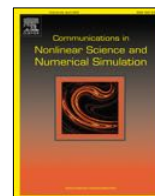


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Research paper

Toward a precision, complexity-informed cultural policy design: Structural bottlenecks to culture-led development in Skaraborg, Sweden

Massimo Buscema^{a,b,*}, Guido Ferilli^c, Christer Gustafsson^d, Pier Luigi Sacco^{e,f,g,**}

^a Semeion Research Center, Rome, Italy^b University of Colorado, Denver, United States of America^c IULM University, Milan, Italy^d Uppsala University, Sweden^e University of Chieti-Pescara, Italy^f ISPC-CNR, Naples, Italy^g metaLAB (at) Harvard, Cambridge MA, United States of America

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ABSTRACT

We analyze the spatial–temporal dynamics of cultural vibrancy in the Swedish sub-region of Skaraborg. Our database consists of 4170 geo-localized cultural activities and facilities, mapped between October 2013 and March 2014. We make use of the TWC methodology for the dynamic simulation of the evolution of geo-localized activity starting from an observed distribution of events, and of the AutoCM ANN architecture to understand how cultural variables are related to the rest of the Skaraborg socio-economy. We find that cultural vibrancy in Skaraborg is likely characterized by a ‘flaring’ pattern of initial, widespread activity followed by a re-concentration into the main local urban hubs. The deep reason behind this unsuccessful developmental trajectory is the lack of centrality of cultural production in the local socio-economy, and of integration across cultural production sectors. This is in turn due also to structural bottlenecks of a non-cultural nature such as insufficient access of women to higher education. We make a case for the necessity to develop a new precision cultural policy design approach founded upon the science of complexity for both policy design and assessment, and we provide and illustrate a first technical toolkit to this purpose.

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1. Introduction

Culture-led development has been an important topic in the local development literature of the past decades [1]. However, despite the hype that has gradually built around this topic, results have been mixed [e.g. 2]. Whereas in certain cases cities and regions have succeeded in positioning culture as a transformational developmental driver, in others results have been less satisfactory [3,4]. What makes the difference between success and failure in this sphere? A major problem is the tendency to consider ‘culture’ as a homogeneous domain of basically equivalent and mutually substitutable activities

* Correspondence to: Semeion Research Center for Sciences of Communication, Via Sersale 117, 00128 Rome, Italy

** Correspondence to: DiSFiPEQ, University of Chieti-Pescara, viale Pindaro, 42, 35127 Pescara, Italy

E-mail addresses: m.buscema@semeion.it (M. Buscema), pierluigi.sacco@unich.it (P.L. Sacco).

in a developmental perspective [5]. When thinking in highly aggregate and abstract terms, it is tempting to think that investing in ‘culture’, be it building a new theater, promoting an artistic project or creating a new facility for cultural entrepreneurship, e.g. a business accelerator for gaming startups, should bring about a positive effect on the local economy no matter what – but such generalization is often problematic [6–8]. More generally, it is often customarily thought that the positive effects of cultural initiative would naturally spill over to the local social fabric, due to the beneficial action of aesthetics, creativity, imagination, and so on [9]. But equating culture with creativity or the presence of creative workers with the existence of a solid local cultural economy is a dangerous mistake [10]. In fact, pursuing a developmental strategy aimed at turning the urban system into a creative city or a cultural city may lead to very different, and possibly conflicting routes [11]. What is generally missed in such approaches is a full understanding of the deeply nonlinear nature of the mechanisms behind culture-led development [12], and of the complex interaction across many different variables [13], so that the developmental impact need not result from the action of a single or a few factors at work, but possibly from a composition of many different factors operating (or failing to operate) together [14–16].

To get a clearer understanding of the critical factors that harness rather than block the developmental potential of culture, we need to develop a toolkit that simultaneously analyzes two different aspects: the spatial dimension of the nonlinear processes operating at the urban or regional scale, and the structure of the interdependencies among the system variables – in particular, the pathways through which cultural variables affect non-cultural ones, and the centrality (or lack thereof) of cultural variables within the organizational structure of the system.

The spatial dimension of the analysis can be, as a first approximation, boiled down to the measurement of the system’s overall cultural vibrancy [17,18], that is, the level of activation of its potential cultural drivers as defined by the cultural activities and facilities located on the territory. The pathways through which the cultural drivers have an effect on the overall functioning of the system may instead be analyzed through a suitable network representation of the essential interactions across the system variables, and more specifically of the structure of the connectivity of cultural variables within the network.

This methodology has already been developed and tested at the regional scale on a number of different cases: the Region of Veneto, Italy [19], the Region of Halland, Sweden [20], and West Kosovo [21]. In the case of Veneto, the methodology has been applied to a large Italian region with world-class cultural heritage (the region alone has 9 UNESCO World Heritage Sites) and one of the nation’s largest cultural production ecosystems, with a strong polycentric structure. In the case of Halland, the analysis has shifted to a Swedish region with significant heritage and cultural production and a less complex but still significant polycentric structure. In the case of West Kosovo, we have considered a (sub-)region whose cultural dynamics are strongly affected by the attraction power of nearby countries, namely Serbia and Albania, whose ethnic groups characterize the overall composition of the region’s population.

This diverse collection of cases has provided an important test of the methodology’s capacity to track the fine-grained features of the local cultural ecosystems and of their relationships with the whole local socio-economy. The analysis has yielded significant insights, which can be summarized as follows.

First of all, contrary to what is often intuitively maintained, there is no clear relationship between density of valuable cultural heritage and cultural vibrancy. World-famous heritage cities such as Venice may feature the highest concentration of cultural sites and even activities, but this does not make of them a culturally vibrant location if, as in the case of Venice, such sites and activities do not reflect a place-based production dynamics but rather function as a mere platform of global visibility of what has been created and produced elsewhere, and as a global tourist attraction [22,23].

Secondly, the spatial dynamics of cultural vibrancy may be very complex, and may also reflect major environmental cues and constraints such as the direction of an important transportation route (e.g., a major railway, motorway or railway) or the proximity to larger or more culturally vibrant regions which exert a strong attraction power on the local dynamics [24]. When two culturally competing, external attractors are located at the opposite sides of the region, as in the case of West Kosovo, this may create a bistable dynamics where two distinct subregions emerge as satellites of the external attractors.

Thirdly, the time dynamics of cultural vibrancy may be equally complex, and may reflect in turn major intervening events and changes occurring both on the local territory and in neighboring ones at the appropriate scale [25]. Thus, an initially monocentric pattern of vibrancy may evolve into a polycentric one and vice versa. This has been for instance the case in the Swedish region of Halland, where a monocentric organization developed into a polycentric one, which eventually folded back to the original scheme.

Finally, and as already pointed out, the dynamics of cultural vibrancy is strongly affected by how cultural variables are connected to non-cultural ones within the territorial system [26]. Whether vibrancy is spatially and temporally sustainable depends on the existence of positive feedback mechanisms such that cultural impulses are caught and magnified in other sectors and fed back into the cultural sphere, in a way that generates cross-sectoral activation, also thanks to the creation of social and economic value [27]. Unlike what is commonly maintained, what is crucial for a culturally vibrant territory is not sheer size – metropolises are not necessarily the most important and vital cultural hubs – but a logic of local interrelationships in which culture is deeply seeded and functionally integrated into the local socio-economy [28]. We can therefore have large metropolitan areas where culture does not play a major driving role, and relatively smaller, less densely populated areas where it does – as well as vice versa, of course.

In this paper, we consider another case of a Swedish sub-region, that of Skaraborg, in the Västra Götaland region. The interest of this case lies in the fact that it is a small territory with a strong rural identity, in one of the countries with

the highest performance at EU level for innovation and cultural participation. It is therefore interesting to check to what extent a culturally vibrant territory may emerge (or fail to emerge) in relatively difficult conditions (rural setting, absence of large cities and of main close-by metropolitan areas, etcetera), but in a favorable larger environment (that of Sweden). In the light of the previous discussion, the crucial factors that will explain the observed (and projected) space–time pattern of cultural vibrancy largely depend on the specific structural organization of the local socio-economy, and in particular on how cultural variables sit within it, how they are connected and what they are connected to.

This analysis will allow us to exemplify a new methodology of precision cultural policy, that is, finding out which are the critical variables that determine cultural vibrancy and their related impact pathways, in order to design and test a new generation of cultural policies that allow to boost the cultural potential of a territory by addressing directly the main structural bottlenecks that prevent the seizing of available opportunities. In this perspective, cultural policy is not to be regarded as a single policy lever, but rather as an element in a larger menu of interdependent policy levers that, building upon a new approach informed by the science of complexity, may allow to break existing policy silos and unleash the potential of new, system-wide local development strategies.

The remainder of the paper unfolds as follows. Section 2 presents the methods. Section 3 presents the data. Section 4 contains the main results. Section 5 discusses them. Section 6 concludes.

2. Methods

2.1. TWC maps

To map the cultural vibrancy of an urban area or of a region, we make use of the TWC (Topological Weighted Centroid) methodology. As this approach has been presented extensively elsewhere [29], here we propose a more concise formulation. The key concept of the approach is the Topological Weighted Centroid. It allows to represent and analyze geo-referenced data by means of a specific form of pseudo-distance, which is influenced by the relative positions of the whole set of observations. The reason behind this choice is that the spatial grammar of a phenomenon emerges from the negotiation of the relative positions of all the observed events generated by the phenomenon. Each such position reflects therefore not the mere event to which it relates, but the way in which the whole collection of events ‘occupies’ the space as directed by its space grammar. The grammar can therefore be reconstructed to some extent from the observation of the events, and it contains important structural information which would not be accessible from the direct observation and analysis of the single events. Once the grammar has been unraveled, it becomes possible to use it as a simulator to reconstruct the past, unobserved spatial dynamics of the phenomenon as well as its future evolution.

The TWC can be thought of as an alternative notion of a centroid, which does not rely on traditional metrics but on a new kind of ‘indirect distance’. In particular, to keep into account the relative position of all events in space, the indirect distance is a function of all the Euclidean distances between the location of the event being considered and the locations of *all the other observed events apart from the other one involved* in the calculation of the distance. The TWC is the point that minimizes the global entropy of the distances from the locations of all the other events and is therefore the informationally optimal point for the coding and retrieval of the locations of all the observed events. As we will see, the TWC is the first centroid in a series of centroids and heat maps (scalar fields) that jointly characterize the evolution of the spatial dynamics of the phenomenon and is in particular also called the Alpha point. The logic behind this terminology will become clear below.

In terms of centroid computation, indirect distances serve, as usual, as weights so that the ‘center’ of the distribution of events locations emerges from the interaction among events, each one of which pulls in its direction the more so the ‘closer’ the other events (in terms of indirect distances). The TWC (Alpha point) is therefore determined as the appropriate weighted sum of location coordinates, suitably warped by the indirect distance. As a consequence, the TWC may also lie far away from the position of the centroid that would be chosen by classical criteria based on direct distances, which simply averages distances without taking into account the specificities of the relative positions of the various events. The more the TWC departs from the classical Euclidean centroid, the more the specificity of the events’ relative positions matters, and the TWC location is determined by a specific space grammar that is not simply the spatial averaging of the events. The trajectory that links the TWC to the Euclidean (arithmetic) centroid can then function as a pivot of a scalar field that we call the Alpha map, defined in terms of each point’s closeness to the trajectory that links the two centroids (and which guides the warping of the space caused by the interplay of each point’s strength of attraction in terms of indirect distance). The Alpha map is a typical heat map that measures the extent to which each point is active with respect to the TWC. The Alpha point, and the corresponding Alpha map, describe the origin of the phenomenon, that is, the most likely original spatial pattern of activation that can be reconstructed from the observed distribution of event locations. It is therefore, in a sense, the ‘past’ of the system.

We can now introduce a whole family of centroids and heat maps that rather characterize the present and the more or less distant future evolution of the spatial pattern of activation we are investigating. First of all, we consider the Self-TWC (STWC), which is constructed following the same logic described above, but now with the inclusion of the indirect distance between each point and itself (remember that the indirect distance between a point and itself is generally not zero). Such distance therefore depends upon the distance of each point from all the other points in the distribution. This seemingly small change has major consequences on the properties of the centroid. The STWC is characterized as the point that strikes

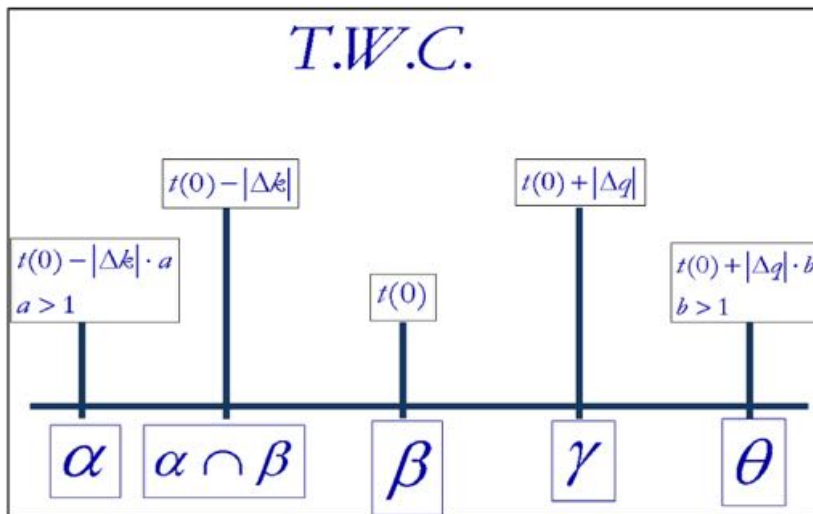


Fig. 1. Relationships between the four heat maps. a , b , Δk and Δq are free parameters to be calibrated experimentally.

an optimal balance between the local information carried by the location of each single event and the global information stemming from the overall distribution of events across space.

The TWC, as already pointed out, provides a picture of the past, that is, of the ‘outbreak’ of the spatial dynamics, a sample of which is being currently observed. The STWC instead offers us a snapshot of how the initial situation is likely to evolve as new events occur. The corresponding scalar field, the Beta map, is therefore a heat map that can also be interpreted, for the reasons just explained, as a probability density map, which moves from the current state of events, i.e. the current situation being observed. However, there is no objective way to assess the actual time scale of the future events predicted by the Beta map. Its scaling needs to be carried out for the specific problem under study, as illustrated in [29].

