
Knowledge-based urban development of cross-border twin cities

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Abstract: Knowledge-based urban development (KBUD) has recently emerged as a central topic of discussion among scholars and practitioners interested in urban development tools and policies. However, what has rarely been discussed before is whether KBUD can be achieved in a cross-border context. This paper sets out to propose an analytical framework for empirical studies on the shared KBUD processes of cross-border twin cities, based on indicators adapted from the literature on cross-border regional innovation systems. The proposed framework was tested with two cases: Helsinki-Tallinn and Copenhagen-Malmö. The results demonstrate the feasibility of the framework, guide potential further studies on KBUD and twin cities and raise relevant suggestions for urban policy-makers in border regions.

Keywords: border region; Copenhagen; cross-border innovation cooperation; cross-border regional innovation system; Helsinki; innovation; integration; knowledge-based urban development; KBUD; Malmö; Oresund; similarity; twin city; Tallinn.

Reference to this paper should be made as follows: Makkonen, T. and Weidenfeld, A. (xxxx) 'Knowledge-based urban development of cross-border twin cities', *Int. J. Knowledge-Based Development*, Vol. X, No. Y, pp.xxx-xxx.

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1 Introduction

Knowledge-based development is “the collective identification and enhancement of the value set whose dynamic balance furthers the viability and transcendence of a given community” [Carrillo, (2014), p.416]. It has recently gained increasing popularity in urban development policy and strategies (Yigitcanlar, 2014a). The academic literature on ‘knowledge-based urban development’ (KBUD) has developed its scope quickly from the introduction of metrics for validating the KBUD model (Sarimin and Yigitcanlar, 2012), to a case study approach (Yigitcanlar et al., 2008; Makkonen, 2012) to global benchmarking exercises of world cities (Yigitcanlar and Lönnqvist, 2013), as well as smaller secondary cities (Yigitcanlar et al., 2015). However, the KBUD has rarely been addressed in a cross-border regional context (Roose and Lepik, 2015). The KBUD can thus have an understudied potential contribution to the development of cross-border regions and cities, for example, by creating joint urban development strategies, facilitating the building of improved transportation links and promoting cross-border innovation cooperation.

So far, cross-border innovation cooperation has been largely studied in the context of regional innovation systems. The literature on ‘cross-border regional innovation systems’ (CBRIS) suggests that cooperation (and increased integration thereof) is the key for successful and sustained innovative futures of border regions (Tripl, 2010; Lundquist and Tripl, 2013). However, the existing empirical studies on CBRIS have concentrated their attention on large regional units while neglecting smaller urban entities, such as cross-border twin cities, where cross-border cooperation can manifest in more informal and mundane ways (Makkonen et al., 2016). Therefore, this paper sets out to empirically explore the potential of shared KBUD processes and innovation cooperation in cross-border contexts. It does so firstly by reviewing the earlier empirical literature related to cross-border twin cities, KBUD and CBRIS. Secondly, the paper proposes an analytical framework for measuring the extent of cross-border innovation cooperation and shared KBUD processes. Thirdly, it tests the feasibility of the introduced framework by empirically exploring two cross-border twin cities: Helsinki-Tallinn and Copenhagen-Malmö. Finally, the paper concludes by summarising the main findings, proposing guidelines for utilising the suggested framework and drawing directions for future studies.

