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Bachelor Thesis
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Mega-event heritage revitalization's effect on tourist flows: A density-based clustering analysis of the 2008 European Capital of Culture's effect on Albert Docks Conservation Area, Liverpool.

Abstract: Cities hosting megaevents often aim to reinvent their image and attract tourists by developing cultural offerings and creating a brand around the city's cultural heritage. Targeted investments in key areas can lead to revitalization on a city-wide scale. This paper studies how Liverpool's 2008 European Capital of Culture development influenced tourism within the Albert Docks Conservation Area, using geotagged photos available from Flickr between the years 2006-2018 to proxy tourist movement patterns. The researcher used a density-based clustering method to reveal likely tourist hotspots in the area. The paper attempts to link these hotspots to Liverpool's cultural tourism goals related to the event. Based on the findings, it can be concluded that elements of Liverpool's tourism efforts in the Albert Docks Conservation Area succeeded post-2008, and that cultural offerings in the area were popular among tourists.

Keywords: *European capital of culture, Liverpool 2008, cultural tourism, Flickr, spatio-temporal movement patterns, megaevents, density-based clustering, HDBSCAN*

1. Introduction

1.1 Background

The European Capital of Culture (ECoC) is an honorary program run by the European Commission that highlights multiple European cities each year with the simultaneous objectives of raising the city's international profile, expanding and promoting its cultural offerings, bolstering the city's sense of place and self image, and attracting visitors (Palmer, 2004, p14). Palmer (2004), Bıçakçı (2012) and García & Cox (2013) discuss efforts by ECoC's to theme their place branding to cultivate a revitalized image for visitors. A common motif in a city's ECoC branding is the city's cultural highlights (Bıçakçı, 2012). Cities tend to develop urban areas around their heritage (Lähdesmäki, 2014) and according to Sanetra-Szeliga (2014), cities vying to become a ECoC tend to revitalize urban space to serve cultural activities and projects. A key goal of ECoC planners is to generate interest in revitalized cultural heritage areas in their cities. Balsas (2004) goes as far as comparing it to an "urban propaganda project mainly designed to channel public investments and market the city" (p397). According to Griffiths (2006), formerly industrial cities like Antwerp and Lille have used the ECoC year to implement revitalization but it is difficult to generate sustained cultural capital in "2nd-tier" European cities, especially former industrial centers.

Mega-events such as sports competitions, cultural celebrations, or other similar occasions can have a positive effect on urban tourism marketing (Ashworth, 2009). While mega-events are traditionally not seen as cultural (Jones, 2020), and receiving UNESCO World Heritage Site (WHS) status is not perceived as a traditional mega-event, it might as well be a mega-event for the tourism benefits it bestows on a site (Gonzalez Santa Cruz & López-Guzmán, 2017). It is largely accepted that WHS status has a positive effect on a tourist site's visitation numbers (Canale et al., 2019). In a world full of place marketing campaigns, transcendent designations and events can help a destination stand out. There is broad consensus on the importance of major cultural honorifics in shaping place marketing to attract tourists.

Tourist flows and movement patterns can be analyzed using geotagged photos from Flickr (Timothy, 2018). This is an established line of research to study tourism movement patterns (Popescu and Grefenstette, 2009; Onder et. al., 2014; Höpken et al., 2020, among others) and should work as a proxy to gauge the success of tourist flows during an ECoC. The framework set up by Kádár & Gede (2013) and Höpken et al. (2020) supports the quantitative analysis of tourist flows in a certain area over a period of time. This is in an overall effort to examine the effect on where tourists congregate as a result of cultural destination marketing, using Liverpool 2008 as a case study.

In 2003, Liverpool was selected as a 2008 ECoC. In the decades leading up to the ECoC effort, Liverpool's reputation was that of "urban blight and ...social deprivation" (Jones & Wilks-Heeg, 2004, p343-44). From the 1970s through the 1990s, Liverpool was the UK's poster child for unsuccessful urban regeneration schemes, but in the late 1990s there was a shift towards approaching culture as a vehicle for urban regeneration (Jones & Wilks-Heeg, 2004). Amid a multitude of projects focused on the built environment, planners targeted the nomination of 2008's ECoC as an effort to celebrate and highlight the work already underway, and to catalyze further development. Liverpool aimed for urban renewal in neighborhoods and the city center through investing in current and future infrastructure and cultural offerings in order to create a "sustainable, inclusive, dynamic premier European city" (Sadiq et al., 2003, p6). Liverpool attracted more than £4 billion in private investments for urban revitalization

along the waterfront, renovations to cultural buildings such as theaters and concert halls, and a huge amount of varied projects intended to incubate and innovate Liverpool's cultural scene (Sadiq et al., 2003; García, 2008). The Albert Docks Conservation Area (ADCA) received substantial development funding.

Liverpool's image had been historically tied to its maritime culture, musical tradition, and successful association football team (Milne, 2011; Jones & Wilks-Heeg, 2004). These aspects featured heavily in key planned ECoC events including concerts by Ringo Starr and Paul McCartney, a music festival, a tall ships race, and a play about Liverpool FC's legendary manager Bill Shankly, images of which can be seen in Figure 1 (Liverpool Culture Company, 2009). The cultural celebration also reflected Liverpool's contemporary culture, including local artistic events and funding for youth culture programs, city-wide sculpture events, and performance art, notably a giant mechanical spider (Liverpool Culture Company, 2009).



Figure 1. Elements of ECoC 2008 cultural programming. Top left: The Shankly Show. Top right: Go Superlambananas. Bottom left: The Tall Ships Races. Bottom Right: La Machine. (Self, Source: Culture Liverpool, N.d.)

Sadiq et al. (2003) analyzed the bid from the perspective that capitalizing on a city's unique culture (p1) provides a springboard for "increased urban quality of life" (p2) and is essential to attract members of with human capital which can have an exponential effect on economic growth. They found these goals, and Liverpool's methodology, to be largely positive for the city, but recommended careful data monitoring in the years before and after the event on all indicators (Sadiq et al., 2003).

After winning the nomination, there was a wave of local and national enthusiasm for the event's expected revitalizing effect (Jones & Wilks-Heeg, 2004). Jones & Wilks-Heeg (2004) demonstrate that there was a dichotomy between expectations for the event, stating that ECoC event planners were citing a 19 million increase in annual tourists whereas Sadiq et al.'s (2003, p29) economic impact assessment predicted a modest increase in tourist arrivals from 6.7 million in 2000 to 9.3 million in 2008. This lack of coherence in such a key performance indicator, especially when the necessity for clarity was stressed (Sadiq et al., 2003; García, 2008), obligates further detailed research into the event's effect on tourist flows.