To move on along the sequence of centroids and heat maps that we can use to analyze the future evolution of the spatial pattern of activity, we now further generalize the notion of indirect distance, removing the limitation that the computation of the distance between the reference location and all the other ones must be carried out using Euclidean distances. We can take more specifically into account the ‘gravitational’ force exerted by each event location not only upon the other locations, but also on the distance itself. The measurement of the distance is accordingly bent and is no longer necessarily a straight line. A larger departure from the linear distance implies a stronger attraction in the direction toward which the distance line bends. For this new form of indirect distance, we get yet another scalar field that we call Gamma map. It is also a projection of the future evolution of the system that lies further away from the Beta map, to an extent that has once again to be determined for the specific problem through suitable calibration.

The next step to generate another heat map that looks ever further out into the future is to consider nonlinear distances as primitive entities and no longer as tweaks of conventional linear (Euclidean) distances. This leads us to introduce yet another version of the linear distance, called Theta distance, with its corresponding scalar field, the Theta map. Working with primitively nonlinear distances we can also introduce a Nonlinear Minimum Spanning Tree (NL-MST), that, being an MST, provides the minimum-energy tree representation connecting all items, but in view of its nonlinear structure also reflects the attraction strengths that are tweaking space. As the previous ones, the Theta map must be suitably calibrated to find the relevant time scale at which it maps the future unfolding of the observed phenomenon. Notice how the scalar fields peek further and further into the future the more they exploit increasingly nonlinear features of the TWC formalism. It is as if, by developing increasingly accurate tools for describing the curvature of the space, they capture more and more fine-grained details of the process that provide even more fundamental clues of the future evolution. The four scalar fields and their relationships are represented in Fig. 1. Together, they provide a toolbox that enables us to leverage upon the implicit space grammar of the phenomenon to understand its origin and future unfolding at various timeframes.

We also have a fifth and last scalar field, Iota, that is based upon an even more complex notion of indirect distance, that we call meta-distance, and that follows a different logic. A meta-distance can be obtained by recursively applying the Euclidean distance algorithm between all points and by linearly rescaling the results of each iteration, as described in detail in [29]. The iterative rescaling process leads to the remapping of all points in the observed distribution so that they cluster around two centroids called vanishing points, and which can be characterized as the points from which the observed distribution is maximally organized. Interestingly, the vanishing points may lie outside the convex hull of the observed events, that is to say, they are ‘external’ vantage points which represent forces that are outside the system but nevertheless exert an influence upon it. The corresponding Iota map provides the scalar field around the vanishing points, which however is not directly comparable to the previous maps in that it does not represent a further projection in the

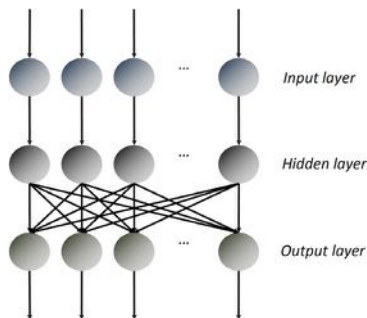


Fig. 2. Structure of AutoCM.

Table 1

Notation for Auto-CM neural network.

Symbol	Meaning
x_i^p	i th input node of the p th pattern
$h_i^p(n)$	i th hidden node of the p th pattern at the n th time
$y_i^p(n)$	i th node in the output of the p th pattern at the n th epoch
$v_i(n)$	Weight of the connection between the i th input node and the i th hidden node at the n th epoch
$w_{i,j}(n)$	Weight of the connection between the j th hidden node and the i th output node at the n th epoch
N	Number of nodes per layer
M	Number of patterns
α	Constant learning rate
C	Constant greater than one, typically $C = \sqrt{N}$

future of the evolution of the system but is rather an alternative ‘perspective’ from which we get a sense of the outside influences acting upon the process throughout its development. In this regard, the Iota map is another addition to the toolkit for the analysis of the spatial–temporal dynamics of the phenomenon under study.

The TWC approach in its entirety is applied in our paper to the analysis of the spatial–temporal dynamics of cultural vibrancy in the sub-region of Skaraborg.

2.2. AutoCM and the MST

Now that we have briefly described the methodology used to track the spatial–temporal dynamics of the phenomenon, we also have to introduce another key component of our toolbox, the one that allows us to analyze the structure of the relationships across the variables that describe our system. To this purpose, we make use on a specific ANN algorithm that has already proven optimal in terms of its capacity to capture the structure of many-to-many associations among a large number of variables in many different problems of very different nature, and in particular in the analysis of cultural vibrancy in the analogous Swedish case study of the Halland region: AutoCM [20,30].

AutoCM is an ANN consisting of three layers of nodes (Fig. 2): an input layer for the incoming external signal, a hidden layer which processes the signal, and an output layer. Each layer has the same number of nodes. The connections between the input and hidden layers are mono-dedicated (one-to-one), whereas those between the hidden and output layers are at full gradient (N -to- N), where N is the (common) number of nodes of each layer; all of them are weighted. Datasets are scaled within the unit interval, and all weights are initialized to a same positive, very small value. A full cycle of processing from the input patterns to the corresponding output (and its related error) is called an epoch. Errors are corrected at the end of each epoch.

More formally, we can describe AutoCM as follows. Basic notation is presented in Table 1.

At the n th training epoch, for each input pattern a value is calculated for the hidden layer by means of a contraction, that squeezes the input value proportionally to the mono-dedicated weight:

$$h_i^{[p]}(n) = x_i^{[p]} \cdot \left(1 - \frac{v_i(n)}{C}\right) \quad (1)$$

The value for the output layer is then calculated through a double step. For each output node, the net input calculation, the contraction of all the hidden nodes through the weights between the hidden layer and output layer (Eq. (2)), is stored.

$$Net_i^{[p]}(n) = \sum_{j=1}^N h_j^{[p]}(n) \cdot \left(1 - \frac{w_{i,j}(n)}{C}\right) \quad (2)$$

At this stage, the output value is calculated via a further contraction of the corresponding value of the hidden node:

$$y_i^{[p]}(n) = h_i^{[p]}(n) \cdot \left(1 - \frac{Net_i^{[p]}(n)}{C^2}\right) \quad (3)$$

At every epoch of training, in addition to the calculation of the output values (3), for each pattern presented as an input, the algorithm computes the weights correction, which is applied at the end. For the N-mono dedicated layers between the input and hidden layers, the algorithm considers the contraction, based on the weight being examined, of the difference between the values of the corresponding input and hidden nodes, modulated by the input node value:

$$\Delta v_i(n) = \sum_{p=1}^M \left(x_i^{[p]} - h_i^{[p]}(n)\right) \cdot \left(1 - \frac{v_i(n)}{C}\right) \cdot x_i^{[p]} \quad (4)$$

$$v_i(n+1) = v_i(n) + \alpha \cdot \Delta v_i(n) \quad (5)$$

Likewise, for the N^2 weights between the hidden and output layers the algorithm computes the contraction between the corresponding hidden and output nodes. The Learning coefficient (α) is updated according to the average of the errors of each weight (δ) at each epoch (n):

$$\Delta w_{i,j}(n) = \sum_{p=1}^M \left(h_i^{[p]}(n) - y_j^{[p]}(n)\right) \cdot \left(1 - \frac{w_{i,j}(n)}{C}\right) \cdot h_j^{[p]}(n) \quad (6)$$

$$w_{i,j}(n+1) = w_{i,j}(n) + \alpha \cdot \Delta w_{i,j}(n) \quad (7)$$

$$\delta_{(n)} = \frac{1}{N^2} \sum_i^N \sum_j^N \Delta w_{i,j(n)}; \quad (8)$$

$$\alpha_{(n+1)} = \alpha_{(n)} + \frac{e^{\delta_{(n)}}}{n}. \quad (9)$$

As to the cost function, the quantity, E , to minimize during the learning process is the following:

$$E = \sum_{p=1}^M \sum_{i=1}^N \left(y_i^{[p]} - h_i^{[p]}\right). \quad (10)$$

From the equations one can immediately observe how the contractions establish a relationship of order between the layers:

$$x_i^{[p]} \geq h_i^{[p]}(n) \geq y_j^{[p]}(n) \quad (11)$$

One can easily see that during training, the mono-dedicated weights v_i grow monotonically, and with different speeds asymptotically toward the constant C :

$$\lim_{n \rightarrow \infty} \Delta v_i(n) = 0 \quad (12)$$

$$\lim_{n \rightarrow \infty} v_i(n) = C \quad (13)$$

just like the values of hidden nodes tend to cancel themselves out:

$$\lim_{n \rightarrow \infty} h_i^{[p]}(n) = 0 \quad (14)$$

along with those of the output units:

$$\lim_{n \rightarrow \infty} y_j^{[p]}(n) = 0 \quad (15)$$

while the corrections of the full set of weights likewise diminish:

$$\lim_{n \rightarrow \infty} \Delta w_{j,i}(n) = 0 \quad (16)$$

AutoCM has remarkable properties. As anticipated, it outperforms other commonly used unsupervised algorithms, including Principal Component Analysis, in a variety of different tasks [31]. It has consequently been applied in diverse scientific fields.

The output of AutoCM is most conveniently visualized as a Minimum Spanning Tree (MST), namely the tree that minimizes the energy of the so-called H function, which measures the topological complexity of any graph [32]. It includes the smallest number of links that allow to capture the structure of the many-to-many associations among variables. The MST then works as a global graph-theoretic map of the key interdependencies among all system variables.

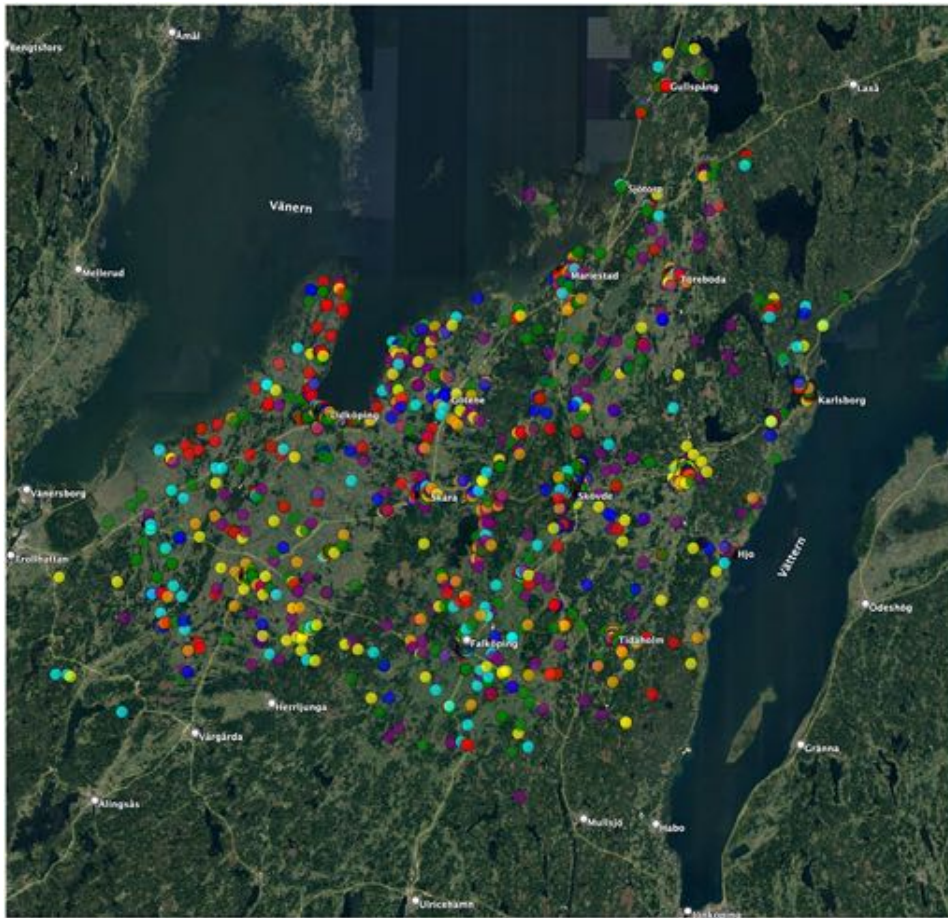


Fig. 3. Spatial distribution of cultural facilities and activities in Skaraborg.

3. Data

3.1. Context: The Skaraborg sub-region

Skaraborg is a sub region of the Västra Götaland region, located in the western part of Sweden between the big lakes Vänern and Vättern. The area has a high-productivity agricultural landscape. Skaraborg has approximately 265,000 inhabitants. It used to be its own county, Skaraborg county, but since 1998 it has been incorporated as the eastern part of Region Västra Götaland. The municipalities in Skaraborg are Essunga, Falköping, Grästorps, Gullspång, Götene, Hjo, Karlsborg, Lidköping, Mariestad, Skara, Skövde, Tibro, Tidaholm, Töreboda, and Vara. Skövde is the largest with 55,000 inhabitants, followed by Lidköping (40,000), Falköping (33,000), Mariestad (24,000), and Skara (18,000).

The Skaraborg demographics has been characterized by a constant birth deficit and by locals' emigration for almost every year over the past ten years. However, the population has increased overall, with growth essentially consisting of immigration from outside. The labor market in Skaraborg is substantially split between the private service sector and the public sector: 34% are employed in the public service sector and 30% in the private service sector, 23% in the production sector, 6% in the construction industry, 4% in farming, forestry and fishing and 3% in other industries. In Skaraborg, the proportion of highly educated people (e.g., with post-secondary education), has increased steadily in the 21st century, but nevertheless such proportion is the lowest among the subregions in Västra Götaland. However, the GDP level per capita is comparable to the average Västra Götaland one.

During the Middle Ages, Skara was the most important town in the region, and still features a Gothic cathedral from the 14th century. From the 17th century, Mariestad became the regional administrative center, while Lidköping was the biggest town until 1900 when the more industrialized Skövde took over as the most populated. Besides the Skara cathedral, Skaraborg's cultural heritage is quite significant, including among others the Askeberga stone ship from the Iron age, the abbey of Varnhem from the 1150s, Gudhem convent ruins, Läckö baroque castle, the Göta channel, and the well-preserved wooden architecture in the small town of Hjo.