2 Literature review

2.1 Cross-border twin cities

In colloquial language the term ‘twin cities’ refers to situations where two geographically close urban settlements have grown into each other over time. In national contexts, the most common example of a twin city is the Minneapolis-Saint Paul metropolitan area. However, twin cities have also emerged in/from cross-border contexts. Thus, there are cases of twin cities that are divided by an international border. These cross-border twin cities have been formed as a result of growth at both sides of the border or have been formed as a result of new international borders. In the latter cases, the international borders have actually divided what was once a coherent city entity into two urban areas now situated on adjacent sides of the border (thus, also referred to as ‘divided cities’; e.g., Nicosia/Lefkosia). In addition, other terms such as ‘bi-national cities’, ‘boundary twin towns’ and ‘border agglomerations’ have been used more or less as a synonym for cross-border twin cities (Ehlers et al., 2001; Lundén and Zalamans, 2002; Lundén, 2007). However, the advocates of city twinning have maintained that, as a term, the twin city concept places its emphasis on cross-border similarities, whereas, for example, the bi-national cities concept highlights the separating role of border divisions and cross-border differences (Joenniemi and Sergunin, 2011a). Again, cross-border twin cities are not to be confused with the terms ‘twin town’, ‘sister city’ or ‘friendship town’, which describe formal relationships for promoting cultural and commercial ties between settlements commonly located far away from each other in different nation-states (Clarke, 2011). In order to bring some consensus into this discussion and confusion concerning the varying terminology, certain criteria have been proposed for distinguishing cross-border twin cities from: divided cities – which do not seek cross-border cooperation, non-international twin cities – such as Minneapolis-Saint Paul, and other forms of international cooperation – such as the above mentioned sister city arrangements that municipal units can take part in. These suggested criteria include the following [Anischenko and Sergunin, (2011), pp.20–21]:

- 1 the cities are to be located in close proximity to the country’s border
- 2 they are to have common history in the past when they were a single entity or have been opposed to each other on the contrary
- 3 the cities are to seek cooperation between each other
- 4 the population of twin cities has mixed ethnic composition and is often bilingual
- 5 the cooperation of twin cities should have a certain legal and institutional basis.

The cross-border twin city concept has received a fair share of scholarly attention (e.g., Durrschmidt, 2002; Heliste et al., 2004; Eskelinen and Kotilainen, 2005; Lundén, 2007; Kaisto and Nartova, 2008; Anischenko and Sergunin, 2011; Joenniemi and Sergunin, 2011a, 2011b). Commonly utilised case study examples include cross-border twin cities located in the Baltic Sea region, such as: Haparanda-Tornio (Sweden-Finland), Valga-Valka (Estonia-Latvia), Narva-Ivangorod (Estonia-Russia), Helsinki-Tallinn (Finland-Estonia), Imatra-Svetogorsk (Finland-Russia) and Guben-Gubin (Germany-Poland). However, the existing literature has typically taken a qualitative and rather descriptive approach to assess the development and integration potential of cross-border regions and

the acceptance of, motives for and obstacles to city twinning. Moreover, only quite recently (and still rarely) have these studies related the concept of cross-border twin cities to innovation and KBUD (Lepik and Krigul, 2014; Roose and Lepik, 2015); both topics which shall be discussed in greater detail below.

2.2 *Knowledge-based urban development*

Talented workers, knowledge and high-tech industries have pivotal roles in boosting urban economic growth (Florida, 2005). Therefore, the KBUD approach pays particular attention to attracting and catering for the needs of knowledge-based high-technology industry, talented workers and investments (Sarimin and Yigitcanlar, 2011). The KBUD, as a multidimensional urban development approach, seeks a balance between the different dimensions of urban development and aims at creating desirable urban environments for living, working and visiting (Fernández-Maldonado and Romein, 2010; Carrillo et al., 2014). Practical examples include the provision and development of infrastructures, improved financial systems, investments in social and human capital, the adoption of new state-of-the-art technologies, catering for the quality of life of city residents and the creation of attractive living places. KBUD thus transcends many areas of economic and social policy (Yigitcanlar and Velibeyoglu, 2008) and is divided into four main dimensions. Each dimension is comprised of two separate, but inter-linked sub-categories. These dimensions and sub-categories (and examples of their operationalisation in earlier empirical studies) include the following (Yigitcanlar, 2011; Yigitcanlar and Lönnqvist, 2013; Yigitcanlar et al., 2015):

- 1 economic development:
 - a macro-economic foundations:
gross domestic product (GDP) and foreign direct investments (FDI)
 - b knowledge economy foundations:
research and development (R&D) expenditures and number of patents
- 2 socio-cultural (or societal) development:
 - a human and social capitals:
public spending on education, educational attainment and university rankings
 - b diversity and independency:
ratio of people born abroad, unemployment and dependency ratios
- 3 enviro-urban (or spatial) development:
 - a quality of life and place:
cost of living and crimes against life and health
 - b environmental sustainability:
CO₂ emissions and population density

- 4 institutional development
 - a governance and planning:
 - electronic governance and city branding
 - b leadership (or support) and partnership:
 - public grants for R&D and number of sister city cooperation agreements.