The lack of clarity in tourism predictions shown by Jones & Wilks-Heeg (2004) combined with the ECoC year's importance to the city's overall tourism plan necessitates this study. García (2008, pg4,7) further motivates this study's topic and methodology by studying "Impact of 08 on visitor numbers" as an indicator in an ex-post analysis and advocating for studying statistics to understand citywide trends. As will be discussed in Section 3.1.2, Liverpool has embraced cultural tourism (VisitLiverpool, 2011; Liverpool LEC, 2014), continuing on from their ECoC event. Analyzing tourist movement patterns within a relevant area of Liverpool before, during, and after their ECoC event will give more insight into the success of Liverpool's investment into the built environment to attract cultural tourists. As a major global force, short and long-term tourism is a primary target for ECoCs and successful methods of attracting tourists to certain areas in a city are prized. Adopting the contemporary practice of analyzing geotagged photos found on social media allows for the most accurate study of tourists movement patterns within set geospatial boundaries. Studying an area highlighted by ECoC administrators as key to their city's new image can show their marketing's efficacy to increasing tourist flows to those locations.

1.2 Research problem

The central question is as follows:

What was the spatiotemporal effect on tourist flows to and within the Albert Docks Conservation Area (ADCA), Liverpool related to the 2008 European Capital of Culture compared to surrounding years?

- 1. How do the points of interest (POIs) generated match Liverpool's approach to capitalizing on the ECoC event to generate sustained cultural tourism?*

This study examines heritage as a motivating factor to tourists and how cities capitalize on this phenomenon. Subquestion 1 will compare the data-driven findings with the literature analysis. POIs for the area's tourism strategy will be generated by combining the results of the data analysis and publications by UNESCO (2003), VisitLiverpool (2009), and Liverpool LEP (2014) detailing the area's use. A numerical perspective to tourist flows in the areas studied during the years surrounding ECoC 2008 will provide a clearer picture of the effect of a cultural approach to place-branding on tourism.

2. Theoretical framework: Cultural tourism and the ECoC

Place branding is "discovering or creating some uniqueness, which differentiates one place from others in order to gain a competitive brand value", and it is performed as advertising; to attract people to that location (Ashworth, 2009, p9). Place branding to attract tourists can be referred to as tourism marketing. The UNWTO (2018, p22) found that heritage and culture plays a consequential role in tourism marketing and that this trend is expected to keep growing. Graham (2002, p1004) conceptualizes heritage as "the contemporary use of the past," and states heritage can be both an economic and socio-political tool for tourism, placing it as the "most important single resource for international tourism" (p1007). According to Kavaratzis (2004) and Bıçakçı (2012), cities are likely to use their culture and heritage to market themselves to tourists.

Being named an ECoC is a coup for a city's cultural tourism efforts. ECoCs often promote certain sites, often run-down areas, recently revitalized for cultural purposes (Balsas, 2004). Lähdesmäki (2014, p2) states that ECoCs tend to focus their energies on revitalization of rundown urban areas, creating new cultural hubs. Palmer (2004, p75) found that most ECoCs invested in restoring heritage buildings and creating new cultural spaces, often in "carefully considered locations." Such significant investments improve residents' quality of life, but a primary driving force of these projects is to portray an image of revitalization through culture. Lähdesmäki (2014, p2) stresses the close relationship between these revitalized spaces and the discourse surrounding the ECoC. Tucker (2008) discusses Glasgow (1990 ECoC), the first post-industrial city to use the ECoC as part of their larger cultural revitalization process. Glasgow invested in the built environment and intangible cultural programs in the years prior, consistently marketed themselves as a revitalized cultural city, and used their ECoC event to push this message into the common discourse (Tucker, 2008). Palmer (2004, p126) states that the intended recipient of ECoC city's rebranding is tourists, due to their economic importance for cities. Gunay's interview-based study (2010) suggests that Istanbul's primary motivation for investing in cultural revitalization was to highlight these attempts to attract tourists. Cities promote important areas to draw attention towards them (Ashworth, 2009). Cities use iconic locations to differentiate themselves in the tourism marketplace. Daramola-Martin (2009) and Uysal (2015) state that ECoC cities use flagship developments, specifically cultural revitalization of industrial areas, to reposition themselves higher in the cultural tourism landscape.

There is a positive spatial effect on tourism flows to destinations that contain and advertise major attractions (Yang & Wong, 2012). Their national scale study found that containing a WHS had by far the biggest influence on inbound tourism to Western Chinese cities when compared with other likely variables (Yang & Wong, 2012). As WHS status can be seen as a form of cultural tourism marketing, this speaks to cultural tourism branding's effect on guiding tourism movement, albeit on a national scale. On the city scale, Garau (2017) posits that awareness (caused by marketing) of an area's significance draws tourists. However, there is a gap in the literature regarding the effect of tourism marketing on behavior on an individual scale.

Logically, a key performance indicator for ECoC cities is the number of visitors the city receives as a result of their ECoC event: does the event increase tourism in the suggested areas? Palmer (2004, p108) states there is a gap in the literature regarding studying tourist flows in ECoC cities and mentions it is a topic for further study. García & Cox (2013, p135) present a range of studies into the effect of ECoCs on tourist numbers in past cities, summarizing that there is a pronounced positive effect in the short-term. Griffiths (2006) points to many examples of ECoC cities being unable to maintain their increased tourism levels in the years following. However, successful ECoC cities build on ECoC efforts to create long-term tourism growth (García & Cox, 2013). These cities experience a short-term decline in tourism like all ECoCs, but end up having a sustained growth that is sometimes greater than their ECoC year (García & Cox, 2013, p135).

3. Case Information

3.1 Liverpool 2008 ECoC areas of focus

Liverpool's 2008 ECoC year demonstrated many characteristics outlined by Balsas (2004), García & Cox (2013), and Lähdesmäki (2014) for successful ECoC events. For this

research, the focus will be on their cultural tourism initiatives including development and promotion of certain spaces in the city, following Uysal (2015), as well as the transition in their tourism planning from ECoC to sustainable growth.

3.1.1 Liverpool's waterfront revitalization projects

The theme of built heritage playing a leading role in cultural tourism efforts and ECoC events is displayed in Liverpool's ECoC and tourism planning. García (2008, p3) prominently positioned historical buildings and heritage in a diagram of Liverpool's cultural system. The literature makes consistent reference to investments in the cultural built heritage through adaptive reuse of historic buildings, neighborhood revitalization projects, and creation of new cultural touchstones for the city (Sadiq et al, 2003; Liverpool Culture Company, 2009; Liu, 2019). Figure 2b shows the location of projects that were particularly prominent in the literature. There is a clustering of projects along the waterfront area. Milne (2011) and Balderstone et al. (2014) find that the waterfront is foundational to Liverpool's culture and identity, and Liverpool's tourism board agrees, pressing the importance of "reinforc[ing] the iconic status of the City Region's waterfront" (VisitLiverpool, 2011, p13). According to Griffiths (2006), Liverpool's maritime industrial culture was a key facet in their distinction from other applicants for the 2008 ECoC award. Combined with Kostopoulou's theory (2013), that mixed-use urban development projects in historic waterfronts lead to increases in tourism, studying development near Liverpool's waterfront is a logical conclusion.