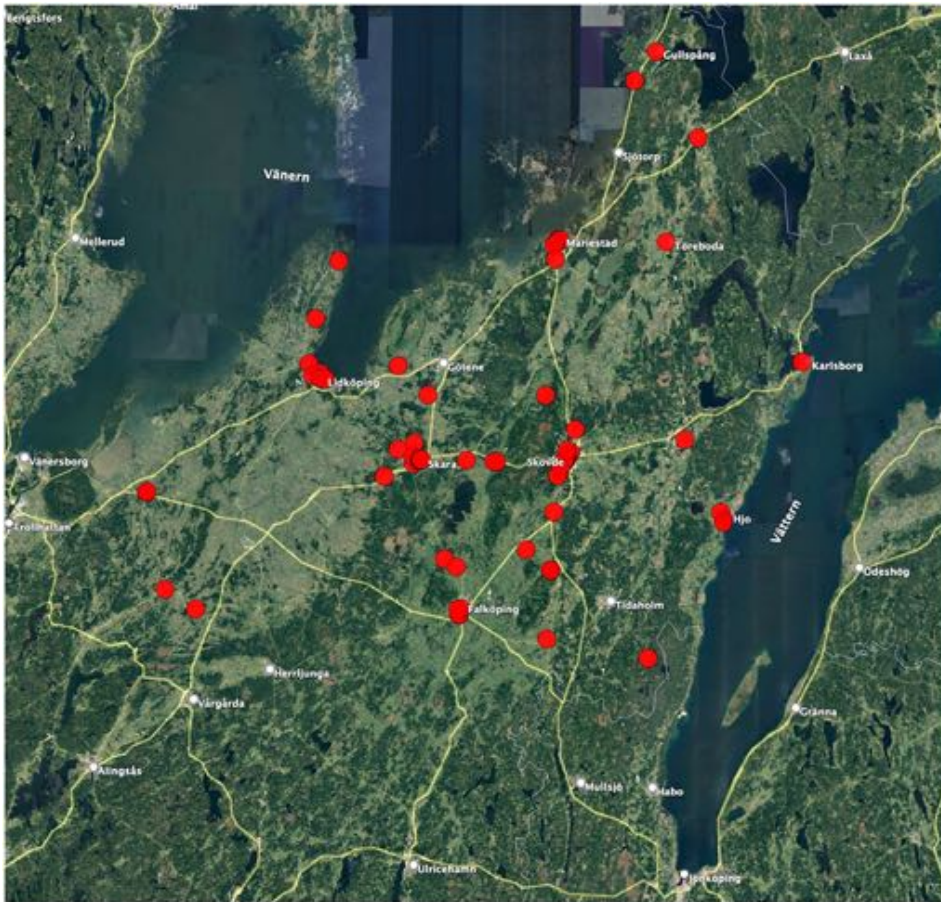


Fig. 4. Architectural studios.

On the cultural production side, Skaraborg is well known in Sweden for the Skara music factory, the Skara scenskola (a theater school), and Skövde University College's program for videogame design. Also the Tibro möbelcentrum, a furniture design cluster with a business incubator, is nationally renowned. There is also an important concert hall in Vara, whereas in Mariestad the Göteborg University has a campus that provides education and research in crafts within the cultural heritage practice field.

3.2. Data collection

Since our aim is to map the spatial-temporal evolution of cultural vibrancy in Skaraborg, the 'events' that correspond to the observable working of the phenomenon are the existing cultural facilities and the cultural activities that happen on the territory on a relatively stable basis.

The data collection of this research started in March 2013. Skaraborg Municipal Federation was the project leader for the implementation of the project *Skaraborg Fields of Creative Power*, and together with Region Västra Götaland Culture Secretariat it funded the cooperation. Data were collected with the help of *Bruk för Alla* in Falköping, an association that worked with a bottom-up approach to help the long-term unemployed to adapt to the labor market. A Steering Committee was created for the monitoring and quality assurance of the data collection process. Chairpersons for the Steering Committee of the project were Annika Stedner, Lidköping municipality (2013–2014) and Catherine Sandh, Skövde municipality (2014–2015). Other members of the Steering Committee were Kristina Anderback and Eva Idmark-Andersson, Skaraborg Municipal Federation, Lars Lundgren, Region Västra Götaland and Per-Olof Ekholm, Tibro municipality. The Steering Committee ensured that all local activities and facilities with cultural purposes were fairly represented in the database. The Skaraborg Municipal Federation and Region Västra Götaland assisted the project with suitable communication strategies, seminars and workshops to raise the awareness of local cultural professionals about the need to collect accurate information on the region's cultural geography, and to contribute to the research by sharing their knowledge with the data collection group. They also organized meetings between the project team and the mayors and other policy- and decision-makers in Skaraborg as well as in Västra Götaland.

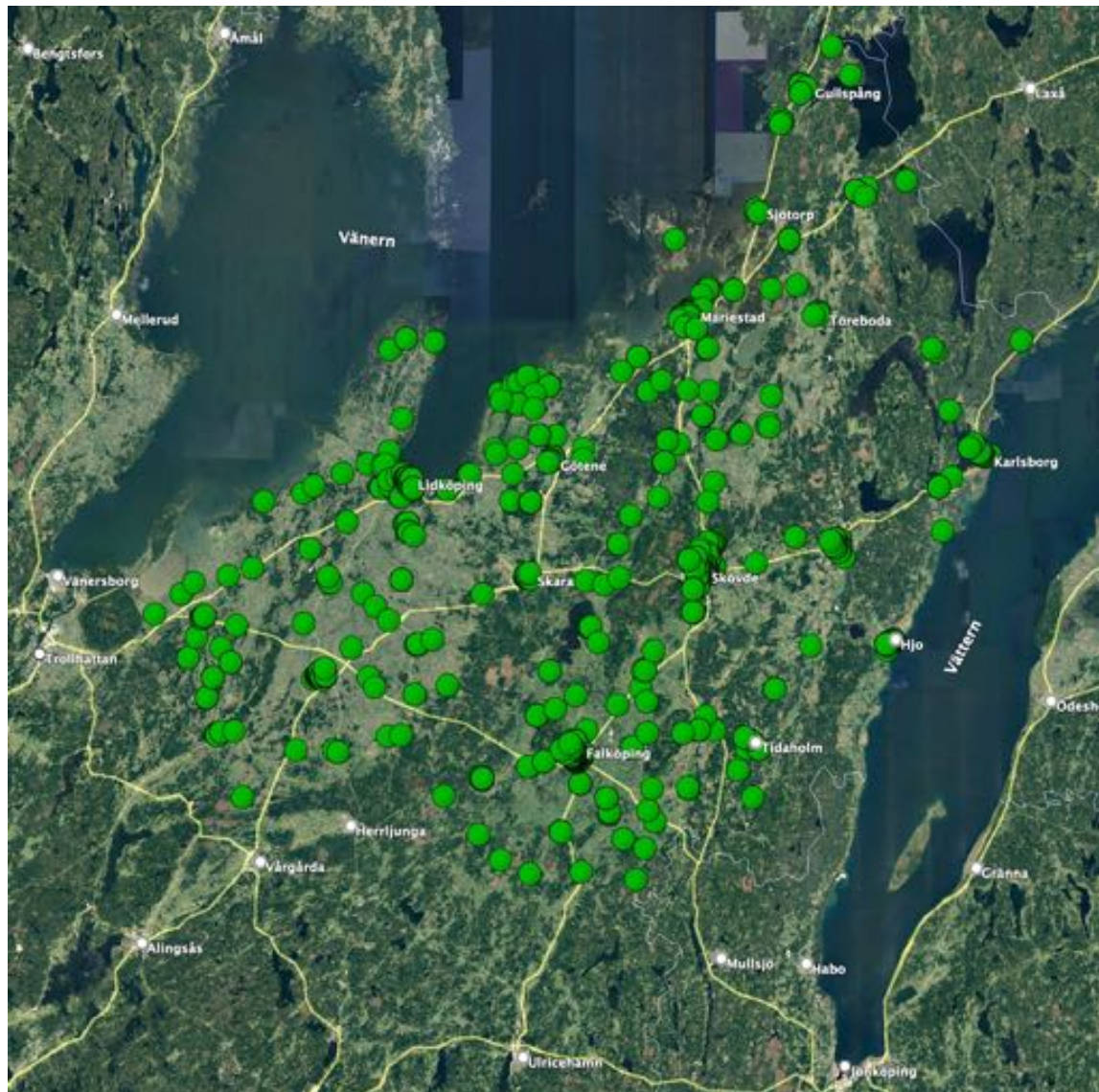


Fig. 6. Cultural education.

hubs, namely the triangle Skövde-Skara-Falköping, as well as Lidköping and Mariestad, respectively. There are relatively few activities and facilities reported in the Tiveden forest in the Northern part of the sub-region or in the plains in the South-Western part. The railway linking Stockholm and Göteborg seems to be more important than the E 20 highway in playing an organizational role in the spatial distribution of cultural activities.

The overall map is provided in Fig. 3. Different colors correspond to different cultural production sectors. Activities have been recorded without any qualitative assessment of their production.

Let us now consider more specifically the distribution of certain cultural production activities and facilities of particular interest. We start from the distribution of architectural firms, as shown in Fig. 4.

We see from Fig. 4 that architectural firms are found in all municipalities in Skaraborg with a clear concentration in Skövde-Falköping-Skara. Several are also found in Lidköping and in the Källandsö peninsula, as well as in Mariestad and Hjo.

Also, movie production is well represented in Skaraborg, as shown in Fig. 5.

Movie production is carried out by local film studios that operate in the cinema d'essai circuit rather than in the big commercial circuit. The operations are relatively evenly spread over the entire area, but with Skövde as a clear center. In Skövde we find the Skövde movie studio, the association Skövde Film Festival, Sequence HB, Video Image Skövde and several schools with film activities. Other cities are also active. We find in particular Falköping's film studio and Mariestad's

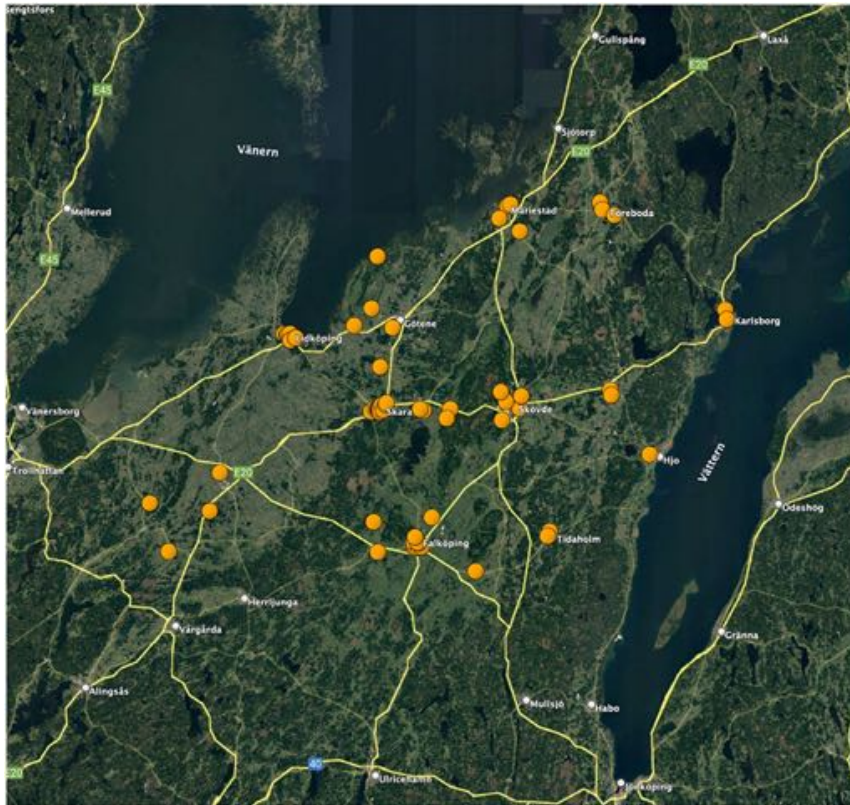


Fig. 7. Fashion design.

film studio. The Göteborg Film Festival also offers a platform for local productions. We also find various production companies, such as iFocus Nossebro, Image trolley in Falkirk, Providoc and Media Teller Productions in Lidköping. There are also businesses that offer equipment for film making, such as Film Office Skaraborg.

In Fig. 6 we have instead cultural education programs in Skaraborg. This category of cultural activities has the absolute highest frequency. Here we find reputable programs such as the Göteborg University campus in Mariestad with the internationally recognized Handicraft Laboratory, the University of Skövde with a rich program and course offerings, for example, in computer games development, the Music Factory in Skara and the Skara Scenskola.

Here activities are rather evenly spread across the entire area. Even minor places such as Grästorps, Karlsborg and Tidaholm interestingly have a large number of cultural programs and thus a relatively large number of residents who are active in various cultural activities.

Moving now to fashion design, the corresponding map is shown in Fig. 7.

Fig. 7 shows the distribution of fashion designers in Skaraborg. The boundaries between different production sectors are often difficult to draw. In this case, for instance, some of the companies sit at the boundary with crafts/cultural crafts. In this category, we find fashion designers (such as Devikas Sewing and Design in Tidaholm), sewing studios (such as Cillas Syateljé in Skara) and jewelry designers (such as Angelica Hvass in Töreboda, Miss Diligent in Skövde), and others.

The closely related crafts sector is shown in Fig. 8. Craft activities are abundant throughout Skaraborg, as it can be seen from the map. A hub of activity is found around lake Vänern, with a concentration in the area between Källandsö in Lidköping and the Hälleklis village in the Götene municipality. Other well-represented areas are found North of the lake Hornborgasjön along the Skärv road in Skara and Skövde municipalities, South-East of Vara, along Road 47 in the municipality of Falköping, between Töreboda and Hova and along Road 26 in the municipality of Tidaholm.

Another important sector is music production, mapped in Fig. 9. Music studios are well represented and music production is a well-known specialization of Skaraborg cultural and creative industries. However, such activities show a clear concentration around Skara and Skövde. Music Factory is a well-established platform for musicians, companies and organizations that work with music production and the music business. It offers a well-equipped music studio with high quality gear. Skara also hosts well-known music studios such as Torgny Söderberg Musikproduktion AB and Anders Engberg Music Production AB.