As pointed out above, there are examples of empirical studies exploring these dimensions with the help of a set of indicators (Yigitcanlar and Lönnqvist, 2013; Yigitcanlar, 2014b; Yigitcanlar et al., 2015; Kacar and Gezici, 2016). However, the only existing case studies on KBUD in a cross-border context have been carried out utilising data from the Helsinki-Tallinn twin city (Lepik and Krigul, 2014; Roose and Lepik, 2015). Moreover, the existing empirical exercises on KBUD seem to be based on national/regional data availability and have been carried out on an ad-hoc manner. This is due to the fact that not all the data one can gather for world cities will be available or suitable when moving between different national contexts – for example, whereas in Finland cities enjoy greater autonomy when it comes to formulating KBUD policies (Yigitcanlar et al., 2015), in China the state has retained its significant role in KBUD of individual city regions (Zhao, 2010) – and to smaller urban settings (Yigitcanlar et al., 2015). This seems to apply particularly to the dimension of institutional development. In other words, the state of the art of studies on operationalising the KBUD model, although sharing definite similarities, has not been able to produce a fixed consensus on what indicators and measures to use when benchmarking city-regions against each other in the various dimensions that the concept entails. Therefore, certain liberties have been taken in constructing and operationalising the analytical framework of this paper; discussed in greater detail below.

2.3 Cross-border regional innovation systems

A recent review paper has tracked down the birth stages of the CBRISs literature and concluded that the concept of CBRIS emerged from the “widespread agreement on the usefulness and importance of the systems of innovation approach as an analytical framework for innovation studies” and from the realisation that in most cases the literature on innovation systems has “focused on national and regional scales ... thereby excluding the possibilities of developing innovation systems in the context of cross-border regions” [Makkonen and Rohde, (2016), p.1623]. Together these notions led to the coining of CBRIS as a new innovation systems concept (Tripl, 2010), which takes into account that “the long-term innovative and competitive success of cross-border regions largely depends on their ability to create these common innovation systems” [Makkonen and Rohde, (2016), p.1623]. The most common example of developing common regional innovation systems across borders has been offered by the Danish-Swedish Oresund region, where a local development agency – namely the Oresund Committee – has taken an active stance towards promoting and monitoring the development of cross-border activities within the region (Hansen, 2013; Nauwelaers et al., 2013; Makkonen, 2016).

Despite the development of a detailed conceptual framework by Lundquist and Tripl (2013), aimed at helping researchers to empirically describe the various integration stages – ranking from weakly integrated to highly integrated CBRIS – of individual CBRIS, as a fairly new theoretical concept the CBRIS literature and its policy

implications rest upon a thin evidence-base (Makkonen and Rohde, 2016). Recently, however, a first attempt at operationalising the proposed conceptual framework into an analytical one was made by Makkonen et al. (2016), based on the integration model suggested by Lundquist and Tripl [2013; see also Lundquist and Tripl (2009) and OECD (2013) for rudimental empirical comparisons and descriptive profiles of innovative activities in certain cross-border regions]. The proposed measurements included a division into a set of dimensions; much like in the KBUD approach (e.g., Yigitcanlar et al., 2015). These dimensions and related empirical metrics, which are also utilised in this paper, for measuring them consist of the following (Makkonen et al., 2016):

- 1 business (or economic structure and specialisation):
similarities/differences in the industrial sectors of employees
- 2 knowledge infrastructure (science-base):
similarities/differences in the reported scientific fields of academic publications
- 3 relational (nature of linkages):
similarities/differences in the reported technological classes of patents
- 4 socio-institutional (institutional set-up):
similarities/differences in cultural dimensions (see e.g., Hofstede, 2001) and the ethnolinguistic composition of population
- 5 governance (policy structures):
shared policy goals relating to formal institutions (the existence of organisations promoting cross-border integration and the acknowledgement of the value of their work)
- 6 accessibility
numbers of daily commuters across the border.