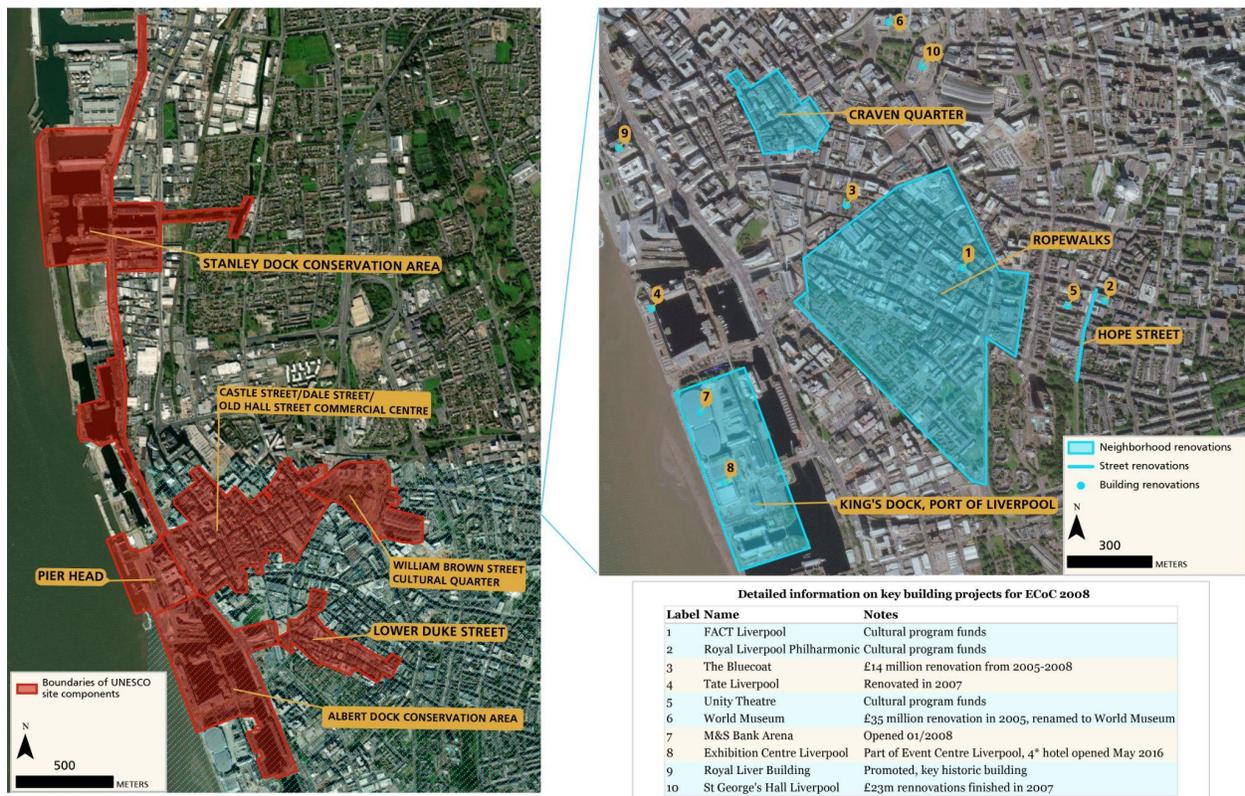


Figure 2a, left. Component areas in Liverpool's UNESCO WHS. Source: (Self, abridged from Sykes and Ludwig, 2015)

Figure 2b, right. ECoC 2008 projects prominent in literature. Source: (Self, abridged data from Sadiq et al, 2003; Jones & Wilks-Heeg, 2004; Liverpool Culture Company, 2009; VisitLiverpool, 2011; Liu, 2019)

Major development projects located near the waterfront include the Exhibition Arena, and renovating Kings Dock, the Albert Docks, and the Tate Liverpool. The Exhibition Arena was a set of 3 buildings, an arena and a conference center opened in 2008, and an exhibition center opened later along the Kings Dock waterfront area (ACC Liverpool, 2021). These buildings are important to Liverpool's goal of encouraging conference tourism (Liverpool LEP, 2014). Kings Dock was formerly a derelict dock used as a carpark, that was turned into a "mixed-use development that offers office, retail, leisure, community and open space uses...opening in 2008" (Maliene et al., 2012, p7). The development of Kings Dock and the construction of the centers happened in tandem to mutually benefit from each others' presence (Sadiq et al., 2003). The Albert Docks are warehouses of historic significance that were developed to support retail and leisure, business, and residential functions (Purwantiasning et al., 2014). Liverpool ONE, a massive shopping and entertainment complex, was constructed between the city proper and the waterfront (Shaw et. al., 2008). The surrounding area also houses the Merseyside Maritime Museum/International Slavery Museum, the Museum of Liverpool, The Beatles Story and Tate Liverpool, all major attractions in Liverpool. Tate Liverpool was renovated as part of the buildup to ECoC 2008, and all major museums were allocated extra funds to prepare world class expositions (Liverpool Culture Company, 2009, p8). Liu (2019, p8) found that these developments were incentivized by the ECoC event.

Section 2.1 laid out the importance of cultural branding to attract tourists and the importance of the UNESCO WHS designation to an attraction's place branding strategy. In 2003, Liverpool applied for WHS status for its waterfront on the basis of its historical port's importance to the British Empire and the unique built environment contained within (UNESCO, 2003). Sadiq et al. (2003) mention the pending nomination as part of the overall plan for Liverpool's cultural marketing, and the VisitLiverpool (2011) and Liverpool LEP (2014) plans both place heavy emphasis on the WHS.

When comparing the ECoC developments and the WHS boundaries, the ADCA, detailed in Figure 3, is most relevant for the purpose of this study. Significant development projects were undertaken here in the run-up to ECoC 2008, including extensive wayfinding and signposting (IS-Group, 2018). Its central location in the waterfront and key attractions, along with proximity to the Exhibition Arena, speak to its relevance in studying tourist flows resulting from ECoC 2008's cultural tourism push. Sadiq et al.'s (2003, p27) expectation that "with the iconic nature of some of the projects involved, additional visits beyond those expected as part of the normal growth rate can be expected" and Kostopoulou's (2013) findings regarding the success of heritage-based tourism around revitalized waterfronts reinforce the selection of the Albert Docks for this study.