In Fig. 10 we find another key pillar of the cultural system: museums. Museums are open to the public and are non-profit institutions that provide permanent service to the society and its development. Museums preserve, interpret and

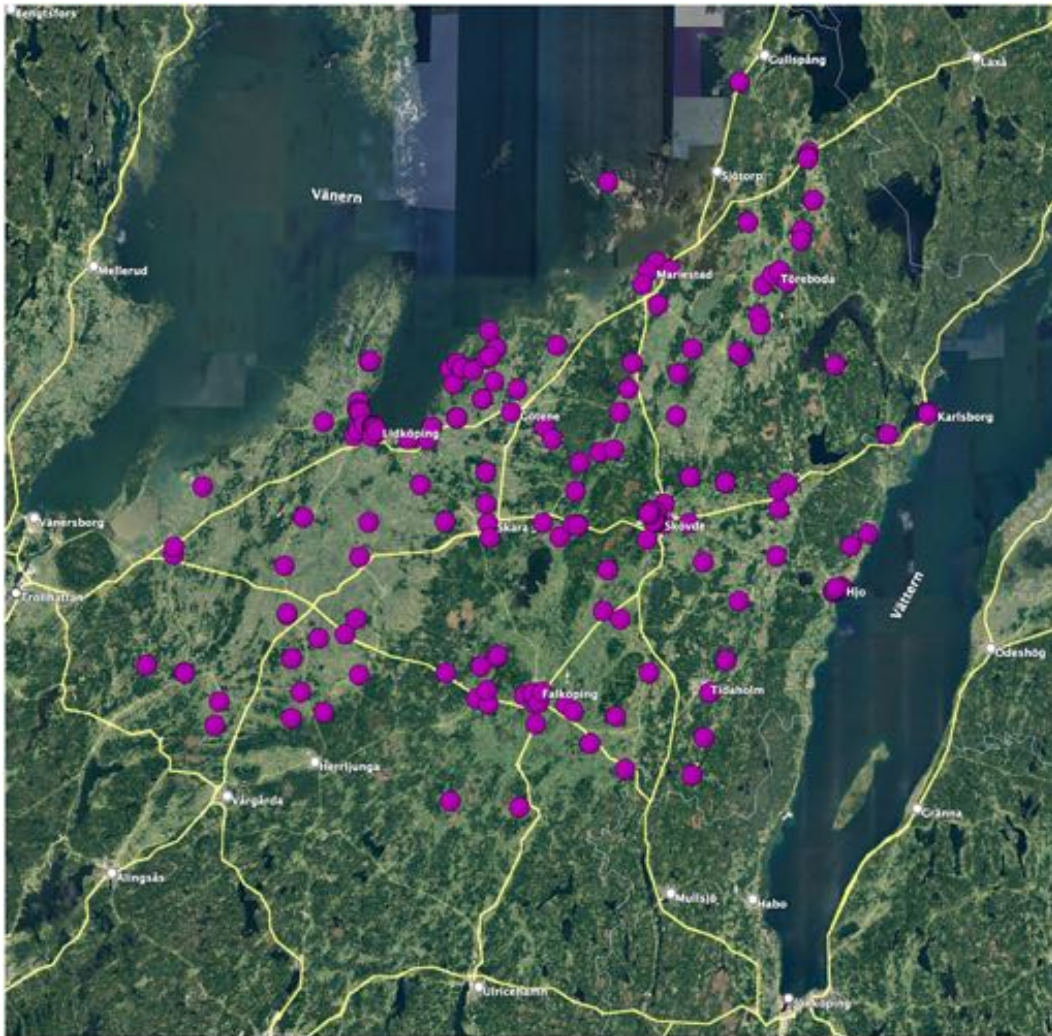


Fig. 8. Crafts.

promote the various aspects of man's natural and cultural heritage and are generally recognized for their important impact on human and social development. The Västergötland Museum is a regional museum located in Skara but operating throughout the whole Skaraborg. Other examples of museums are: Karlsborg Fortress Museum, Rörstrand Museum in Lidköping, Tidaholms Museum, Lake Vänern Museum in Lidköping, Falbygdens Museum, Retro Nossebro, Skövde City Museum, Läckö Castle Museum, and Falbygdens Sports Historical Society. Museums are clearly concentrated in the largest towns in Skaraborg: Skövde, Falköping, Mariestad, Lidköping and Skara jointly cover most of the museum offer in the sub-region.

Another important pillar of any cultural system is artistic production. Fig. 11 maps the distribution of artists' studios. The geographical distribution of artist studios follows a logic that slightly differs from those of several other mapped activities and facilities. A clear concentration is found in Götene, and another hub is found East of lake Hornborgasjön. Even in Tidaholm there is a relatively large number of artists' studios. Unlike other sectors, the triangle Skara-Skövde-Falköping is not playing such a central role here as it was found in most other maps. Unlike film or music production, art production does not need to locate in the main urban centers, and artists could be more interested in opening their studios in quiet places with good environmental amenities rather than in busy downtowns.

Another key sector is that of archives and libraries, mapped in Fig. 12. Libraries and archives are available in all municipalities and are relatively evenly distributed across Skaraborg. The survey has found a variety of different libraries: municipal, public, school, and even corporate ones. The mapping also features stops of the mobile libraries, which further extend their reach to rural areas. The relative majority of libraries and archives is documented in Skövde, but also Grästorps and Lidköping are well endowed.

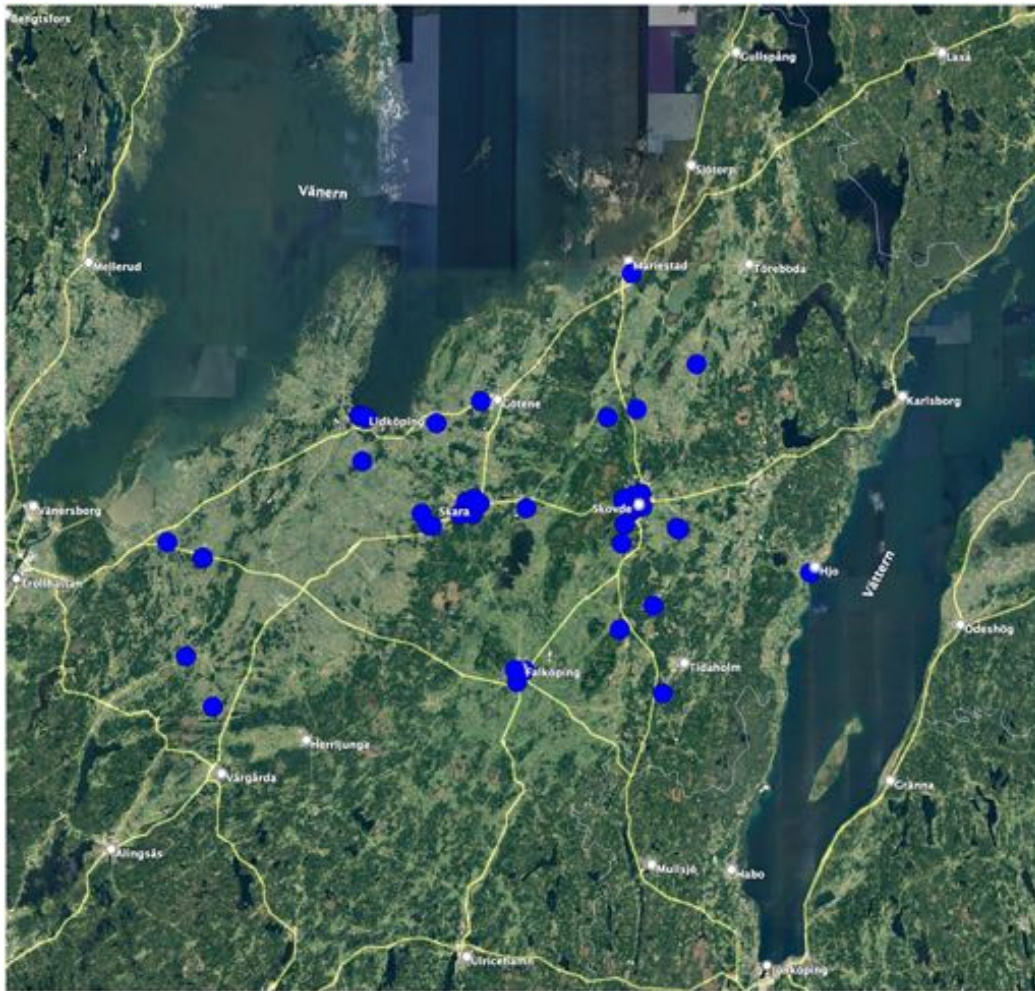


Fig. 9. Music studios.

Overall, the distribution of cultural activities and facilities across the Skaraborg sub-region responds to clear and relatively unsurprising criteria. Skaraborg has no major urban centers and the local cultural offer mainly serves a regional public, but it is relatively rich and varied, covering also industry-oriented sectors such as music and film. From these data, one would expect that the geography of cultural vibrancy of Skaraborg mostly revolves around the largest urban centers and is relatively polycentric, but looking at the mere spatial distribution of the activities little more can be said. How these dynamics are likely to evolve over time? To respond to this question, we need to use a more sophisticated toolbox such as that provided by the TWC approach described in the previous section.

4. Results

4.1. Spatial-temporal dynamics: centroids and scalar fields

The Alpha map for all the surveyed activities and facilities in every sector across the whole sub-region of Skaraborg is shown in Fig. 13. As explained above, the Alpha map describes the ‘outbreak’ situation from which the current observed state of things has evolved. The Alpha map shows only one focus of activity around the main town of Skövde. The other two vertices of the basic urban triangle which concentrates most of the activities, namely Skara and Falköping, fall outside the area of activation. The other centers are even farther away from the activation hub. Therefore, the status quo from which the current situation has evolved is a typical monocentric pattern, centered around the main city.

However, the Beta map, shown in Fig. 14, presents some significant change. As we can see, the whole Skövde-Skara-Falköping triangle is now fully included within the activation hub and functions as the multipurpose cultural hub of Skaraborg, reaching further out to include in its outer ring, among others, Lidköping, Mariestad, Götene, and Tidaholm.

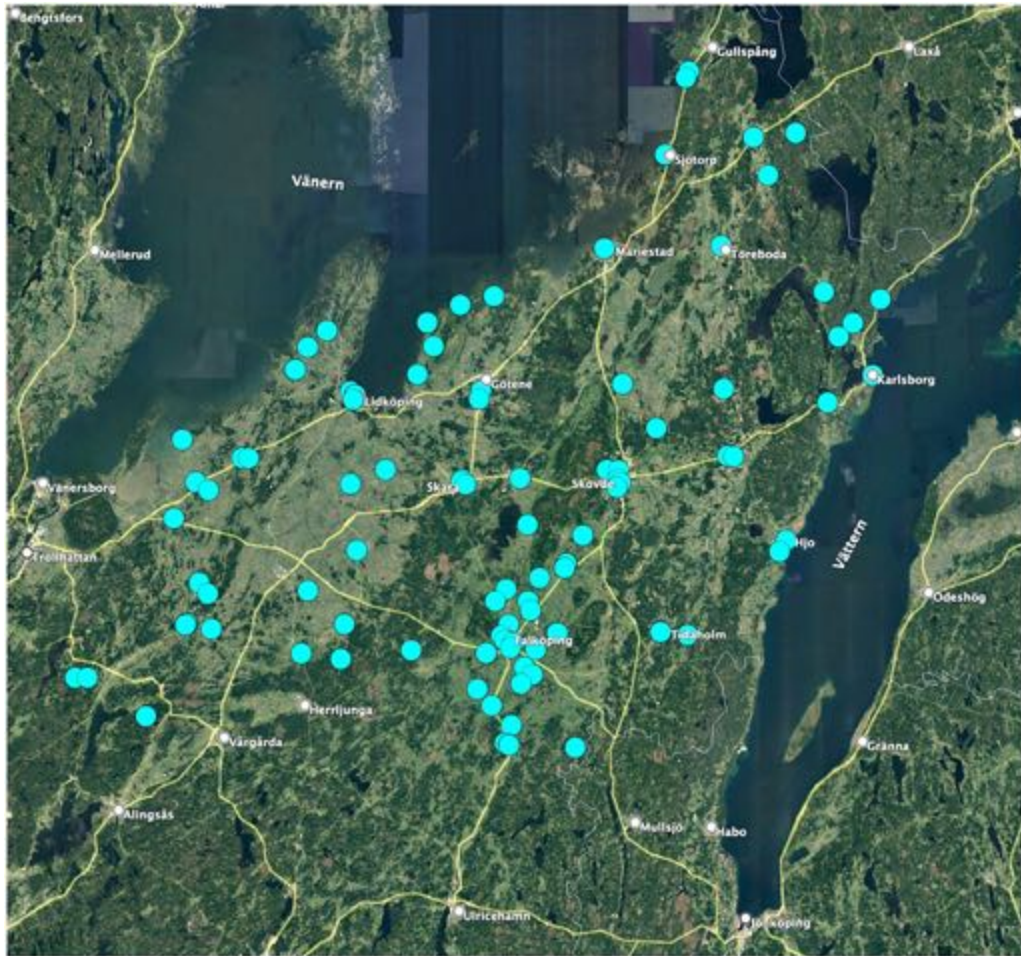


Fig. 10. Museums.

The Beta map corresponds to the probability density related to the observed state of things, and therefore suggests that, at the time of observation, almost all of Skaraborg, with the exception of the outer, more rural regions, was emerging as a whole, culturally vibrant area, whose furthestmost rings would marginally involve even the less urban parts of the territory. This seems to make room for an optimistic forecast as to Skaraborg's future capacity to successfully adopt a culture-driven local development model. But is this optimistic prospect confirmed by the data? To check this, we need to consider the other scalar maps presented in Section 3, which give us a picture of the further future evolution of the area.

The Gamma map is shown in Fig. 15.

Surprisingly enough, the Gamma map shows a significant contraction of the area of activation with respect to the Beta map, that is, the further dynamic evolution of the system presents a prospect of reduced and not increased cultural vibrancy, that is now more closely concentrated around the Skövde-Skara-Falköping triangle. For some reason, then, the 'burst' of activity shown by the Beta map is likely not sustainable in the longer term. To get some more insight about this, we will have to turn to the AutoCM analysis below. But before doing that, let us consider the situation in the even more distant future as shown by the Theta map, reported in Fig. 16.