The authors tested the framework with data on three Danish regions sharing borders either with Germany or Sweden and concluded that it was able to show clear differences between the regions and fitted well with the existing knowledge on their contemporary integration processes (Makkonen et al., 2016). This analytical CBRIS approach is amalgamated into the KBUD methodology in the following section to allow for a comparison between different cross-border twin cities in terms of cross-border KBUD integration.

3 Analytical framework, data sources and cases

When comparing the analytical CBRIS and KBUD frameworks, it becomes obvious that they share a lot of similarities in terms of their dimensions and metrics. Here, these two frameworks are merged together. The new proposed framework follows the established KBUD model (Yigitcanlar and Lönnqvist, 2013; Yigitcanlar, 2014b; Yigitcanlar et al., 2015), but borrows most of its indicator choices from the CBRIS literature (Lundquist and Tripl, 2009; Makkonen, 2016; Makkonen et al., 2016) as follows (see the Appendix for the raw values upon which the indicators are based upon):

- 1 economic development:
 - a macro-economic foundations:

cross-border commuters/total population (%): the number of cross-border commuters are applied to signal how well the labour markets of the opposing sides of the border are integrated
 - b knowledge economy foundations:

number of cross-border patents/number of domestic regional collaborative patents (%): patents have been commonly utilised in both the KBUD and the CBRIS literature to describe the state of the cities' knowledge economy and relatedly the intensity of knowledge linkages and networks within cross-border regions
- 2 socio-cultural development:
 - a human and social capitals:

number of cross-border publications/total number of publications (%): scientific publications have been utilised in the CBRIS literature to indicate cross-border similarities or differences in knowledge-bases and (scientific) human capital
 - b diversity and independency:

ratio of people born in the neighbouring country (%): the share of foreign-born inhabitants and the ethnolinguistic similarities of the population have been utilised in both the KBUD and the CBRIS literature to signal how diverse (and potentially connected) the populations of a (cross-border twin) city are
- 3 enviro-urban development:
 - a quality of life and place:

cross-border passenger traffic/total population (%): cross-border traffic is used as proxy for the quality of life and place, since it is closely tied to tourism flows, which in cross-border settings signal both the appeal (willingness to travel) of the cities in question and the income level (possibility to travel) of their inhabitants¹
 - b environmental sustainability:

transport mode choice (cross-border passenger traffic/private cars = person per private car ratio): the transport mode choice has been applied in earlier studies on KBUD as a benchmark for the environmental sustainability of cities

4 institutional development:

a governance and planning:

qualitative index² on shared policy goals relating to formal institutions (scale: 0–10): the governance and planning index proposed by Makkonen et al. (2016) was updated here by adding two new sub-measures, including:

- 1 the utilisation of city twinning strategies, which in light of the topic under study here, is an important additional measure for KBUD in cross-border twin cities
- 2 the existence of symbols of co-planning, since particularly transportation links have been designated as the ultimate symbols of cross-border integration (Durand and Nelles, 2014)

b support and partnership:

common R&D projects/total number of R&D projects funded by the EU (%): common R&D projects funded by the EU function both as an indicator for the ability and willingness of firms and organisations from the opposed sides of the border to team up and to signal their success in securing financial support (Makkonen, 2016).

The KBUD framework utilises the z-score normalisation technique that reflect the specific distribution of the indicator values with a relative scale according to the best and worst performers (Yigitcanlar, 2014b). Normalisation works well for benchmarking cases within a single study. However, it hinders the possibilities of cross-study comparisons, since the indicator values are dependent on the choice of the cases (i.e., the best and worst performers) included. Naturally, by utilising the raw data of existing studies, subject to availability, one could conduct these comparisons, but not without significant care and effort. Therefore, this paper follows the principles of the CBRIS framework, which aims at providing a set of measures that are readily comparable between different case studies. This is achieved, by normalising the indicator values in a way that gives us ratios of cross-border activity in relation to the magnitude of the whole dimension within the region. Thus, for example in the case of human and social capitals the number of cross-border publications is divided by the total number of publications within the case study region. The data was mainly collected for the year 2012, or the closest one available, but for publications, patents and R&D projects the data was derived for years 2000–2012, to bypass the shortcomings of potential erratic year-to-year swings in these indicators (see Makkonen, 2016). The selection of data sources was largely based on data availability in relation to the indicator utilised here. The data sources can be considered as reliable, which is evidenced, for example, by their wide use in earlier academic literature (e.g., Perkmann, 2003; Roediger-Schluga and Barber, 2008; Hansen, 2013; Nauwelaers et al., 2013; Makkonen, 2015, 2016; Morescalchi et al., 2015; Makkonen et al., 2016). The following databases and online sources were used when collecting the data:

1 databases:

- a databases of the national statistical authorities of Denmark, Estonia, Finland and Sweden
- b Cordis – the European Commission’s primary public repository and portal to disseminate information on all EU-funded research projects

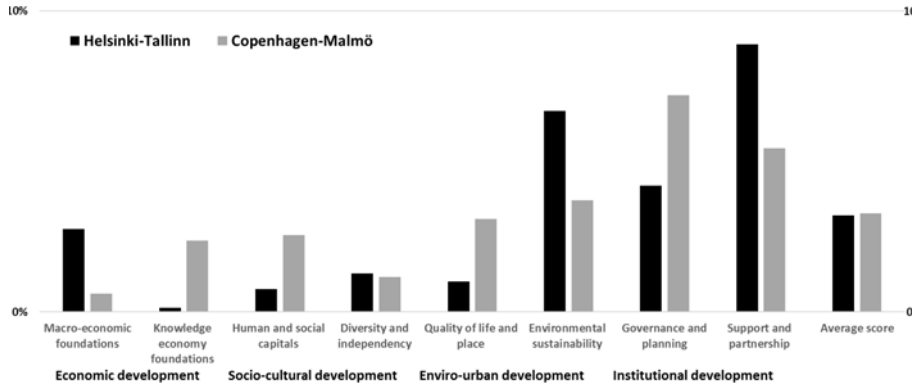
- c Oresund database – a databank covering the Oresund region
 - d RegPat – OECD’s regional patent database
 - e Web of Science – citation indexing service, by Thomson Reuters, for scientific publications
- 2 web pages:
- a Association of European Border Regions (<http://www.aebr.eu>)
 - b EURES – European Job Mobility Portal³ (<https://ec.europa.eu/eures/>)
 - c FinEst Link⁴ (<http://finestlink.fi>).

Since many KBUD elements are not only dependent on the city itself but also on the conditions of the larger regional level where the city is situated (Esmaeilpoorabi et al., 2016), for example, Helsinki and Copenhagen cannot functionally be delineated from their surrounding capital metropolitan regions. Thus, the data was collected for two case study regions including the central cross-border twin city pairs and their surrounding regions: Helsinki (Uusimaa) – Tallinn (Harju) and Copenhagen (Hovedstaden) – Malmö (Scania). These regions were selected because they are commonly used as examples of thriving and successful cross-border integration, particularly the Oresund region incl. Copenhagen-Malmö (as has been repeated in the CBRIS literature), and practically the only existing example of case studies on cross-border KBUD, particularly Helsinki-Tallinn (Lepik and Krigul, 2014; Roose and Lepik, 2015). While these city pairs have not in the past formed a single city entity, Copenhagen-Malmö and Helsinki-Tallinn fulfil the other criteria, proposed by Anischenko and Sergunin (2011), for delineating cross-border twin cities (see Section 2.1).

4 Results

4.1 Overview

Figure 1 depicting the indicator scores of KBUD in the cross-border twin cities of Helsinki-Tallinn and Copenhagen-Malmö, shows that overall Helsinki-Tallinn and Copenhagen-Malmö perform almost equally well: Helsinki-Tallinn performs better in four out of the eight KBUD indicators (see Section 3 for explanations and scales), while Copenhagen-Malmö does better in the rest (the raw values upon which the indicators are based on can be found in the Appendix). Thus, their average scores are almost identical. However, since the measurement of the individual dimensions are based on absolute values and not on normalised values (cf., Yigitcanlar, 2014b) based on the best and worst performers (i.e., not scaled between 0 and 1 or 100), the average scores should only be taken as a tentative illustrator of the overall performance. What is more important is the actual differences in the individual indicators, which will be discussed in greater detail below.

