivity in total	GDP per capita	[USD]	County	DOC BEA	2022
04.34	C04: Labor market and workforce	Working time	Working hours average	Working hours per year on average	[#]	State	DOC BEA	2022
04.35	C04: Labor market and workforce	Working time	Working hours average	Working hours per week on average in manufacturing	[#]	State	DOL BLS	2023
05.01	C05: Taxes and transfers	Transfers and subsidies	Government transfers and subsidies	Transfers and subsidies as percentage of income	[%]	State	Fraser institute	2021
05.02	C05: Taxes and transfers	Taxation	Capital gains tax	Individual income tax total	[USD]	State	DOC USCB	2022
05.03	C05: Taxes and transfers	Taxation	Corporate income tax	Corporate income tax total	[USD]	State	DOC USCB	2022
05.04	C05: Taxes and transfers	Taxation	Corporate income tax	Corporate income tax	[%]	State	Tax-Rates.org	2023
05.05	C05: Taxes and transfers	Taxation	Sales tax, including VAT and GST	Sales tax, including VAT and GST total	[USD]	State	DOC USCB	2022
05.06	C05: Taxes and transfers	Taxation	Sales tax, including VAT and GST	Sales tax, including VAT and GST	[%]	State	Tax-Rates.org	2023
05.07	C05: Taxes and transfers	Taxation	Income and payroll tax revenue	Score for income and payroll tax revenue as a percentage of income	[#]	State	Fraser institute	2021
05.08	C05: Taxes and transfers	Taxation	Income tax	Income tax	[%]	State	Tax-Rates.org	2023
05.09	C05: Taxes and transfers	Taxation	Top marginal income tax rate	Score for top income tax rate and the income threshold at which it applies	[#]	State	Fraser institute	2021
05.10	C05: Taxes and transfers	Taxation	Property tax and other taxes	Score for property tax and other taxes as a percentage of income	[#]	State	Fraser institute	2021
05.11	C05: Taxes and transfers	Taxation	Property tax	Property tax	[%]	State	Tax-Rates.org	2023
05.12	C05: Taxes and transfers	Taxation	Sales tax	Score for sales tax as a Percentage of Income	[#]	State	Fraser institute	2021
06.01	C06: Legal system and certainty	Regulatory business friendliness	Regulatory business friendliness ranking	Regulatory business friendliness ranking	[#]	State	CNBC LLC.	2022
07.01	C07: Political stability	Crime	Crime rate	Criminal incidents per 100,000 inhabitants	[#]	State	DOJ FBI	2022
07.02	C07: Political stability	Crime	Corruption	Uncovered cases of governmental corruption per 10 years	[#]	State	UIC	2022
07.03	C07: Political stability	Political stability	Government employment	Score for government employment as percentage of total employment	[#]	State	Fraser institute	2021
08.01	C08: Economic stability	Economy overall	Economy overall ranking	Economy overall ranking	[#]	State	CNBC LLC.	2022
08.02	C08: Economic stability	Economic freedom	Economic freedom index	Score within subnational economic freedom index	[#]	State	Fraser institute	2021
08.03	C08: Economic stability	Access to capital	Access to capital ranking	Access to capital ranking	[#]	State	CNBC LLC.	2022
08.04	C08: Economic stability	Access to capital	Venture capital deal activity	Venture capital deal activity	[USD]	State	NVCA	2022
08.05	C08: Economic stability	Access to capital	Venture capital fund raising	Venture capital fund raising	[USD]	State	NVCA	2022
08.06	C08: Economic stability	Access to capital	Venture capital	Assets under management	[USD]	State	NVCA	2022
08.07	C08: Economic stability	Access to capital	Financial institution	Number of financial institutions	[#]	County	DOC USCB	2017
08.08	C08: Economic stability	Financial stability	Public debt	Public debt over GDP	[%]	State	DOC USCB	2021
09.01	C09: Business establishment	Attractiveness for foreign investments	Foreign direct investments	Foreign direct capital investments	[USD]	County	FBI Markets	2023
09.02	C09: Business establishment	Attractiveness for foreign investments	Foreign direct investments	Jobs created	[#]	County	FBI Markets	2023
09.03	C09: Business establishment	Attractiveness for foreign investments	Joint ventures and mergers	Joint ventures	[#]	County	FBI Markets	2023
09.04	C09: Business establishment	Attractiveness for foreign investments	Business established	Business established by sector and size	[#]	State	DOC USCB	2021
09.05	C09: Business establishment	Ease of doing business	Business climate	Bankruptcy filings	[#]	County	U.S. Courts	2022
09.06	C09: Business establishment	Ease of doing business	Business established	Number of manufacturing businesses	[#]	County	DOC USCB	2017
09.07	C09: Business establishment	Ease of doing business	Ease of doing business ranking	Ease of doing business ranking	[#]	State	Forbes advisor	2022
09.08	C09: Business establishment	Ease of doing business	Ease of doing business ranking	Ease of doing business ranking	[#]	State	CNBC LLC.	2022
09.09	C09: Business establishment	Ease of doing business	Cost of doing business ranking	Cost of doing business ranking	[#]	State	CNBC LLC.	2022
10.01	C10: Transport and telecom infrastructure	Airway transportation	Airway transportation	Airway facilities	[#]	County	DOT BTS	2020
10.02	C10: Transport and telecom infrastructure	Airway transportation	Airway facilities	Passengers	[#]	State	DOT BTS	2022
10.03	C10: Transport and telecom infrastructure	Airway transportation	Airway facilities	Freight tons	[#]	State	DOT BTS	2022
10.04	C10: Transport and telecom infrastructure	Highway transportation	Highways	Highway lane miles	[#]	State	DOT FHWA	2022
10.05	C10: Transport and telecom infrastructure	Highway transportation	Public roads	Public road miles	[#]	State	DOT BTS	2022
10.06	C10: Transport and telecom infrastructure	Highway transportation	Trucking services	Trucking services	[#]	State	DOT BTS	2022
10.07	C10: Transport and telecom infrastructure	Railroad transportation	Railroads	Railroad freight miles	[#]	State	DOT BTS	2021
10.08	C10: Transport and telecom infrastructure	Railroad transportation	Railroads	Rail freight miles	[#]	County	DOT BTS	2020
10.09	C10: Transport and telecom infrastructure	Railroad transportation	Railroads	Rail passenger miles	[#]	County	DOT BTS	2020
10.10	C10: Transport and telecom infrastructure	Telecommunication systems	Mobile network coverage	Area covered with 4G	[%]	County	FCC	2023
10.11	C10: Transport and telecom infrastructure	Water transportation	Waterways	Docs	[#]	County	DOT BTS	2020
10.12	C10: Transport and telecom infrastructure	Water transportation	Waterways	Inland waterway miles	[#]	State	DOT BTS	2018
10.13	C10: Transport and telecom infrastructure	Transportation and warehousing	Transportation and warehousing businesses	Transportation and warehousing establishments	[#]	County	DOC USCB	2017
11.01	C11: Industrial infrastructure	Technology and innovation	Technology and innovation ranking	Technology and innovation ranking	[#]	State	CNBC LLC.	2022
11.02	C11: Industrial infrastructure	Industrial facility establishment	Land costs	Land price per acre of residential land	[USD]	County	FHFA	2019
11.03	C11: Industrial infrastructure	Industrial facility establishment	Land costs	Land price per acre of agricultural land	[USD]	State	USDA NASS	2021
11.04	C11: Industrial infrastructure	Industrial facility establishment	Construction industry activity	Private non-residential construction spending	[USD]	State	DOC USCB	2023
11.05	C11: Industrial infrastructure	Industrial facility establishment	Construction industry activity	Private residential building permits	[#]	County	DOC USCB	2023
11.06	C11: Industrial infrastructure	Suppliers	Size of industrial sectors	GDP by industry	[USD]	County	DOC BEA	2022
11.07	C11: Industrial infrastructure	Suppliers	Size of industrial sectors	Total employees of industrial sectors	[#]	County	DOC BEA	2022
11.08	C11: Industrial infrastructure	Service suppliers	Service suppliers	Professional, scientific and technical services	[#]	County	DOC USCB	2017
12.01	C12: Environmental sustainability	Risk of natural disaster	Natural disasters	Historical natural disasters	[#]	County	DHS FEMA	2023
12.02	C12: Environmental sustainability	Risk of natural disaster	Natural disasters	Expected annual loss by natural disasters	[USD]	County	DHS FEMA	2023
12.03	C12: Environmental sustainability	Renewable energy availability	Renewable electricity share	Renewable energy jobs over non-renewable energy jobs	[%]	County	DOE EIA	2024
12.04	C12: Environmental sustainability	Sustainability development	Sustainability development	Sustainable development goals report	[#]	State	SDSN	2021
12.05	C12: Environmental sustainability	Pollution	Air pollution	Energy-related carbon dioxide emissions	[t]	Multi-state	DOE EIA	2022