The Theta map shows a further shrinkage of the area of activation with respect to the Gamma map. The area now strictly coincides with the Skövde-Skara-Falköping triangle, apart from the most marginal outskirts. Towns that were previously fully included such as Mariestad, Götene, Tidaholm and Lidköping are now either on the extreme border of the area or just out of it. In other words, in the long term the pattern of activation does not stably spread beyond the Skövde-Skara-Falköping but rather folds back to its original, 'outbreak' condition. That is to say, the current increase and diffusion of activity is not a stable impulse but rather a 'flare', an explosion of activity that is followed by a rapid return to the previous state of things. This is clearly something that is difficult to tell by just looking at the spatial distribution of the various activities and facilities across all sectors as presented in Section 3. There must be some less visible, more complex factors at work that account for this unstable development. Before considering such factors, however, it is useful

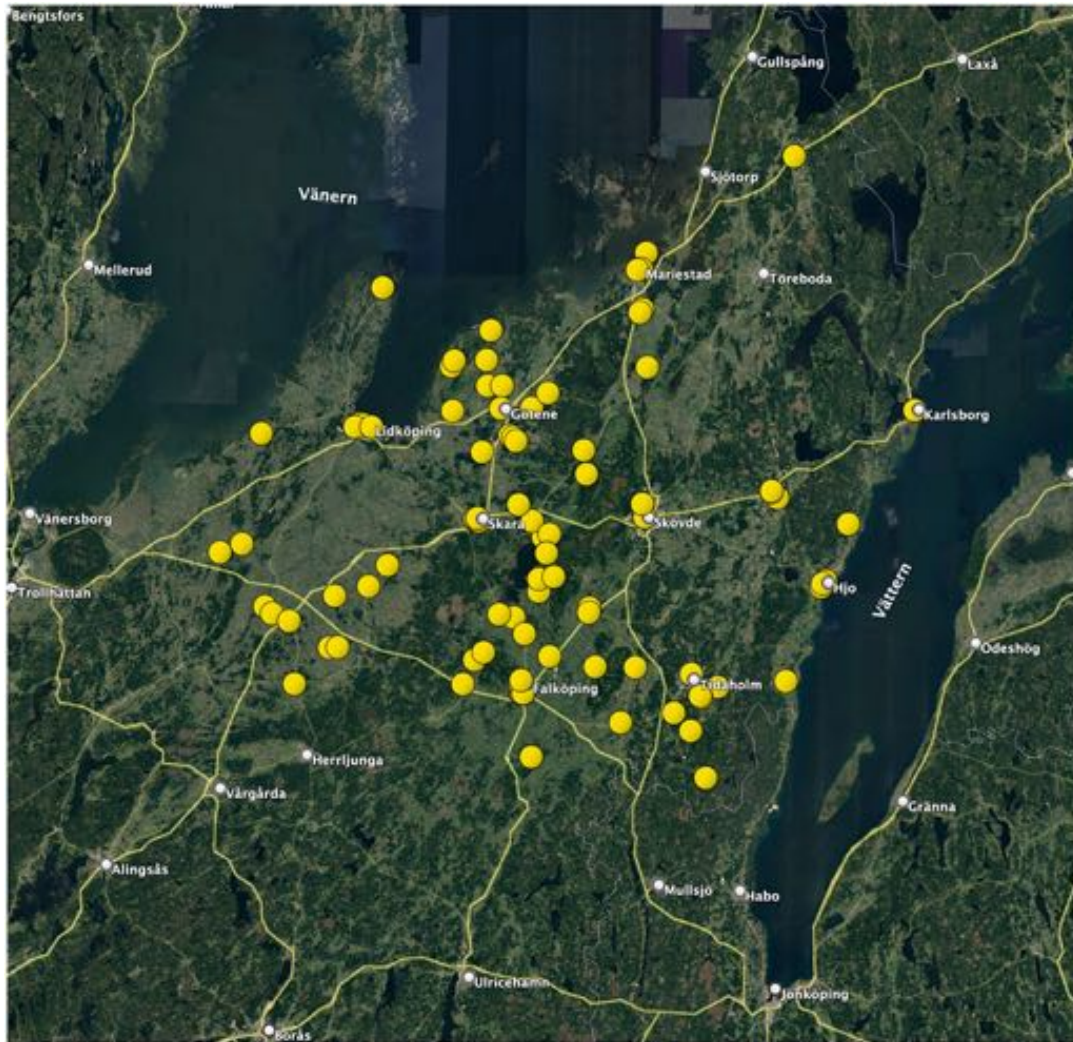


Fig. 11. Artists' studios.

to have a look also at the Iota map, to understand where the vanishing points for the dynamics are located. This is shown in Fig. 17.

As shown in Fig. 17, the vanishing points are both outside the Skövde-Skara-Falköping triangle. One of them is actually outside Skaraborg itself, in the nearby sub-region of Fyrbodalen, which is renowned for its vibrant cultural production activity. The Iota map then shows that the nearby attractive power of Fyrbodalen may explain why the culture-driven local development model of Skaraborg fails to take off: the competition from its closest neighbor is likely draining creative talent and resources out of the area. The location of the other vanishing point is still outside of the Skövde-Skara-Falköping triangle, but relatively close to it. It is located on the way toward the nearby region of Jönköping which, like Fyrbodalen, may be a powerful attractor of local resources from Skaraborg, draining away the cultural vibrancy momentum. However, as this vanishing point sits fully within the Skaraborg territory and close to the Skövde-Skara-Falköping triangle, we can deduce that the pull exerted by the Jönköping region is substantially weaker than that exerted by Fyrbodalen on the other side, and it is especially in this direction that the most critical draining is occurring as far as Skaraborg's cultural resources are concerned. It is also worth mentioning that the Iota map shows a very small but significant spike of activity in the remote rural area close to Lake Vättern, hinting at a possible development of a new, small rural cultural hub, likely related to crafts and artists' studios, that is, a peripheral production hub for activities that do not require the high density of urban environments. Interestingly, in all the maps it seems that the main communication routes have relatively little impact on the spatial-temporal dynamics of cultural vibrancy. Neither highway E20 nor the railway between Stockholm and Göteborg make a major difference. However, the E20 further contributes to the consolidation of the Skara-Falköping-Skövde triangle as Skaraborg's cultural hub by facilitating mobility across the three towns. The railway does not seem

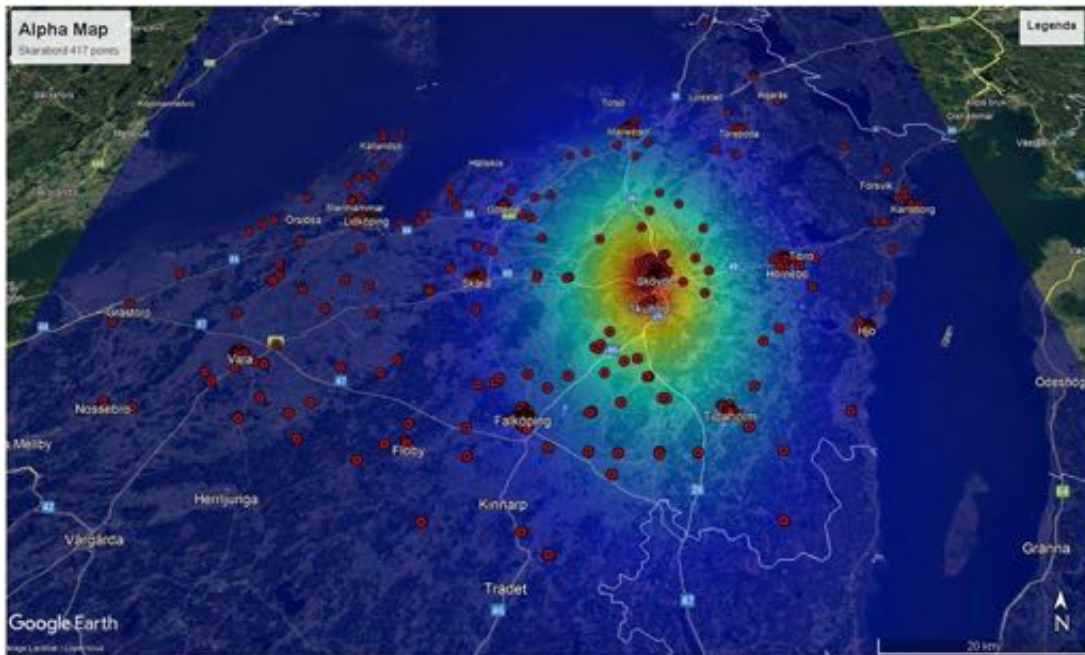


Fig. 13. Alpha map.

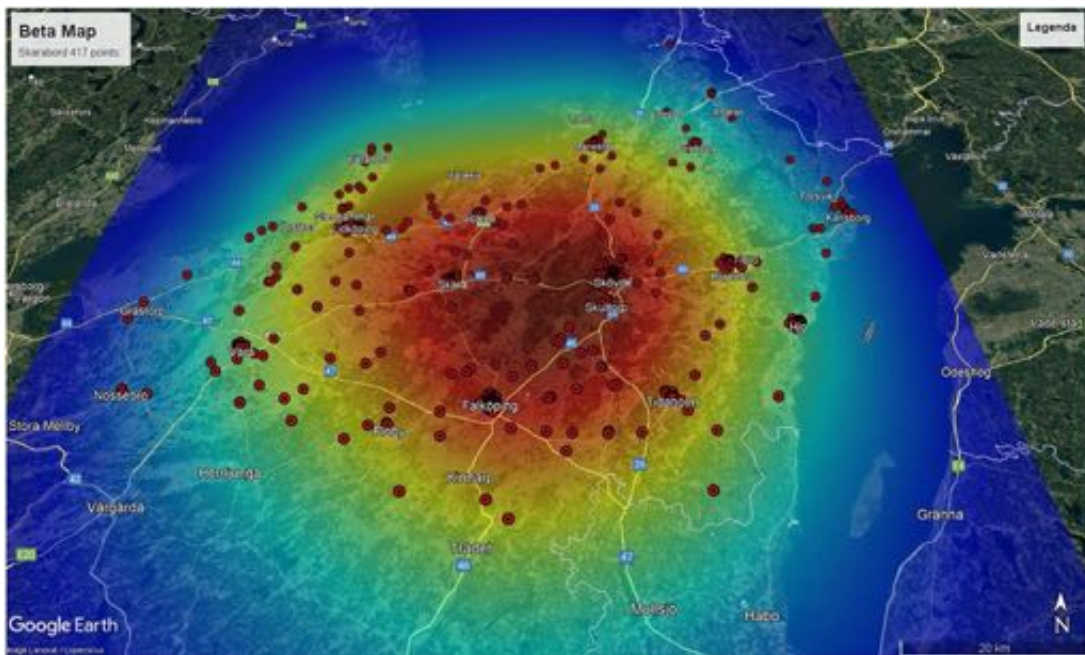


Fig. 14. Beta map.

Axis A is clearly the graph's backbone. Several of the variables along axis A are related to people in working age and elderly people. Since this axis occupies the center of the MST it plays a central role in the Skaraborg socio-economy. At the very center of the MST, at the junction between axes A and B, and more systematically on the left-hand side, we find several variables related to a lower level of education. The socio-economy of Skaraborg is therefore still predominantly informed by a rural, low-education development model, in accordance with its macroeconomic characterization.

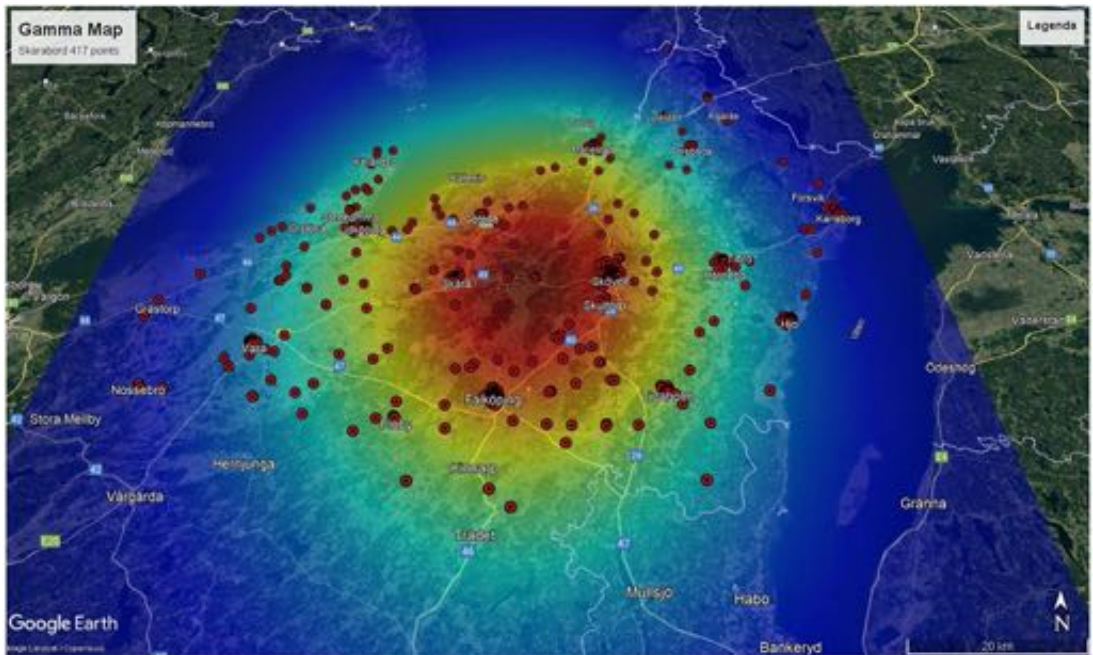


Fig. 15. Gamma map.

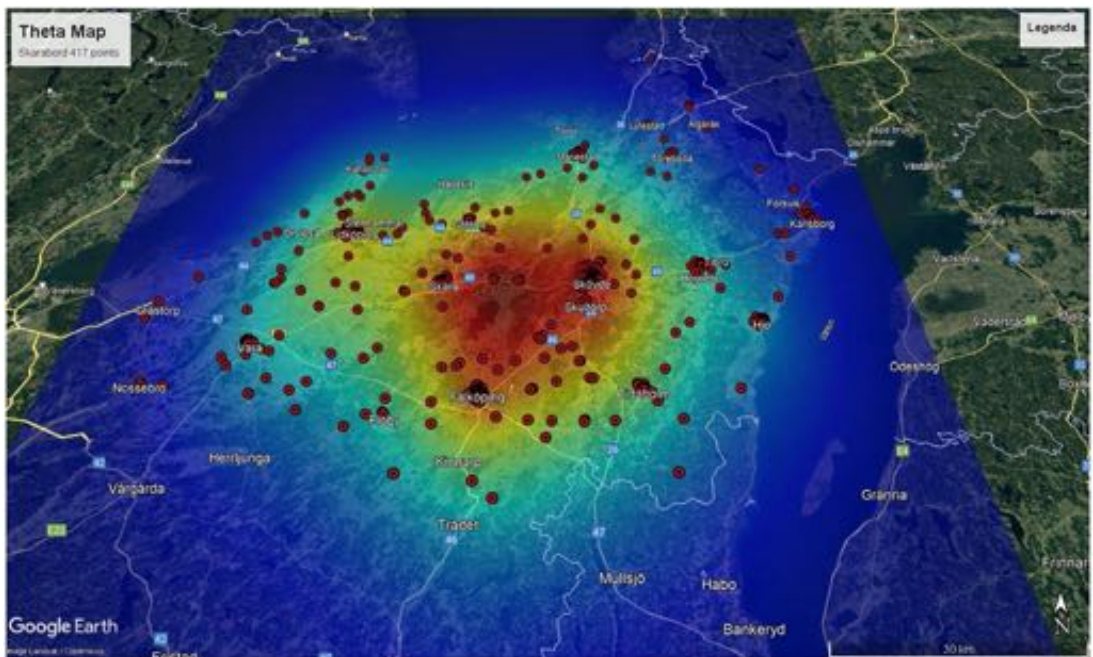


Fig. 16. Theta map.