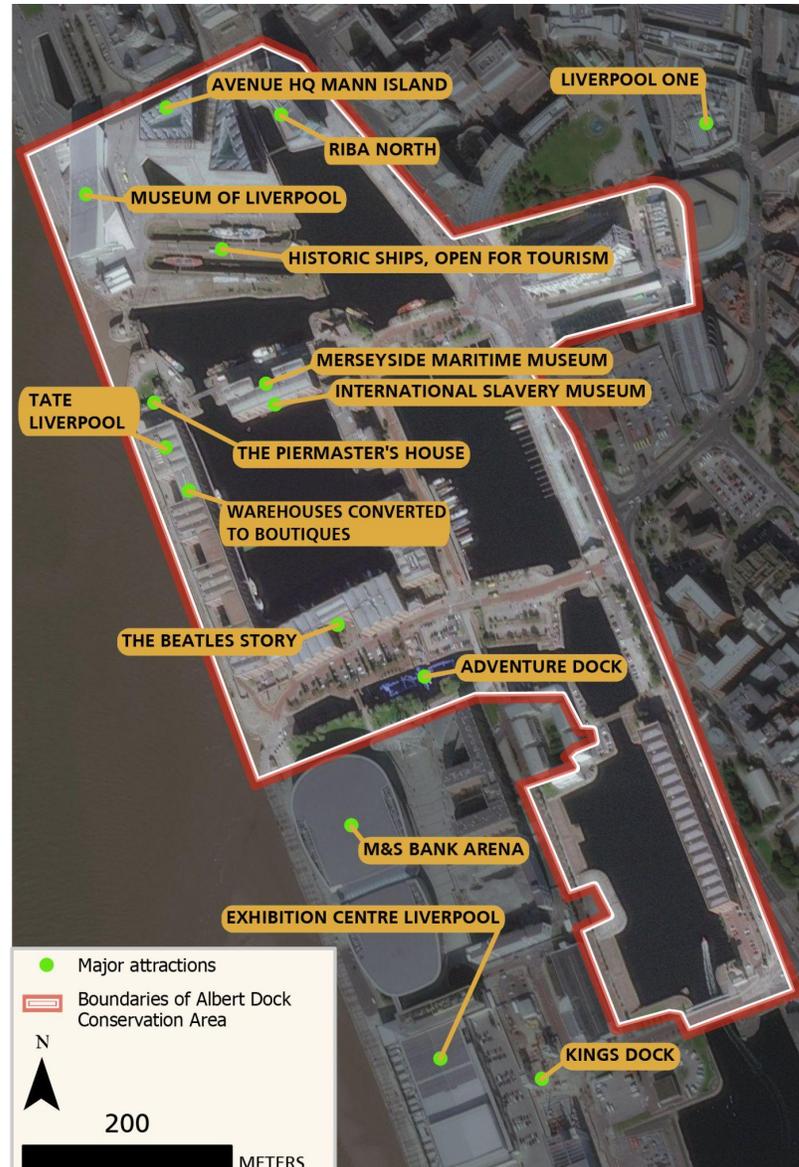


Figure 3. Major attractions in ADCA. Source: (Self, abridged data from Liverpool Culture Company, 2009; VisitLiverpool, 2011; Purwantiasning et al., 2014)

3.1.2 Existing indicators of success for Liverpool's cultural tourism

Sadiq et al. (2003, p29) predicted that inbound tourism to Liverpool would peak in 2008 and would have an annual decline in the years following. As expected, Liverpool tourism increased 26% from 23.3 million tourists in 2007, to 31.7 million tourists in 2008, and experienced a decline of 22% to 25.9 million in 2009 (Liverpool LEP, 2015, p10). Subsequent years however revealed a consistent year-on-year rise in tourist arrivals in Liverpool, with the highs of 2008 eclipsed by 2016 (32.2 million) and far overtaken by 2018 (35.3 million) (Liverpool LEP, 2015; 2018; 2019). Liverpool experienced the expected dropoff in tourists in the immediate years after 2008, but accounting the entire dropoff to “the year after” does not take into account the effect of financial crises on tourism, which Smeral (2010) found could account for an 8% to 10% reduction in global tourism in 2009. Additionally, Liverpool's data shows a

clear picture of growth sustained on a longer timeframe afterwards, supporting from a tourism perspective, the consensus of ECoC 2008's success (García & Cox, 2013).

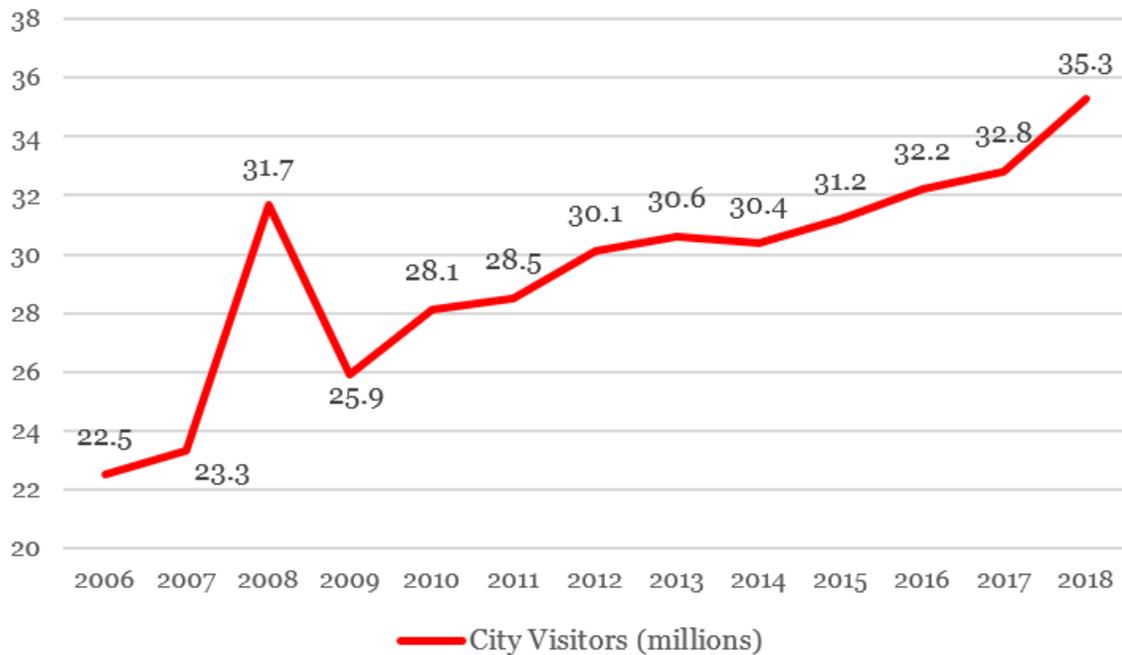


Figure 4. Year-on-year visitation, Liverpool. (Source: Self, abridged data from Liverpool LEP, 2014-19)

When focusing on likely tourism hotspots within Liverpool, the Liverpool Culture Company's information center saw a 150% increase in visitors from 2007 to 2008 (Liverpool Culture Company, 2009). If this statistic was applicable to a wider city, this would have meant an increase to 58.3 million tourists in the city, far overreaching even the wildest predictions. Obviously the real statistic was lower, but this information is relevant to this research because it shows that the percent increase in a key location for tourists (a tourist information center) might be higher than the overall city's percent increase in tourism. Visit Britain (2010) and ALVA (2006-2009) have statistics for some key attractions in Liverpool, displayed in Figure 5. Certain locations had a higher percent increase year-on-year in tourism (Mersey Maritime Museum 71%, Tate Liverpool 66%) when compared to the overall city.