Figure 3: Regional location selection data sets

5. Conclusion and outlook

The motivation for this study was to enable factory location selection via a data driven decision support system. The objective of this study was therefore to select relevant data sets for integration in the decision support system. Factors were considered relevant if they are widely applicable to regional location comparisons regardless of case-specific context. The scope is limited to the USA as one of the most relevant locations for establishment of new factories. The focus was on regional location selection.

The study design was to first identify categories and factors considered in comprehensive scientific studies on this topic. The studies were identified in a documented systematic literature search. Second, the categories and factors were ordered in a comprehensive manner. Third, relevant data sets were researched and presented in a newly created comprehensive framework. It also specifies units, actuality and sources to provide an easy to understand source for further practitioners and researchers.

The conclusion is that many factors to be considered in regional location selection can be analysed with publicly accessible data sets. The seemingly limited suitability of other data requires further analysis regarding their relevance, trustworthiness of the source, trustworthiness of the contained information, comprehensiveness, granularity, precision, actuality and accessibility as pointed out in the discussion.

As an outlook, the data sets will be assessed according to the aspects outlined in a previous publication [1]. At the same time the decision support system for data driven factory location selection is developed as an online app. Therefore the selected data sets and suitable means of data analysis and visualization will be implemented. The data may be extended to further nations in the future.