Cluster	Variables
Working people	M Edu Bus adm W Edu Healthcare Hum Health soc acr M employed M tot Age 20–64



Fig. 17. Iota map.



Fig. 18. MST for Skarborg.

All	Age W 20-64 W tot Marriage status T Age tot Age WT Divorced
Elderly people	Age W 80-115 Age T 80 115 W Edu Widower

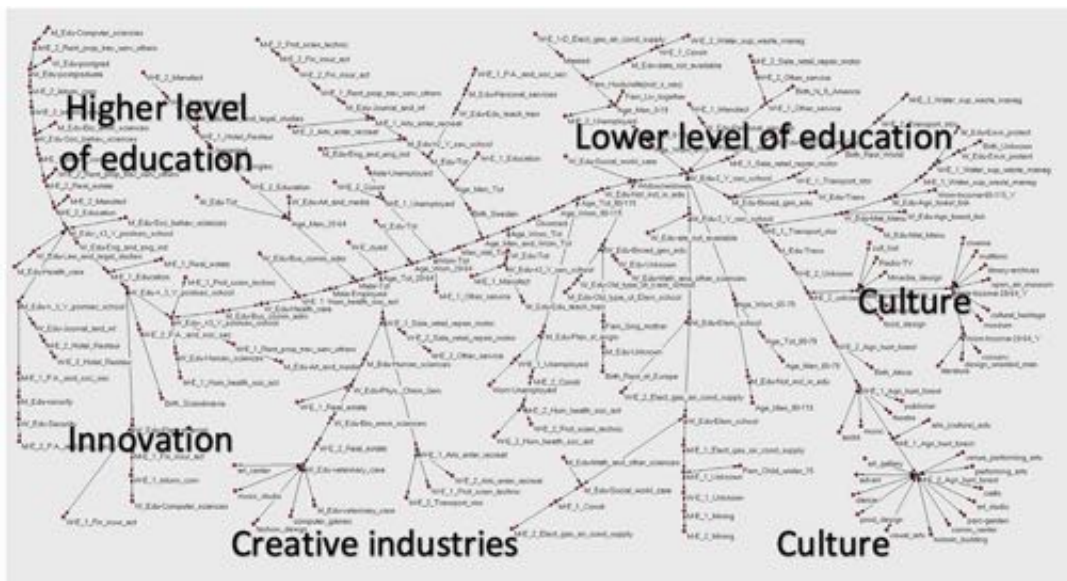


Fig. 19. Location of the main spheres of activity on the MST.

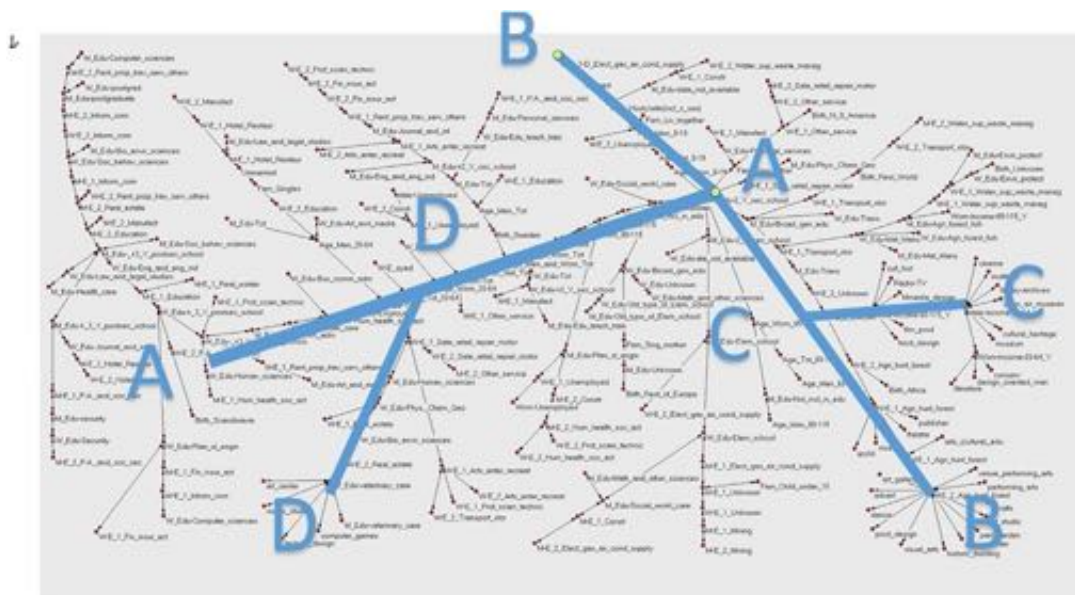


Fig. 20. MST main axes.

Axis B

W-E_1-D_Elect_gas_ais_cond_supply - W_Edu_2_Y_sec_school - M-E_2_agri_hut_forest

Axis B contains an important cultural cluster at its far end, and it is also closely linked to axis C (see below). The cluster in the bottom representing cultural and creative production is made of three sub-clusters, all of which are close to agriculture, hunting and forestry. A first interpretation is that culture in Skaraborg still relates to traditional rural values rather than to cutting-edge aesthetic research and innovation. However, agriculture in Skaraborg is partly highly technically advanced and a real innovative industry. Therefore, a probably sharper interpretation here is that the link between culture and agriculture has more to do with new models of smart rural areas rather than with traditional rural productions and values.

In the first sub-cluster, located more toward the center of the MST, we find architecture, music, theater, and publishers. In the next we find art education. In the far end we find art galleries, advertisement, dance, product design, visual arts, historic buildings, community centers, parks and gardens, art studios, crafts, performing arts, and venues for performing arts. So, a large part of Skaraborg’s cultural system is located in this part of the tree. However, culture, just like agriculture, forestry and hunting, actually sits in the very outskirts of the MST.

An interesting case here is represented by furniture production, where the link between forestry and culture (design) is most apparent. Skaraborg’s furniture production in Tibro is very well-known in Sweden (Prod_design), and the local population presents much larger rates of employment in furniture production than in the rest of Sweden. However, these variables in the culture cluster are not closely linked to variables representing innovation or business. The reason is that this local industry is not related to growing firms or startups, but to established, traditional firms that still produce furniture designed by the famous designer Bruno Mattson in the 1950s, with relatively little attention to contemporary (young) designers.

From the bottom:

Cluster	Variables
Culture cluster	Art gallery Advert Dance prod_design Visual arts Historic buildings comm_center Park-garden art_studio Crafts Performing arts Venue performing arts Agriculture, hunting, for M-E_2_Agriculture hunting forest M-E_1_Agriculture hunting forest => Arts (culture) edu W-E_1_Agriculture hunting forest => Publisher Theater Music Architect W-E_2_Agriculture hunting forest => Born Africa M-E_2-unknown => Male Income 65-115 => Culture cluster (see below)
Transport	W_E_2_Unknown M_Edu-Trans M-E_1_transport_stor
Low, broad education	M_Edu_broad_gen_edu W_Edu_2_Y_sec_school
Young people Age W 0-19	Age tot 0-19 Age men 0-19
Family	Fam Husb Married
Energy	W-E_1-D_Elect_gas_ais_cond_supply

Axis C

M-E_2_Unknown Male 65-115 - Male income 65_115 – Male income 24_65

Creative industry: cult hist, radio TV, mmedia, film prod, food design

Axis C represents men activities in general and the ‘men’ economy. Directly connected to it are two culture clusters. In the first one we can find variables mostly representing creative industries such as food design, film production, multimedia design, Radio TV, and cultural history. Despite that these sectors are generally related to the innovation sphere, in the case of Skaraborg they seem to be unrelated to innovation – another clear sign that culture is not a driver

of the local knowledge economy. The second one in the very far end of the MST, we can find mostly cultural facilities such as cinema, multifunctional buildings, library archives, open air museums, cultural heritage, museum, conservation, design-oriented manufacturing, and literature.

It is of interest to explore the relation between culture and prevalently men activities in the local economy and society. In our study we have not mapped passive cultural participation, such as visiting museums or attending concerts, that is, activities where participants are prevalently women. It is therefore significant that, as far as cultural production is concerned, women tend to be somewhat under-represented – a surprising result in view of Sweden’s attention toward gender equality issues, and in view of the large role of women professionals in the cultural sectors.

At the end of axis C, we find a sub-cluster related to cultural activities and income for women in the 20–64 years age groups. It is interesting that income variables occupy such a marginal position in the MST, rather than the center. It is also of interest that the income of men and women are so closely linked to cultural activities and facilities. Income of women are directly linked to conservation, design-oriented manufacturing and literature. Therefore, women participation, and especially so at professional level, seems to be circumscribed to a relatively limited range of cultural activities, all of which outside the core of creative industries.

Cluster	Variables
Culture	Food design Film prod Mmedia design Radio TV cult hist - Male Income 20–64 Cinema Multifunct Library archives Open air museums Cultural heritage Museum - Women income 20–64 Conservation Design-oriented manuf Literature

Axis D

Age tot 20–42 – W_Edu_veterinary_care

In Sweden, Skaraborg’s cultural profile is strongly related to its dance music culture that crosses over various genres (country/rock/schlager, performing mostly at dance restaurants) and in the last years to video game design. At the end of axis D, we find a cluster consisting of both music studios and computer games, as well as fashion design and art centers – the most industrially oriented part of the local cultural economy. Unlike the culture clusters in axes B and C, the cluster in axis D is the only one that presents significant links to high education and knowledge, and to an innovation-based economy. Therefore, the advanced components of Skaraborg’s cultural economy are related to very specific sectors, which interact in a limited way with other cultural sectors.

From the bottom:

Cluster	Variables
CCI cluster	Age_Tot_20-64 W-E1_Sale retail repair motor, M_Edu-Human science, W_Edu-Phys_Chem_Geo W_Edu-Bio enviro_science W-E_2_Real_estate, W_Edu_veterinary_care Music studios Computer games Fashion design Art center

In turn, around the four main axes we can single out a number of sub-axes, as detailed in Fig. 21.

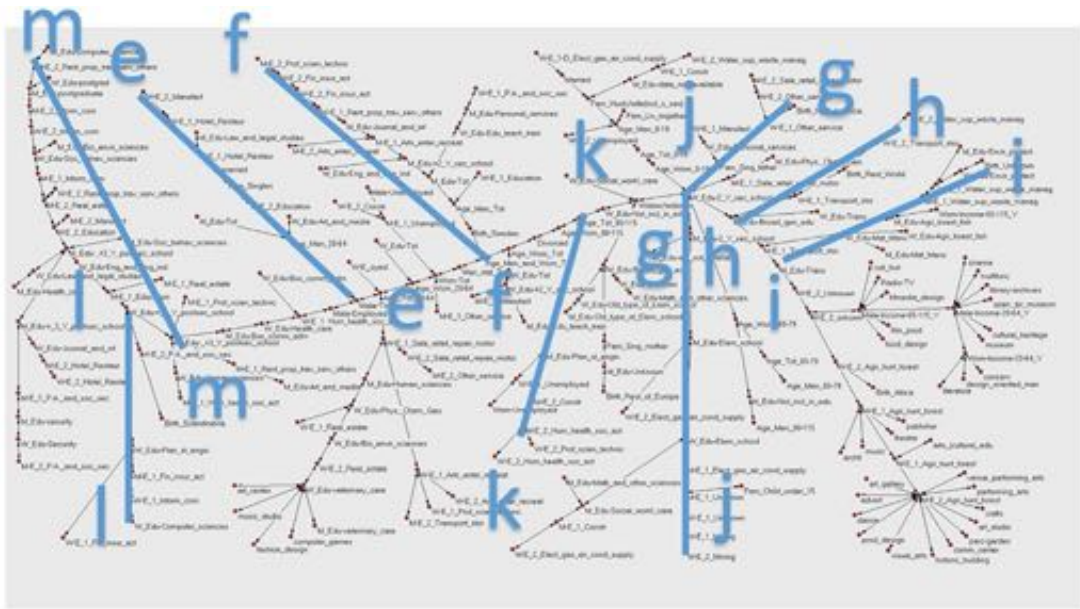


Fig. 21. MST sub-axes.