Figure 1 The KBUD performance indicators of cross-border twin cities

Note: See Section 3 for explanations and scales.

4.2 Economic development

When it comes to the *macro-economic foundations* of the cross-border twin cities, Helsinki-Tallinn performs better than Copenhagen-Malmö. In Helsinki-Tallinn the cross-border commuter streams are directed mainly from Estonia to Finland, where a relatively large number of Estonians are working in Helsinki, whereas in Copenhagen-Malmö the main commuter flows come from Sweden to Denmark. In the former, commuting is mainly driven by the wage gap between Finland and Estonia (the wages are significantly higher in Finland than in Estonia), whereas in the latter the lower housing prices in Sweden have created a situation, where a large number of Danes have moved to the Swedish side of the twin city, while still continuing to work in Copenhagen (Nauwelaers et al., 2013).

However, the situation is reversed in the dimension of *knowledge economy foundations*: while overall, particularly the Finnish side of, the Helsinki-Tallinn twin city does well in patenting, the number of cross-border patents is extremely low. In comparison, the co-patenting activity is much livelier in the Oresund region, particularly due to the strong biotech and life sciences industries active in both sides of the border within the Oresund region and promoted by cross-border initiatives – such as the Medicon Valley Alliance (Asheim et al., 2009). This non-profit organisation has been very active in promoting cross-border innovation cooperation among the firms within the bi-national Danish-Swedish life sciences cluster of Medicon Valley (Medicon Valley Alliance, <http://mva.org/>). Strong similarities between the science and sectoral bases of adjacent border regions can lead to complementarities, which often engender cross-border cooperation, and vice versa a large technological gap between the two sides of the border can lead to low intensity in cross-border cooperation (Lundquist and Trippel, 2013). The cases presented here follow the above reasoning: in Copenhagen-Malmö there are strong similarities between the cities, particularly in the biotech and life science sectors (Coenen et al., 2004; Hansen, 2013), leading to a relatively high number of cross-border patents, whereas in Helsinki-Tallinn the wide technological gap between the two cities (the number of domestic regional collaborative patents is almost 50 times

higher in Helsinki than in Tallinn) has led to a modest performance in terms of cross-border patents.

4.3 Socio-cultural development

The Oresund region seems to be a leading example of integration development, when measured with indicators related to the dimension of *human and social capital* (Makkonen and Williams, 2015). Sufficient similarity in science-bases and educational backgrounds between neighbouring parts of twin cities can facilitate positive synergies and higher levels of cross-border integration and co-publications (Lundquist and Trippel, 2013; Makkonen et al., 2016). Thus, high numbers of cross-border publications are commonly driven by close ties within similar research fields active on both sides of the border (Makkonen, 2015). As in the case of cross-border patents, the biotech and life sciences sectors are particularly active (while naturally there is still room for intensifying this cooperation) in publishing scientific papers based on cross-border cooperation (Coenen et al., 2004; Hansen and Hansen, 2006; Hansen, 2013). Contrarily, while co-publishing scientific papers is relatively common compared to other cross-border regions (Makkonen and Williams, 2015), the number of cross-border publications between Helsinki and Tallinn remains much smaller than in Copenhagen-Malmö.

Both twin cities perform almost equally well in the dimension of *diversity and independence*: the share of foreign born persons coming from the neighbouring country is only slightly higher in Helsinki-Tallinn compared to the share in Copenhagen-Malmö. As already stated, in the case of Helsinki-Tallinn, a high number of Estonians have moved to Helsinki for a better living and higher wages, whereas in Copenhagen-Malmö twin city lower housing prices in the Swedish side of the border is a significant contributor to cross-border diversity in the Oresund region. Language similarities facilitate this development, since both language pairs, i.e., Finnish and Estonian as well as Danish and Swedish, are close relatives with each other and, thus, relatively easy to adapt by a speaker of the language spoken on the adjacent side of the border (Ringbom, 2007).