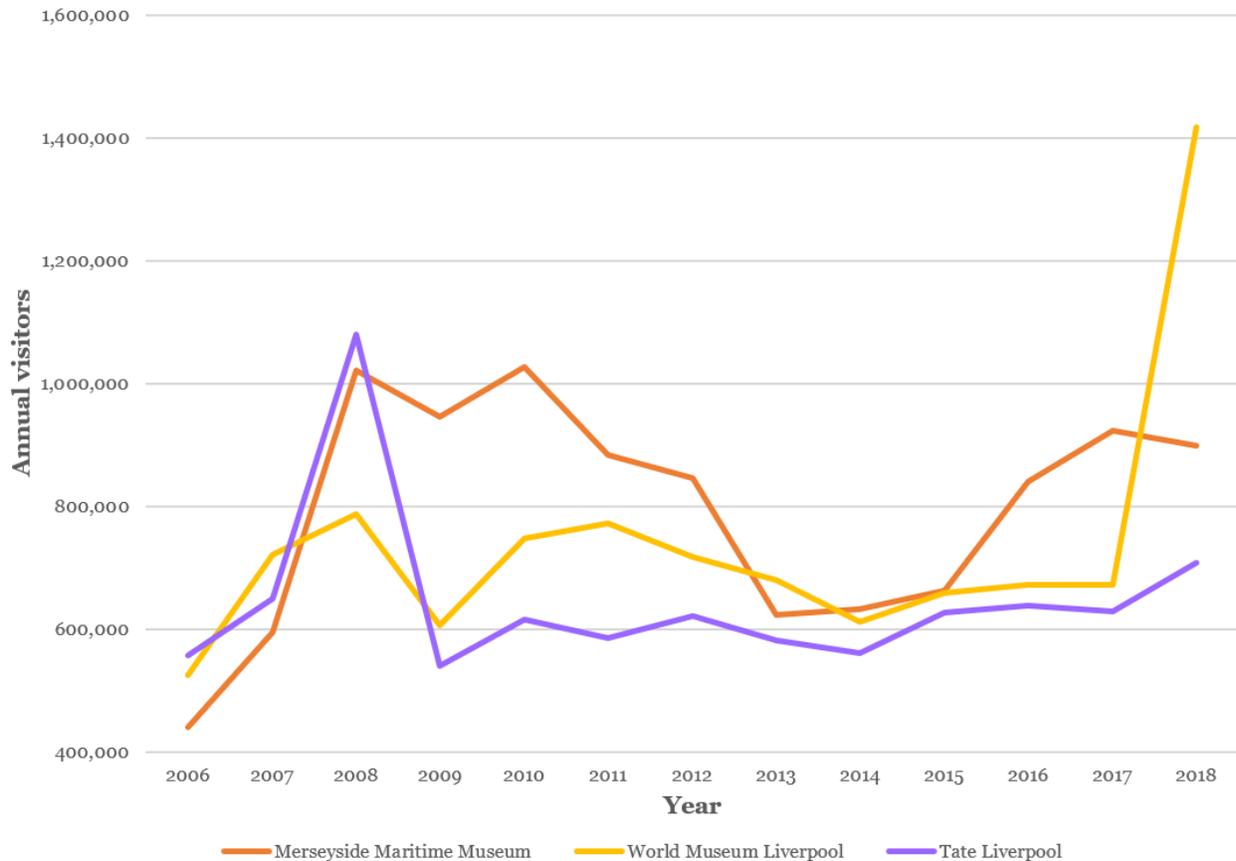


Figure 5. Year-on-year visitation, key attractions in Liverpool.
 (Source: Self, abridged data from ALVA, 2006-2018; VisitBritain, 2010)

This far exceeds pre-event predictions, pointing to the overall success of the event from a tourism perspective (Liverpool LEP, 2014; Liu, 2019). From a planning perspective, Liu (2019) believes that the 2008 event’s legacy was continued by planners and that the “20 years of continuous regeneration and investment in its cultural economy and urban infrastructure” (p10) was even more important than the flagship event. This theme can also arguably be applied to Liverpool’s continued tourism success. The 10 year plans for visitor management created by VisitLiverpool (2011) and Liverpool LEP (2014) contain details of how the city approached cultural tourism in the wake of ECoC 2008. The 2011 plan states that “Liverpool is renowned for its diverse and distinctive culture, for its iconic waterfront and World Heritage Site... [its cosmopolitan and festive spirit...industrial heritage... and public artworks]” (VisitLiverpool, p5). The plan places an emphasis on pressing the progress in the city’s image and economic, social and urban development through continued investment in cultural infrastructure, built and intangible (VisitLiverpool, 2011, p13). One of the two pillars of Liverpool’s place branding was “Culture and heritage” (VisitLiverpool, 2011, p16). Liverpool LEC’s (2014) plan takes a broader outlook on regional tourism, but again stresses the importance of culture and heritage tourists to their vision of Liverpool’s tourism industry. Since ECoC 2008, Liverpool has used culture as a foundational aspect of their overall tourism strategy. Liverpool stresses the importance of certain cultural locations to the city’s image. Analyzing footfalls in the ADCA will generate a more detailed understanding of Liverpool’s success in promoting this key cultural offering.

3.2 Hypotheses

Liverpool has a stated interest in encouraging cultural tourism (VisitLiverpool, 2009; Liverpool LEP, 2014). Their tourism statistics indicate similar growth patterns as other successful ECoCs (García & Cox, 2013, p137). Based on the theoretical framework and background research, the hypothesis for each research question is as follows:

What was the spatiotemporal effect on tourist flows to and within the Albert Docks Conservation Area (ADCA), Liverpool related to the 2008 European Capital of Culture compared to surrounding years?

The area, and POIs within, will experience an increase in rate of tourists during the 2008 ECoC year, followed by a decrease in rate of tourists in 2009, followed by stop-start growth in the decade following. Based on Figure 4, it could be expected that the years 2011-2014 exhibit slow or negative growth. The growth rates could be expected to be greater than the growth rates for the city as a whole.

How do the POIs generated match Liverpool's approach to capitalizing on the ECoC event to generate sustained cultural tourism?

POIs are expected to be key locations within the area, such as museums. The POIs within the area will be expected to have greater rates of change each year than the Albert Docks Conservation Area as a whole, and the baseline of Liverpool, as they can be seen as tourist focal points.

4. Methodology

Innovation in quantitative methods of tracking tourist flows have led to a better understanding of how to manage tourists. Manual tracking methods, GPS/phone tracking, interviews and other such methods have various downsides, from cost to user discomfort (Toha & Ismail, 2015). An emerging method is analyzing metadata from geotagged photos, uploaded by tourists. Urry (1990, p138) makes the case that the advent of photography created a new norm for tourists, where taking photos becomes part of consuming a destination. This is to the point where "People feel that they must not miss seeing particular scenes since otherwise the photo-opportunities will be missed" and that "much tourism becomes in effect a search for the photogenic" (Urry, 1990, p139). Kádár and Gede (2013, p80) writing about Nov and Ye's 2010 study said that "those who uploaded photos to [Flickr] were more motivated travellers according to the surveys, with a stronger desire to discover places, and they were also more frequent travellers, taking regular vacations abroad".