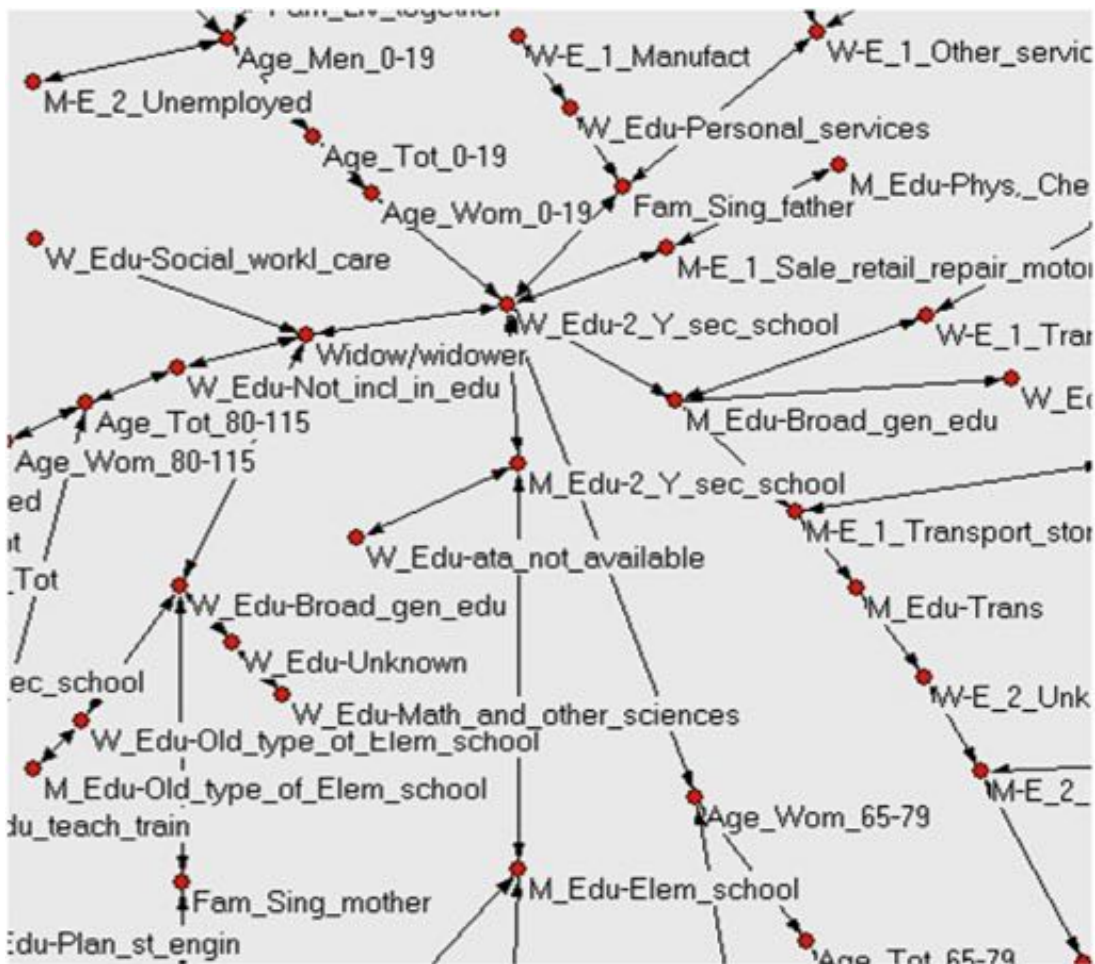


Fig. 22. The center of the MST.

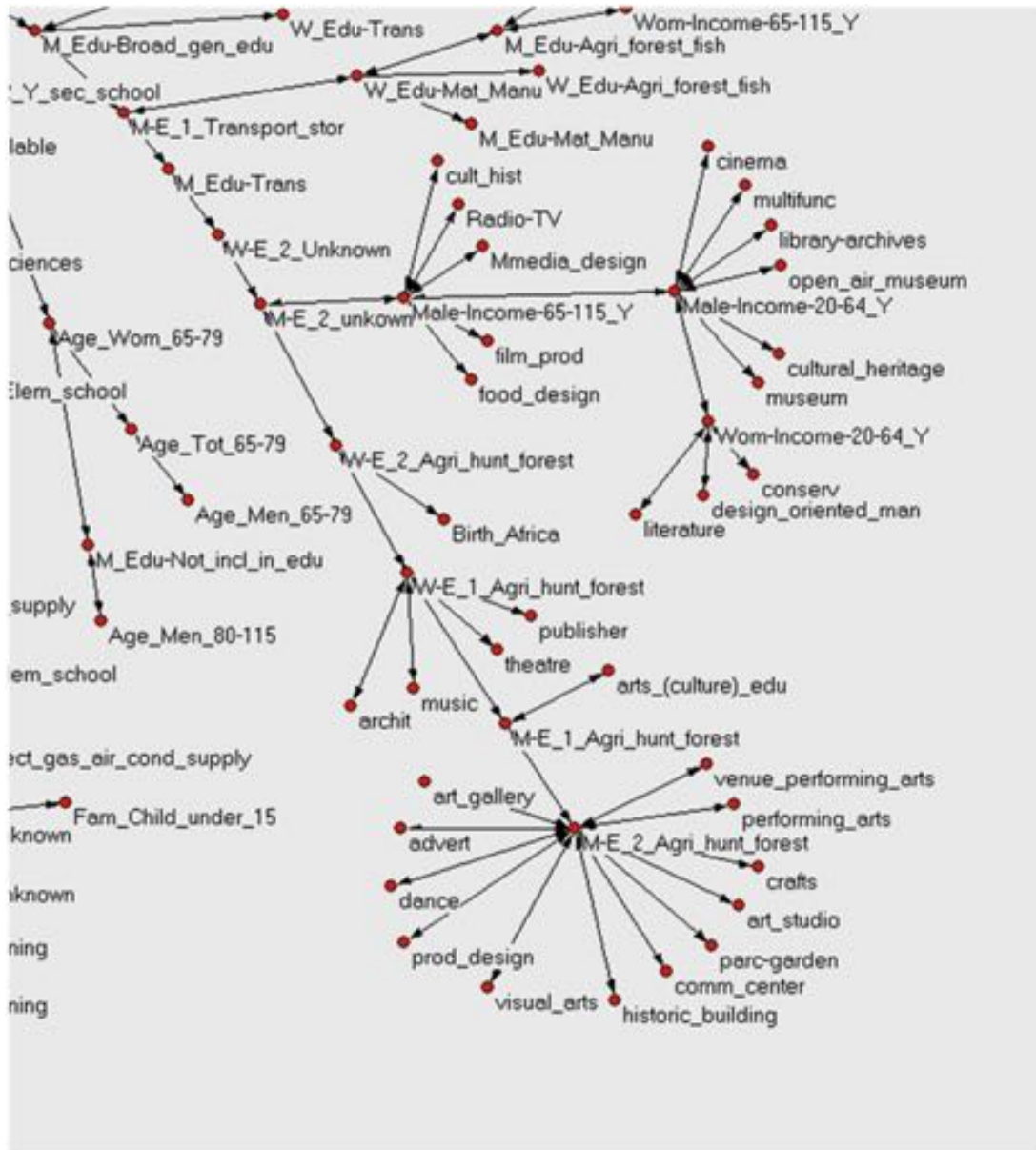


Fig. 23. South-East corner of the MST.

The sub-axes can be synthetically characterized as follows.

Axis e

Men dominant (male total and male 20–64 years old), family, hotel and restaurants. At the far end, women education in arts and media, which seems to be an appendix of the local tourist economy rather than a variable related to the creative industry.

Axis f

Age and education in general. People born in Sweden. In the far end, more innovative variables such as science technical, finance and insurance, journalism and information.

Axis g

Service-oriented.

Axis h

Transport-oriented.

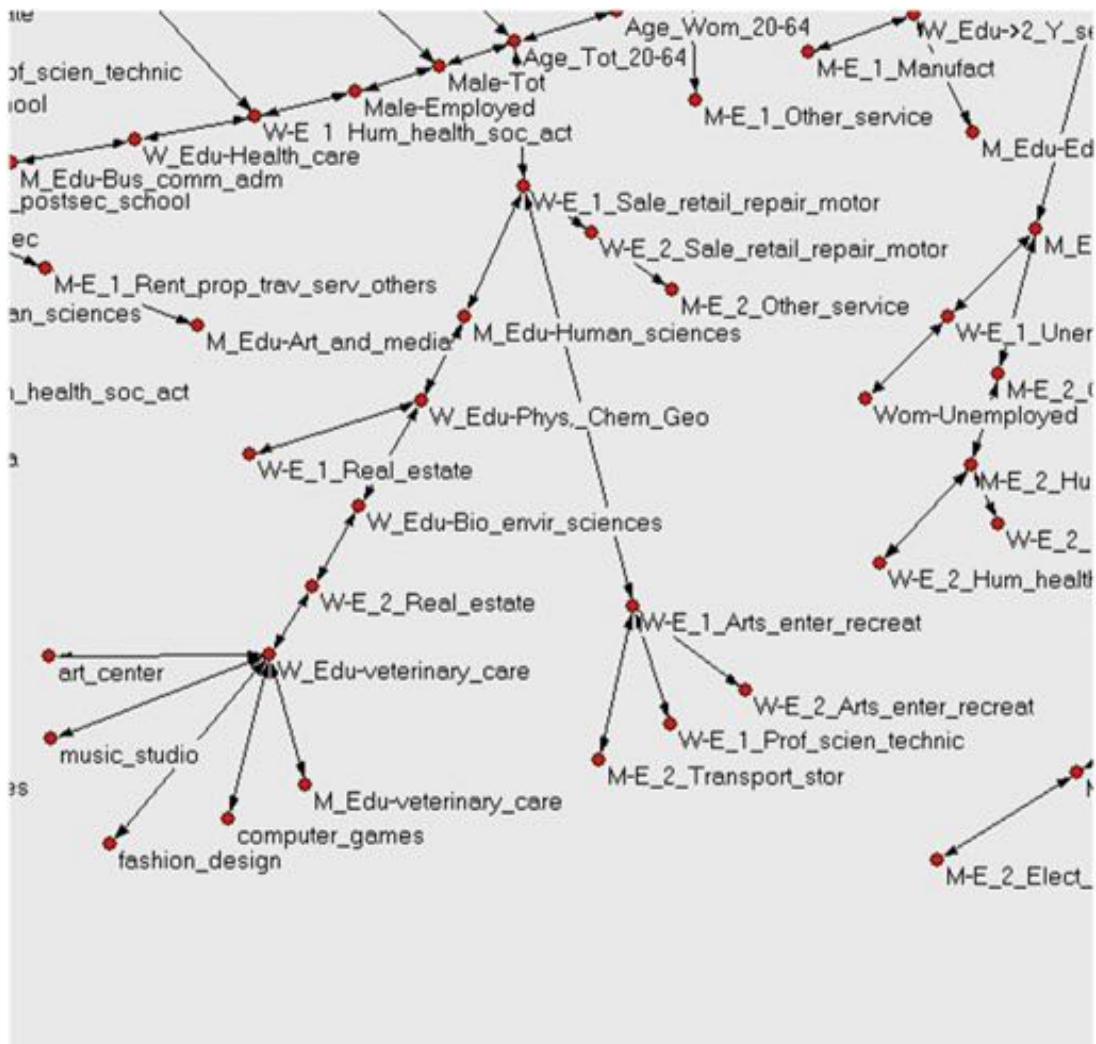


Fig. 24. Cultural and creative industries (music, fashion, gaming).

Axis i

Manufacturing, and in the far end waste management and environmental protection.

Axis j

General education and mining.

Axis k

Elderly people, construction and health care.

Axis l

Creative industries, innovation, people born in Scandinavia, engineering, computer science, higher levels of education, finance, insurance, information.

Axis m

Higher education, innovation. Real estate, information, social and behavioral sciences, biology and environmental sciences, computer science.

As we see, only the sub-axis l presents a significant interaction between creative industries, innovation, and the knowledge economy. It is a rather specialized subsystem rather than a key pillar of the local economy, and it seems to be characterized by a significant gender imbalance.

At this point, it is of particular interest to explore what are the variables that sit at the center of the MST and that, therefore, most strongly characterize Skaraborg's socio-economy. We report a close shot of the center of the MST in Fig. 22.

A number of significant branches stretch out from the MST backbone (the A axis). The key factors of sustainable growth in Skaraborg are found at the junctions of these branches. However, there is no single variable that seems to play a truly central role. The variable that occupies the centroid of the tree is actually two-years of secondary school education for women, sitting at the junction between the A and the B axes. This variable is directly linked to the respective variable for men, but also to non-specialized education. Low-level, unspecialized education (negatively) sets the bar for innovation-driven regional growth and can be considered as a major obstacle to development opportunities in Skaraborg. In the immediate vicinity we can find corresponding variables for men (M_Edu_2_Y_sec_school) as well as variables relating to very young people (Age_Wom_0-19, Age_Tot_0-19 and Age_Men_0-19). Other points of interest in close connection are widow/widower, single fathers (Fam_Sing_father), broader general education (M_Edu-Broad_ge_educ) and business related to vehicles (M-E_1_Sale_retail_repair_motor).

Overall, then, the center of the MST relates to a main structural gap rather than to a strength of the Skaraborg socio-economy, and the weak link seems to be first and foremost the low educational level of women.

Let us now consider more closely the portions of the MST where most cultural variables sit, starting from the one at the South-East corner, shown in Fig. 23. First of all, as already remarked above, we notice that most of the cultural variables are located far out in the periphery of the graph, at the opposite side with respect to variables representing higher education and innovation. Culture therefore plays a marginal role in innovation-driven growth in Skaraborg. Cultural activities such as radio/TV, multimedia design, film production and food design are found in a marginal position close to men pensioners' income, which is remarkable. At the bottom of the graph, as branch leaves of agriculture, forestry, hunting and fishing, we find visual arts, dance, advertising, park and garden design, arts and culture, crafts, art galleries and cultural and historical buildings – practically most of the cultural economy of a region. Notably, men pensioners' income (Male-income-65-115_Y) as well as agriculture, forestry, hunting and fishing (W_E_2_Agr_hun_Forest, W-E_1_Agri_hun_forest, M_E_1_Agr_hun_Forest and M-E_2_Agri_hun_forest), are more relevant for regional development than culture as they occupy a less marginal position in the tree.

It is also interesting to consider more closely the region of the MST where the variables related to the most dynamic cultural and creative industries sit. This is reported in Fig. 24.

Despite their still relatively marginal position, the most dynamic cultural and creative industries such as music, fashion and gaming are more closely connected to the local knowledge economy. Interestingly, also art centers sit in this part of the graph. However, the main variables related to research and innovation are found elsewhere, in the North-Eastern branch, where we meet variables related to postgraduate education and computer science.

5. Discussion

From our TWC analysis, we have seen that the dynamics of a possible culture-led development trajectory for Skaraborg, despite the promising enlargement of the area of highest cultural vibrancy across most of the sub-region's main towns, is likely to be a 'flare', i.e., to be short-lived with a return to the old, mono-centric status quo around the main town of Skövde. The reason has become apparent by carrying out the AutoCM analysis that has enabled us to build the MST for the Skaraborg socio-economy.

From the analysis of the MST, it is clearly shown that culture plays a marginal role in the Skaraborg socio-economy, and that such role, with limited exceptions, is related to a traditional developmental logic in which most cultural sectors and activities more closely connect to the rural economy than to the economy of knowledge. The sector of furniture production is especially revealing in this regard: it is a classic example of a natural complementarity between forestry and design, but the local companies are relatively uninterested in experimenting with innovation and keep on producing items designed back in the 50s.

On the other hand, computer games, fashion and music are more dynamic sectors, which are closer to the innovation and business dimension, but they are rather isolated with respect to the rest of the local cultural and creative economy, and as a consequence this is both limiting the transformation of the other sectors, but also limiting the growth potential of these more dynamic ones. The 'flare' pattern observed in the spatial-temporal analysis of cultural vibrancy therefore reflects the essential lack of momentum for the local cultural and creative economy deriving from the fact that culture neither acts as a development driver nor gains traction from non-cultural drivers. As a consequence, even a promising start is going to die out in the medium-long term.