4.4 Enviro-urban development

The results are again mixed for the dimensions of *quality of life and place* and *environmental sustainability*. Whereas Copenhagen-Malmö attracts larger numbers of cross-border traffic, in Helsinki-Tallinn the transport mode choice of the fewer cross-border passengers is environmentally more sustainable than in the Oresund region. A large volume of cross-border traffic is considered to be indicative of a high quality of life in border regions: it is a proxy for pull factors heightening the attractiveness of a city for migrants and tourists and for economic factors (such as the income level of the population) that enable the inhabitants of the cities to travel across the border. However, the performance of cross-border twin cities in these dimensions is also strongly linked to accessibility and connectivity issues. Fixed transportation links (such as tunnels and bridges) reduce time-distance barriers and eliminate land-sea bottlenecks (Matthiessen, 2004). Thus, compared to the ferry transportation links between Helsinki and Tallinn, the Oresund Bridge allows more opportunities for crossing the border and, thus, has improved cross-border accessibility and connectivity between Copenhagen and Malmö. This is reflected in the higher numbers of cross-border traffic across the Oresund Bridge compared to that between Helsinki and Tallinn.

However, Helsinki-Tallinn is characterised by a better performance in the indicator (i.e., persons per private car ratio) measuring transport mode choice. The non-existence of fixed transport links between Helsinki and Tallinn lowers the numbers of vehicles crossing the border: it is far more convenient to drive across the border via a bridge compared to taking a car on the ferry. The construction of a tunnel between Helsinki and Tallinn is expected to create somewhat similar accessibility and connectivity to that provided by the Oresund Bridge (FinEst Link, <http://finestlink.fi>). However, the construction of such a fixed link between Helsinki and Tallinn is not likely to be realised in the immediate future.

4.5 *Institutional development*

Given the fact that Estonia only became independent in 1991, Helsinki and Tallinn have a long history of city twinning and cross-border cooperation. As stated by EURES (<https://ec.europa.eu/eures/>): “the first attempts to promote cross-border cooperation between the Finnish and Estonian capitals were made in 1991 with the so called twin city idea and in 1999 with the Helsinki-Tallinn EUREGIO”. The Helsinki-Tallinn EUREGIO, which was the only formal cross-border coordinating body in the region (Lepik and Krigul, 2014), had a promising start, but several challenges and limitations (such as differences in policy goals) remained for it to function effectively (Pikner, 2008). Therefore, alternative organisational forms for cross-border cooperation were sought, which ultimately led the city of Helsinki to withdraw from the Helsinki-Tallinn EUREGIO institutional mechanism. Since then both cities have engaged in alternative cross-border initiatives, such as developing and improving mobility and transport links between them (FinEst Link, <http://finestlink.fi>). Still, the Oresund region has an even longer history of formalised cross-border cooperation. This cooperation, driven by common supranational organisations (Schmidt, 2005), has led to the construction of the Oresund bridge. Moreover, the work done in the Copenhagen-Malmö area to promote cross-border cooperation has been acknowledged with the Sails of Papenburg cross-border award by the Association of European Border Regions (<http://www.aebr.eu>). Contrarily, in Helsinki-Tallinn there are no significant symbols of co-planning and the cross-border twin city has not been rewarded with the Sails of Papenburg cross-border awards. Therefore, Copenhagen-Malmö is performing better in the dimension of *governance and planning* and receives a higher score compared to Helsinki-Tallinn. Earlier studies on Helsinki-Tallinn have also identified a lack of cross-border cooperation and joint strategies by concluding that “despite deepening functional and socioeconomic ties between Tallinn and Helsinki, territorial governance of cross-border remains on project level” [Roose and Lepik, (2015), p.310] and that “there are parallel similar innovation strategies on national and local level with no joint cross-border elements; hence the other side (*of the border*) is neglected” [Lepik and Krigul, (2014), p.341].

However, when it comes to *support and partnership*, the organisations in Helsinki and Tallinn are performing better than in Copenhagen-Malmö. The participation of Estonian organisations from Tallinn in collaborative EU funded programs had already begun prior to their attaining EU membership in 2004, which demonstrates their focus and success in partnering-up across the border. That is, the share and the absolute number of cross-border R&D projects funded by the EU were larger in Helsinki-Tallinn than in Copenhagen-Malmö. Whereas there is significant year-to-year variation in the number of ongoing collaborative R&D projects in the Oresund region, as is also evidenced by earlier

studies (Makkonen, 2016), it seems that, in this dimension, Helsinki-Tallinn has been a steadily good performer through the time period covered here.