According to Popescu and Grefenstette (2009), is it possible to use metadata from Flickr photos selected for their geotag location (within certain boundaries) to study tourist movement patterns in cities. Wu et. al. (2018) used geotagged social media data to study tourism networks in Beijing, find common itineraries, and propose public transport modifications in light of their findings. Lee and Tsou (2018) used geotags to analyze tourist hotspots at Grand Canyon National Park. Onder et. al. (2014) used this methodology on a regional level, to study where tourists go in Austria. Timothy (2018, p3) states social media analysis and technological data

collection to track tourist movements is emerging specifically within the field of heritage tourism studies. Analyzing open sourced geotagged photos uploaded to Flickr is one of the most accurate methods to gain insight into tourist movement patterns.

4.1 Data collection

The researcher will use Flickr's API to download the EXIF tags of all Flickr photos with geotags within the spatial boundaries of the ADCA between 2006-01-01 00:00 and 2018-12-31 24:00 (dates with data from the city), using the methodology of Kádár (2014) and Höpken et al. (2020). Once downloaded, each data will be cleaned to only include the metadata (Ardizzone et al., 2012). This metadata will consist of owner, date taken, date uploaded, latitude and longitude, title, url, and viewcount drawing on Spyrou et al.'s (2015) methodology. Kádár & Gede (2013) filter tourist users from local users by designating Flickr users who have only uploaded images within a set period of time (5 days in their case) as tourists, and the rest as locals. This study finds that ECoC planners, including Liverpool's, focus on local engagement as well as tourists (García & Cox, 2013; Liverpool Culture Company, 2009), so this step is not necessary. If the user did not provide the date taken when uploading the photo, Flickr will set the date taken equal to the date uploaded, so if $dt=du$, that photo will be removed from the dataset (Höpken et al., 2020, p73). This is in effort to remove photos from the dataset with unreliable metadata.

4.2 Data analysis

DBSCAN is a density-based clustering method to “identify clusters of arbitrary shapes... and filter out noise” (Höpken et al., 2020, p74-75). DBSCAN can be used with geospatial point data, and there is a growing body of work regarding its applicability in analyzing open sourced geotagged photos to study tourism movement patterns (Hu et al., 2015; Höpken et al., 2020). HDBSCAN builds on DBSCAN by using the data to cluster more judiciously based on varying densities throughout the dataset (ESRI, N.d.) and Ibrahim (2020) finds it superior to DBSCAN in a similar research setting. HDBSCAN is the most nuanced clustering method for this type of dataset, exhibited in the bottom-right panel of Figure 6. There is a third clustering method, k-means, but there are issues associated with it that make it unsuitable for this study. More discussion into k-means' and DBSCAN's limitations comes later.

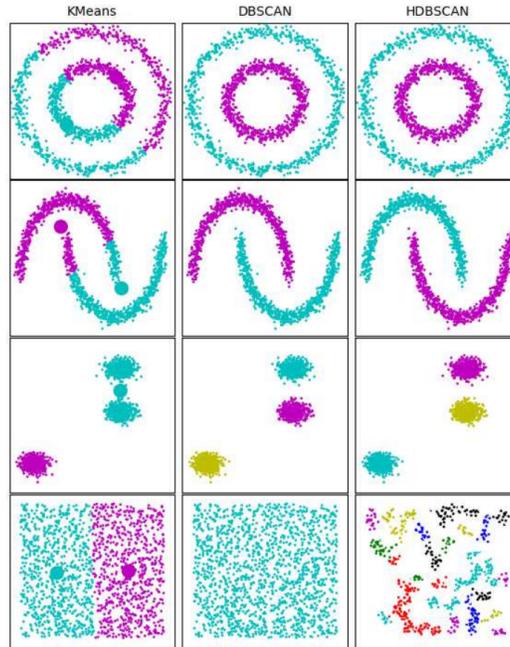


Figure 6. Comparison of K-means, DBSCAN and HDBSCAN (Source: Ibrahim, 2020, p. 34)

Applying the methodology laid out by Höpken et al. (2020) and Ibrahim (2020) to this dataset will generate a clear picture of clusters within photos geotagged to locations within the ADCA for 2006-2019. An initial overview of all photos in the dataset will allow for general patterns to emerge and for calculating the rate of annual change for the study area. An HDBSCAN method will then be used to create clusters and eliminate noise, or photos that do not fit in a cluster. The clusters will be manually identified, using information about their location and the given photo titles, and grouped with other clusters if appropriate. The hypothesized identifications will be cross referenced with the literature on developments in the area and Liverpool’s tourism planning related to cultural tourism and the ECoC. A polygon representing the area of each cluster will be generated to enable inter-year comparison of key POIs within the study zone. A year-by-year analysis will follow, with all photos including those previously considered noise, to search for wider inter-year patterns. Major inter-year changes will be analyzed to get a quantifiable understanding of Liverpool’s ECoC success, as it relates to cultural tourism initiatives. Table 1 describes the data analysis procedure.

Table 1. Conceptual model of GIS analysis

Step	Operation	Result
1	Created points from latitude and longitude from geotag representing each photo’s location.	Dataset with point for each photo
2	Clipped dataset to include only points within ADCA	Dataset with point for each photo (removed misc. photos in water etc)

3	Visualized all points as point-density heatmap	Figure 9b
4	Created clusters to represent POIs using an HDBSCAN clustering method	Figure 10
5	Created polygons representing key POIs, including mapping all signposting/wayfinding	Figures 11, 12
6	Generated point-density heatmaps for each year in study and year groupings, identified possible explanations for hotspots	Figures 13, 14
7	Identified number of photos within each key POI polygon per year	Figure 15, Table 3

The expectations for analyzing clusters in the dataset is that clusters will form in the vicinity of important tourist attractions in the area. Tourists are more likely to congregate in these locations, take photos and ultimately upload these photos to share their experience. Sizeable clusters that can be linked to ECoC developments would support their effectiveness in attracting tourism activity. Any discrepancies can be cross referenced with conditions regarding that POI. An example of this could be if a museum underwent construction during this time period, as the Museum of Liverpool did for two months in 2017. The annual rates of change of the ADCA, and the major POIs within, can be compared to the growth rates of major attractions, and the city itself (Figures 4 and 5).

4.3 Conceptual model

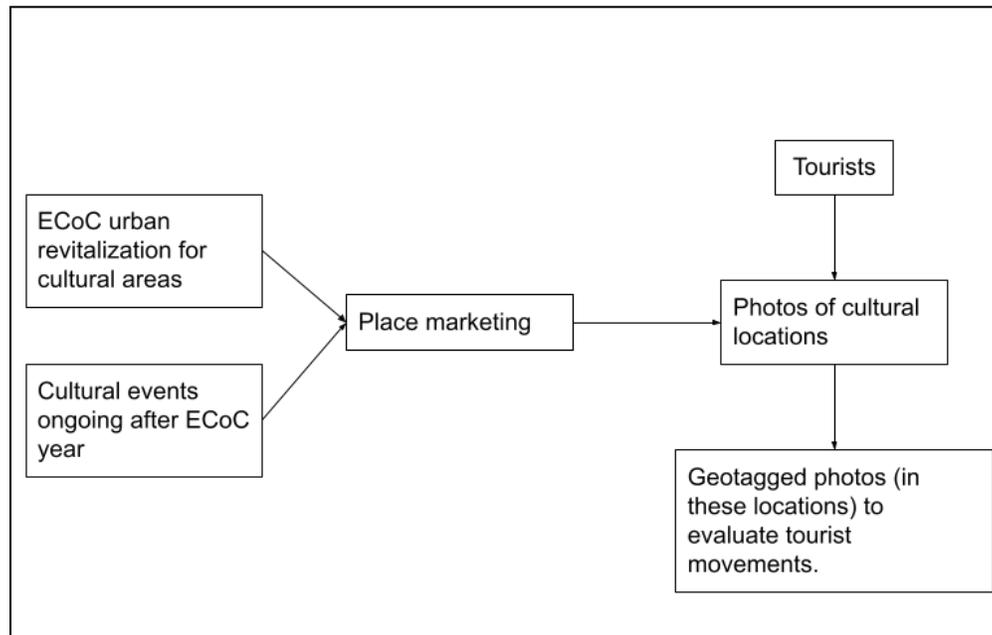


Figure 7. Conceptual model of research project.