Acknowledgements

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy – EXC-2023 Internet of Production – 390621612.

References

- [1] Riesener M, Adlon T, Schukat E, Salzwedel J, Engeln C, Paßlick F. From Complexity To Clarity In Sustainable Factory Planning: A Conceptual Approach For Data-driven Integration Of Green Factory KPIs In Manufacturing Site Selection. Conference on production systems and logistics. CPSL 2023-2. p. 875-877
- [2] Schuh G, Gützlaff A, Adlon T, Schupp S, Endrikat M, Schlosser TX. Data-driven Site Selection. Zeitschrift für wirtschaftlichen Fabrikbetrieb Volume 117 Issue 5. 2022
- [3] German american chambers of commerce. 2024 German American Business Outlook Press release. 2024. p. 1
- [4] Burggräf P, Schuh G, Dannapfel M, Esfahani ME, Hoeschen A, Ivanescu SM, Jasinski T, Kupke D. Standortplanung. In: Burggräf P, Schuh G. Fabrikplanung: Handbuch Produktion und Management 4. 2021. p. 84 – 89
- [5] vom Brocke J, Simons A, Niehaves B, Riemer K, Plattfaut R, Cleven A. Reconstructing the giant: On the importance of rigour in documenting the literature search process. 17th European Conference on Information Systems. 2009
- [6] Booth A. "Brimful of STARLITE": Toward standards for reporting literature searches. Journal of the Medical Library Association JMLA. 2006
- [7] Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009
- [8] Arunyanart S, Sureeyatanapas P, Ponhan K, Sessomboon W, Niyamosoth T. International location selection for production fragmentation. Expert Systems with Applications. Volume 171. 2021
- [9] Badri MA. Dimensions of Industrial Location Factors: Review and Exploration. Journal of Business and Public Affairs. Volume 1. Issue 2. 2007
- [10] MacCarthy BL, Atthirawong W. Factors affecting location decisions in international operations – a Delphi study. International Journal of Operations & Production Management. Volume 23. Issue 7. 2003
- [11] <https://www.wzl.rwth-aachen.de/cms/wzl/Forschung/Produktionssystematik/~suqn/Fabrikplanung/lidx/1/>
- [12] U.S. Energy Information Administration (EIA). PADD regions enable regional analysis of petroleum product supply and movements. 2012. <https://www.eia.gov/todayinenergy/detail.php?id=4890>
- [13] CNBC LLC. <https://www.CNBC.com>
- [14] U.S. Department of Homeland Security (DHS) - Federal Emergency Management Agency (FEMA). <https://www.fema.gov/>
- [15] U.S. Department of Commerce (DOC) - U.S. Bureau of Economic Analysis (BEA). <https://apps.bea.gov/>
- [16] U.S. Department of Commerce (DOC) - International Trade Administration (ITA). <https://www.trade.gov/>
- [17] U.S. Department of Commerce (DOC) - U.S. Census Bureau (USCB). <https://www.census.gov/>
- [18] U.S. Department of Energy (DOE) - U.S. Energy Information Administration (EIA). <https://www.eia.gov/>
- [19] U.S. Department of Energy (DOE) - National Renewable Energy Laboratory (NREL). <https://maps.nrel.gov/>
- [20] U.S. Department of Justice (DOJ) - Federal Bureau of Investigation (FBI). <https://cde.ucr.cjis.gov/>
- [21] U.S. Department of Labor (DOL) - U.S. Bureau of labor statistics (BLS). <https://www.bls.gov/>
- [22] U.S. Department of Labor (DOL) - Wage and Hour Division (WHD). <https://www.dol.gov/>
- [23] U.S. Department of Transportation (DOT) - Bureau of Transportation Statistics (BTS). <https://www.bts.gov/>
- [24] U.S. Department of Transportation (DOT) - Federal Highway Administration (FHWA). <https://www.fhwa.dot.gov/>
- [25] Federal Communications Commission (FCC). <https://broadbandmap.fcc.gov/>
- [26] Fdi Markets. <https://www.fdimarkets.com/>
- [27] Federal Housing Finance Agency (FHFA). <https://www.fhfa.gov/>
- [28] Forbes advisor. <https://www.forbes.com/>
- [29] Fraser institute. <https://www.fraserinstitute.org/>
- [30] National Oceanic and Atmospheric Administration (NOAA). <https://www.ncei.noaa.gov/>
- [31] National Venture Capital Association (NVCA). <https://nvca.org/>
- [32] UN Sustainable Development Solutions Network (SDSN). <https://us-states.sdgindex.org/>
- [33] Tax-Rates.org. <https://www.tax-rates.org/>
- [34] U.S. Courts. <https://www.uscourts.gov/>
- [35] University of Illinois Chicago (UIC). <https://pols.uic.edu/>
- [36] U.S. Department of Agriculture (USDA) - National Agricultural Statistics Service (NASS). <https://www.nass.usda.gov/>
- [37] U.S. Geological Survey (USGS) - MD-DE-DC Water Science Center. <https://www.usgs.gov>