5 Conclusions

This paper provides an empirical investigation into the existence of and potential for shared KBUD processes in a cross-border regional context and an analytical framework in which to study these processes. By combining features from the established KBUD and CBRIS models, the framework suggests four dimensions of KBUD including: economic, socio-cultural, enviro-urban and institutional development. These dimensions were measured by a set of indicators (such as cross-border commuters and traffic, co-patents, co-publications and the number of collaborative R&D projects) drawn from the CBRIS literature. In this way one can derive snapshots and conduct benchmarking exercises of KBUD processes in various cross-border contexts. Here the framework was tested with two cases of cross-border twin cities – namely Helsinki-Tallinn and Copenhagen-Malmö – to justify the feasibility of the proposed framework.

The empirical parts of this paper show that the framework can indeed be applied in the case of cross-border twin cities. The results paint a complex picture of varying performances in the different dimensions of KBUD based on the CBRIS integration measures. Overall, the two cross-border twin cities perform almost equally well, but the varying results in individual measures can identify the dimensions which are in need of improvement and further development. For example, Helsinki-Tallinn could focus on improving its performance in the dimension (sub-category) of knowledge economy foundations by adopting the working methods of the Oresund Committee and the Medicon Valley Alliance that have (at least partially) raised the numbers of cross-border patents to an exceptionally high level in Copenhagen-Malmö. Cross-border regions in general and cross-border twin cities in particular should learn how to perform better and improve their policy outcomes from each other. Therefore, other cross-border twin cities could potentially benefit from applying the framework introduced here via benchmarking (and subsequently by drawing policy guidelines based on this benchmarking exercise) their performance against the two well-known examples of cross-border cooperation presented here.

The chosen approach naturally contains several limitations to be further developed and tested in subsequent studies. Firstly, the empirical material depicted here is rather static and offers only a snapshot of the situation that pertains to the time of the data collection. The availability and collection of time series data would allow researchers to draw more definite conclusions on the performance of cross-border twin cities in the various dimensions of KBUD. This would also better guide the work of policy-makers in drawing development strategies to promote cross-border cooperation. Secondly, the data presented here is limited, stemming from the focus on only two cases of cross-border twin cities. Collecting data from other cross-border twin cities and subsequently benchmarking this data against the (leading) example cases presented here would improve our understanding of the contemporary KBUD processes of border regions. As stated above, this would be extremely helpful for policy-makers within individual border cities – it would help them to identify the dimensions of KBUD, where they have the biggest need and the most potential for further development. Lastly, the proposed analytical framework is still a quite simple one. This naturally has advantages (i.e., the

framework utilised and the analyses conducted here are easily adaptable and repeatable in other cross-border twin cities) but also limitations (i.e., the results remain rather descriptive). Therefore, further work is needed in order to develop the framework by suggesting additional or alternative metrics to measure cross-border KBUD processes. These can include similar studies with a wider geographical scope, including a large number of cross-border twin cities at different stages of their integration process. Such studies could also compare the CBRIS and KBUD processes between cross-border twin cities and more rural and less developed cross-border regions.

Acknowledgements

This work was supported by the Marie Curie Actions (Intra-European Fellowship for career development) within the seventh framework program (FP7) of the EU under Grant PIEF-GA-2013-624930.

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Notes

- 1 Additionally, tourism flows are an important facilitator of cross-border knowledge transfer (Weidenfeld, 2013).
- 2 Governance and planning = [city twinning strategies + symbols of co-planning (e.g., the Oresund bridge) + recognition of cross-border work (by sails of Papenburg cross-border award) + common formal institutions driving cross-border cooperation + history and age of formalised cross-border cooperation].
- 3 *Cooperation Across the Sea – The Helsinki-Tallinn Example* [online] <https://ec.europa.eu/eures/main.jsp?lang=en&level=0&parentId=2...&myCatId=9188&showRegion=false&catId=9188&myTitle=Nyheter&chatRoom=enter>.
- 4 Particularly, the facts and figures (provided by Dr Ulla Tapaninen) on the transport flows between Helsinki and Tallinn.