At the same time, cultural demand does not seem to be related to young people, but rather to mature and retired citizens. As a consequence, there is little chance that the local cultural production is able to react to new ideas and trends deriving from the latest waves of the creative discourse. They are more likely to cater to the tastes of a seasoned, and probably culturally conservative public who wants to enjoy well-recognized forms of cultural expression. It is therefore likely that the younger creative talents in the area will move to more stimulating venues which pay more attention to contemporary culture – starting from the nearby one, Fyrbodalen, which is very well positioned in cultural and creative production and, as shown by the Iota map, is actually draining the cultural vibrancy of Skaraborg.

But probably the most profound and interesting insight deriving from the analysis of the MST is the key role of women and education as the main bottleneck of Skaraborg's socio-economic growth. Educated women are generally a main driver of creative economies, and especially so in the cultural and creative sectors, in particular in countries that pay high attention to gender equality such as Sweden. It is therefore rather surprising to see that in Skaraborg there is

a very weak link, if any, between educated women and the creative economy, and the main problem in this regard is that there are too little educated women in the first place. The rather conservative, traditional socio-cultural environment of Skaraborg is imposing a heavy toll on its developmental potential. An apparently paradoxical but in fact very well grounded implication of our analysis is therefore that, to boost Skaraborg's creative economy, the smartest and most important move is not necessarily that of funding new incubators for creative entrepreneurship or building new cultural facilities or launching new, attractive festivals, but rather to increase opportunities for women in the higher education sector, and not only in relatively obvious majors such as STEM but also in those related to culture, creativity and the arts. This would likely boost both the demand for more innovative cultural contents by women audiences, but also a new wave of highly educated women cultural professionals that are at the moment the missing pivot to enable Skaraborg's socio-economy to move along a sustainable path of culture-driven development. This kind of issue is likely to be even more crucial in local contexts where gender equality is substantially more problematic than in Sweden [33].

Another important implication is the necessity to stimulate more cross-sector interaction between different spheres of cultural production. If the most dynamic sectors such as computer gaming, fashion and music would be put in the condition to interact and to exchange ideas and competences more with sectors such as the visual arts, literature, architecture and design, or film, to make a few examples, the local Skaraborg cultural and creative economy would likely become more dynamic and robust, and eventually also possibly able to retain the best local talents and to attract external ones. Without such structural robustness, even positive signs such as Skaraborg winning the prize for the best plan in 2020 at the national Architectural Annual Ceremony (<https://www.skaraborg.se/Var-verksamhet1/regional-utveckling/hallbar-samhallsplanering/Strukturbygg-Skaraborg/>) is bound to remain an isolated upshot with no major long-term benefits.

The key policy implications of our analysis are therefore that cultural policy should not be considered as a separate policy sphere, but should be deeply integrated in the broader policy canvas. The most decisive moves to boost a region's cultural economy may not be primarily related to direct interventions in the cultural sphere, and could rather point at the basic structural conditions that prevent higher and more impactful participation in the cultural sectors, both on the supply and demand sides. This lesson is still largely not considered by policy-makers in its full-blown importance and implications, and facilitating a shift of perspective in this regard is a key priority of the future policy discourse about regional development.

6. Conclusions

Our analysis has shown that, by making use of a sophisticated analytical toolbox that builds on methods and techniques from the sciences of complexity, it is possible to derive new, profound insights that allow us to better understand under what conditions local economies can successfully embark in new trajectories of culture-driven local development.

Most cultural policy design nowadays relies on a very modest empirical basis in analyzing and assessing alternative policy choices [34], and most cultural policy decisions in the public interest, such as for instance whether to build a new cultural facility or what kind of cultural productions to support, are often taken without any proper evidence or standard of accountability [35] or any clear standard of expertise [36]. Founding cultural policy making on a solid analytical basis is therefore a key priority [37,38]. What an approach built on complexity science offers us is the opportunity to develop a precision cultural policy design, i.e., a strongly evidence-based framework that goes radically beyond the merely intuitive arguments on the basis of which decisions are customarily taken in the field, to leverage upon the fine-grained information on the functioning of the local socio-economy that emerges from the application of a sophisticated methodological toolkit to the available data.

This study offers a telling example in this regard. We have found that the main issue related to the relatively ineffective developmental trajectory of Skaraborg as far as culture-led development is concerned is not strictly linked to any cultural variable, but to the bottleneck created by an insufficient number of women reaching high education levels that could be successfully employed in the cultural sector. Therefore, the more urgent measure to take to boost the local cultural and creative economy is not even a measure of cultural policy, but rather a measure that falls in the education and gender policy realms. And yet, building the analysis on sophisticated models that allow us to take into account the very complex chains of interaction between many different variables belonging to different sectors and spheres is exactly what allows the policy maker to choose a targeted action, on the basis of clear hypotheses that can be tested and assessed in their capacity to guide effective policy interventions.

However, we are not making a case for a technocratic, top-down policy design approach where policy makers work with sophisticated tools that the general public cannot understand and appreciate in their usefulness and importance. The whole Skaraborg project, for instance, has been based upon a close dialog with the local community, which has actively cooperated in the data gathering phase, has been consulted widely to discuss the meaning and implications of the results for future policy choices, and has been informed about the scientific rationale of the toolkit that was going to be used to interpret the data. This is particularly important in relatively small communities with a strong rural component [39], where active inclusion is especially important to develop a local sense of agency and responsibility [40] and to fight socio-economic inequalities [41], as a more general approach toward increasingly participative local development models, and especially so in contexts where there is little tradition in such practices [42,43].

A further development of this approach will derive from monitoring the actual dynamics of cultural vibrancy in regions for which future heat maps of cultural vibrancy and insights about the positioning of the cultural and creative

sectors in the regional socio-economy are available. By comparing the simulations and the observed dynamics and by dynamically adjusting the simulation tools on the basis of the available evidence it will become possible to build even more sophisticated tools and to discuss and validate their results with the local community, thereby encouraging an increasing involvement of citizens in the precision cultural policy design process and making an important step toward a fully integrated top-down/bottom-up policy framework.

A wider adoption of the toolkit proposed in this study in many different regional contexts would provide a solid basis for learning, fine-tuning and skills building through its application. Therefore, we need more studies, in as heterogeneous socio-economic and cultural contexts as possible, to further develop and validate these techniques, possibly in direct cooperation with policy makers and regional and urban development agencies. This is therefore a main priority for future research and policy experimentation.

CRedit authorship contribution statement

Massimo Buscema: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Guido Ferilli:** Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Supervision. **Christer Gustafsson:** Conceptualization, Investigation, Data curation, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Pier Luigi Sacco:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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References

- [1] Sacco PL, Ferilli G, Blessi G Tavano. Understanding culture-led local development: A critique of alternative theoretical explanations. *Urban Stud* 2014;51:2806–21.
- [2] Kagan S, Hauerwaas A, Holz V, Wedler P. Culture in sustainable urban development: Practices and policies for spaces of possibility and institutional innovations. *City Cult Soc* 2018;13:32–45.
- [3] Ferilli G, Sacco PL, Tavano Blessi G, Forbici S. Power to the people: When culture works as a social catalyst in urban regeneration processes (and when it does not). *Eur Plan Stud* 2017;25:241–58.
- [4] Sacco PL, Ferilli G, Tavano Blessi G, Nuccio M. Culture as an engine of local development processes: System-wide cultural districts. II: Prototype cases. *Growth Change* 2013;44:571–88.
- [5] Qian J. Redeeming the Chinese modernity? Zen buddhism, culture-led development and local governance in XinXing county, China. *Environ Plan A: Econ Space* 2019;51:187–205.
- [6] Gunay Z, Dokmeci V. Culture-led regeneration of Istanbul waterfront: Golden horn cultural valley project. *Cities* 2012;29:213–22.
- [7] Hudec O, Dzupka P. Culture-led regeneration through the young generation: Košice as the European capital of culture. *Eur Urban Reg Stud* 2016;23:531–8.
- [8] Sitas R. Creative cities, graffiti and culture-led development in South Africa: Dlala Indima ('play your part'). *Int J Urban Reg Res* 2020;44:821–40.
- [9] Bayliss D. Creative planning in Ireland: The role of culture-led development in Irish planning. *Eur Plan Stud* 2004;12:497–515.
- [10] Lysgård HK. Creativity, culture and urban strategies: A fallacy in cultural urban strategies. *Eur Plan Stud* 2012;20:1281–300.
- [11] Alberti V, Montalto V, Panella F, PL Sacco. Cultural and creative vs. cultural or creative: reconceptualising culture-led urban development. *Ispra: Joint Research Center*; 2022, Preprint.
- [12] Lysgård HK. The 'actually existing' cultural policy and culture-led strategies of rural places and small towns. *J Rural Stud* 2016;44:1–11.
- [13] Bille T, Storm HN. Local development policy: Do new culture houses have an impact on migration? The case of Norway. *Eur Plan Stud* 2021;29:1556–77.
- [14] Grossi E, Sacco PL, G Tavano Blessi. Cultural, creative and complex. a computational foundation of culture-driven urban governance. *Milan: IULM University*; 2022, Preprint.
- [15] Massimo Buscema. *Theory: Foundations of artificial neural networks*. Subst Use Misuse 1998.
- [16] Guido Ferilli, Massimo Buscema, Luigi Sacco Pier. The non-linear relationship between scientific production and national states' journals. *Adv Comput Sci Eng* 2012.
- [17] Montalto V, Tacao Moura CJ, Langedijk S, Saisana M. Culture counts: An empirical approach to measure the cultural and creative vitality of European cities. *Cities* 2019;89:167–85.
- [18] Cerisola S, Panzera E. Cultural and creative cities and regional economic efficiency: Context conditions as catalyzers of cultural vibrancy and creative economy. *Sustainability* 2021;13(7150).
- [19] Ferilli G, Sacco PL, Buscema M, Tavano Blessi G. Understanding cultural geography as a pseudo-diffusion process: The case of the Veneto region. *Economies* 2015;3:100–27.

- [20] Buscema M, Ferilli G, Gustafsson C, Sacco PL. The complex dynamic evolution of cultural vibrancy in the region of Halland, Sweden. *Int Reg Sci Rev* 2020;43:159–202.
- [21] Buscema M, Ferilli G, Gustafsson C, Massini G, Sacco PL. A nonlinear, data-driven, ANNs-based approach to culture-led development policies in rural areas: The case of gjakovë and Peć districts, Western Kosovo. *Chaos Solitons Fractals* 2022;162:112439.
- [22] Reyburn S. Venice is a stage for Damien Hirst's 'treasures' (and a Biennale, too). *The New York Times*; 2017, May 12, <https://www.nytimes.com/2017/05/12/arts/damien-hirst-venice-biennale.html>.
- [23] Salerno GM, Russo AP. Venice as a *short-term city*. Between global trends and local lock-ins. *J Sustain Tourism* 2022;30:1040–59.
- [24] Sonnenschein TS, Scheiber S, Zheng S. The rebirth of urban subcenters: How subway expansion impacts the spatial structure and mix of amenities in European cities. *Environ Plan B: Urban Anal City Sci* 2022;49:1266–82.
- [25] Zukin S, Braslow L. The life cycle of new york's creative districts: Reflections on the unanticipated consequences of unplanned cultural zones. *City Cult Soc* 2011;2:131–40.
- [26] Cerisola S. A new perspective on the cultural heritage-development nexus: The role of creativity. *J Cult Econ* 2019;43:21–56.
- [27] Bertoni A, Dubini P, Monti A. Bringing back the spatial dimension in the assessment of cultural and creative industries and its relationship with a city's sustainability: The case of milan. *Sustainability* 2021;13(10878).
- [28] Waitt G, Gibson C. Creative small cities: Rethinking the creative economy in place. *Urban Stud* 2009;46:1223–46.
- [29] Buscema M, Massini G, Sacco PL. The topological weighted centroid (TWC): A topological approach to the time-space structure of epidemic and pseudo-epidemic processes. *Physica A* 2018a;492:582–627.
- [30] Buscema M, Massini G, Breda M, Lodwick S, Newman F, Asadi-Zeydabadi M. Artificial adaptive systems using auto-contractive maps – theory, applications and extensions. In: *Studies in systems, decision and control*, Vol. 131. Cham: Springer; 2018b.
- [31] Buscema M, Sacco PL. MST fitness index and implicit data narratives: A comparative test on alternative unsupervised algorithms. *Physica A* 2016;461:726–46.
- [32] Buscema M, Asadi-Zeydabadi M, Lowdick W, Breda M. The H0 function: A new index for detecting structural/topological complexity information in undirected graphs. *Physica A* 2016;447:355–78.
- [33] Beta A. Out of thin air: Emerging muslim fashion entrepreneurs and the spectre of labour in Indonesia. *Contin J Media Cult Stud* 2021;35:824–37.
- [34] Lewandowska K, Kulczycki E. Science policy as implicit cultural policy: Evaluation of the arts in polish academia. *Int J Cult Policy* 2021;27:202–17.
- [35] Lindqvist K. Dilemmas and paradoxes of regional cultural policy implementation: Governance modes, discretion and policy outcome. *Admin Soc* 2019;51:63–90.
- [36] Lewandowska K. License to judge: Fleshing out expertise in cultural policy. *Int J Cult Policy* 2019;25:337–49.
- [37] Sacco PL, Crociata A. A conceptual regulatory framework for the design and evaluation of complex, participative cultural planning strategies. *Int J Urban Reg Res* 2013;37:1688–706.
- [38] Rius-Ulldemolins J, Pizzi A, Arostegui JA Rubio. European models of cultural policy: Towards European convergence in public spending and cultural participation? *J Eur Integr* 2019;41:1045–67.
- [39] Lysegård HK. The assemblage of culture-led policies in small towns and rural communities. *Geoforum* 2019;101:10–7.
- [40] Rodríguez-Pose A. The revenge of the places that don't matter (and what to do about it). *Camb J Reg Econ Soc* 2018;11:189–209.
- [41] Tubadji A, Gheasi M, Crociata A, Odoardi I. Cultural capital and income inequality across Italian regions. *Reg Stud* 2022;56:459–75.
- [42] Hui ECM, Cheng T, Lang W, Ou Y. Urban community regeneration and community vitality revitalization through participatory planning in China. *Cities* 2021;110:103072.
- [43] Copic V, Dagićević-Sesic M. Challenges of public-civic partnership in cambodia's cultural policy development. *ENCATC J Cult Manage Policy* 2018;8:4–15.