This model attempts to distill the analysis in visual form, as it relates to the theory behind the choice of subject matter and the choice of methodology.

4.4 Ethics Discussion

This study focuses on the numerical effect of the ECoC event on tourism and takes the view on tourism as a positive economic force. Flickr photos used in the study are freely available to study, as the photographers have made them open to the public. There is a growing view of overtourism as a destructive force due to reduction in local quality of life that is not included in the scope of this study. This study also does not focus on the potential negative effects of the ECoC on cities, namely gentrification and paying lip service to social programs without implementing systematic change (Jones & Wilks-Heeg, 2004). Jones & Wilks-Heeg (2004, p347) show that prior to the ECoC there were citizen concerns that the planners would propel further gentrification of the inner city using tired tropes with little to no support for grassroots cultural practitioners. Figure 2b shows that a lot of the major investments in the built infrastructure were in the city center - to be expected, but hints at this city-center-first approach, hoping for spillover effects to less-prominent areas. Despite the substantial investment in the urban environment, Maliene (2012, p6) writing four years after the event, found that significant brownfield areas still existed near the most vulnerable populations in the city.

According to Bandarin & van Oers (2012) and Mieg et al. (2020), development in industrial World Heritage Sites can create conflict over development versus conservation. Perhaps contradicting the claim that “WHS status for Liverpool will be a key means of ensuring an appropriate and equitable balance between conservation, sustainability and development” (UNESCO, 2003, p223), Sykes & Ludwig (2015) present plans for a massive investment worth over £5 billion to develop further sections of Liverpool’s waterfront which could put the city’s UNESCO heritage status at risk. UNESCO and the city are working together to create a

development that preserves the city’s heritage, but the situation remains up in the air (Moss, 2020). Sustainable heritage-based development is a separate topic, but the debate between the perceived need for development versus conservation interests warrants mention when discussing Liverpool’s built heritage.

5. Results

Between 2006 and 2019, there were 21,296 photos uploaded to Flickr in the study zone, when photos tagged in locations outside of the ADCA, including surrounding water, were discarded. The distribution year by year is presented in Figure 8. The pattern roughly matches that of Liverpool’s overall tourism (Figure 4) until 2015, where the Flickr dataset deviates, indicating a decline in tourism to the ADCA whereas Liverpool’s inbound tourism increased steadily through 2018. The first photo was taken on January 8, 2006 at 10:54am and the last photo was taken on December 29, 2018 at 4:10pm. The photo with the highest view count was taken on August 19, 2012 with 71,237 views. Over 11% of the photos directly mention “Albert” in their given titles.

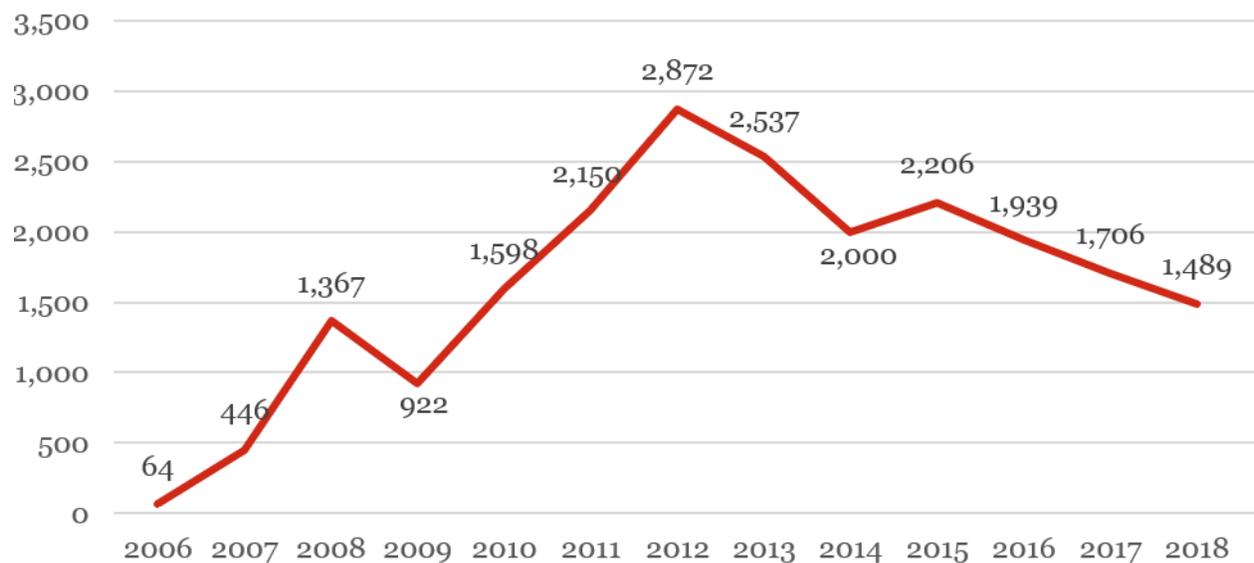


Figure 8. Annual distribution of Flickr photos tagged in study zone, 2006-2019.

5.1 2006-2019 trends

When examining all photos from 2006-2019 mapped together (Figure 9), patterns already begin to emerge. The southernmost section of the study zone does not attract lots of visitors. This is logical, as this area consists of apartments, a multilevel carpark, and a welding supply store - in short, no tourist attractions. The exhibition centre/arena complex lies outside of the study zone, although interestingly, both would register as hotspots if included. The Beatles Story and the Museum of Liverpool both register as densely populated areas. The warehouses that house the Tate Liverpool and other museums all register on the point-density heatmap, although not as intensely. The crossover between Albert Dock and Pier Head, near the Piermaster’s house, registers as well. There is a bit of photo buildup in the area just south of Liverpool ONE. This area largely serves as a bus terminal and a Hilton hotel, although an entrance to the ADCA is only a few meters due west.



Figure 9a, left. Flickr photos tagged in ADCA, 2006-2019.

Figure 9b, right. Point-density heatmap of Flickr photos tagged in ADCA, 2006-2019.

Following Höpken et al. (2020) and Ibrahim (2020) as methodological guidelines, an HDBSCAN was run with a minimum cluster size of 106 photos, or 0.5% of all photos in the dataset. Ibrahim (2020, p. 53) recommends using a minimum cluster size proportional to the dataset size, ranging between 0.25% and 1%, based on the dataset's size. 0.5% of all photos in the dataset is a reasonable minimum cluster size based on this dataset's size.

This generated 28 unique clusters (Figure 10a), encompassing 8,812 photos (41.38% of the dataset), ranging in size from $n=108$ to $n=1,088$ photos. The mean cluster size was 314.71 photos and the median cluster size was 209 photos. 12,484 points were classified as noise. Hu et al. (2015) recommend that clusters of points be represented as polygons, and going forward, the point clusters will be represented as such. Figure 9b shows the 28 clusters as 14 polygons representing POIs generated. Some clusters were grouped based primarily on one main theme, with secondary characteristics included to increase granularity. Primary characteristics related to the building/area's main purpose, whereas secondary characteristics included information about that area that could possibly explain its existence. For example, the Museum of Liverpool (the primary characteristic) has 5 clusters, each representing a slightly different aspect of the location (secondary characteristics). These POIs range in size from $n=108$ to $n=1,920$ photos, with a mean cluster size of 629.43 photos and a median cluster size of 415 photos.



Label	Primary Characteristics	Secondary Characteristics	Photos in Cluster
1a	Albert Dock entrance South	Signage	194
1b	Albert Dock entrance North	view, Signage	586
2	avenue hq Mann Island		194
3a	Bus terminal		410
3b	Bus terminal	view, car show	250
4	Georges Dock Pumping Station	Mann Island, Open Eye Gallery	351
5	Hartley Quay	view	153
6	Hilton City Centre		199
7	Liverpool Waterfront Carpark		132
8	Merseyside Maritime Museum/International Slavery Museum		820
9a	Museum of Liverpool	Cafe and shop	207
9b	Museum of Liverpool	inside	476

Label	Primary Characteristics	Secondary Characteristics	Photos in Cluster
9c	Museum of Liverpool	Main entrance, River Mersey	152
9d	Museum of Liverpool	Mersey River Festival 2015, Three Graces view	231
9e	Museum of Liverpool	view	129
10a	Pier Head crossover North	Signage, Working horse sculpture	382
10b	Pier Head crossover South	Signage	1,088
11	Swing Bridge	view	108
12a	Tate Liverpool		268
12b	Tate Liverpool	Love locks, River Mersey	169
13	The Beatles Story		393
14a	Warehouses	Signage	541
14b	Warehouses	view	1,379

Figure 10a, left. Location of HDBSCAN clusters, ungrouped but using Figure 9b's labels, 2006-2019.

Figure 10b, right. HDBSCAN clusters as polygons, identified and grouped, 2006-2019.

The largest cluster in the ungrouped HDBSCAN clusters is the South entrance to the Pier Head (n=1,088), representing 5.10% of the dataset. Other clusters of note in Figure 10a include the warehouse labelled 14b immediately after entering the south entrance of Albert Docks (n=835, 3.92%), and the Merseyside Maritime Museum/International Slavery Museum (n=820, 3.85%). The warehouse affords views of the inner harbor area, the M&S Bank Arena, and the

Wheel of Liverpool, a ferris wheel. Notable clusters in Figure 10b include the grouped warehouses throughout the area (n=1920, 9.02%), the grouped Pier Head crossover (n=1470, 6.90%), the grouped Museum of Liverpool clusters (n=1,195, 5.61%), the Merseyside Maritime Museum/International Slavery Museum (n=820, 3.85%) and the combined entrances (n=780, 3.66%).

The signage and wayposting created by IS-Group in the leadup to ECoC 2008 features prominently in multiple clusters. 12,515 photos, or 58.77% of the entire dataset, is within 50m of any signpost/waymarker, and 936 photos or 4.40% is within 10m of any signpost/waymarker. Their role is to guide tourists and inform them of their setting, and they prominently display the UNESCO insignia as a symbol that Albert Docks is a cultural heritage. An example of this signposting as it relates to the North entrance cluster is shown in Figure 11.



Figure 11. Proximity of signage/wayposting to North entrance cluster, 2006-2019.

They act as prominent visual reminders of the area's heritage and serve to guide tourists around the area and promote cultural offerings. It is difficult to say if their position causes tourists to cluster around them, or that they are located in areas where tourists are expected to frequent (intersections, major buildings, etc). This, and the fact they were installed for ECoC 2008, speaks to their suitability to be considered a key POI to study the ECoC's long term effects on tourist movement patterns in the area.

The Beatles Story registers as densely populated in Figure 9b, but as only 393 photos register to that cluster, or 1.85% of the dataset. This can be attributed to photos taken in The Beatles Story being located very close to one another, but evidently, not as many photos were taken there as other attractions.

Combining the point-density heatmap, the cluster analyses, and the literature on ECoC 2008, 4 key POIs are formed (Figure 12). These are

- 1) a 10 meter radius buffer around all signage/wayposting,
- 2) Tate Liverpool,
- 3) the Pier Head crossover area and
- 4) the Museum of Liverpool.

Table 2 shows the relevance of the 4 final POIs, and the total number of photos registered at each POI in the dataset. Combined, the POIs encompass 6,382 photos, or 29.97% of the dataset.



Figure 12. Key POIs in study zone, 2006-2019.

Table 2. Characteristics of key POIs, 2006-2019.

POI	Photos at POI, 2006-2019	ECoC 2008/tourist relevance
1. Signage/wayposting 10m buffer	1,362	Installed in run-up to 2008, intended to assist tourists and highlight the area's (UNESCO) heritage. Feature prominently in expected areas of heavy traffic including intersections and entrances.
2. Tate Liverpool	1,257	Renovated in buildup to ECoC 2008, hosted 2008 Liverpool Biennial. Major attraction in Liverpool. Features in point-density heatmap and cluster.
3. Pier Head crossover area	1,505	Crossing point between Albert Docks and Pier Head (component of UNESCO site north of ADCA, see Figure 2a). River Mersey and Three Graces view, signage on both sides of crossing, busy thoroughfare.
4. Museum of Liverpool	2,258	Major free attraction in Liverpool. Constructed 2005-2011, centerpiece building in Albert Docks Conservation Area. Outside the building provides views of Three Graces.

The cluster polygons generated in Figure 10b were used as rough approximations for the POI polygons, but the POI polygons are more encompassing of each POI in question. The cluster polygons were only ever generated to indicate the key POIs. The key POI polygon design is at the researcher's discretion, and is intended to more accurately select photos taken at the POI in question. These POIs will be studied year-by-year in section 5.3.

The most densely-populated areas in Figure 9b were The Beatles Story, the Museum of Liverpool, the warehouses housing Tate Liverpool and the Merseyside Maritime/International Slavery Museums, and the Pier Head crossover area. While The Beatles Story had the densest concentration of photos, this was due to photos linked to that site all existing in the comparatively small geographical location of the attraction. The POIs generated through clustering in Figures 10a and 10b followed roughly the same trends, although a pattern of POIs appearing near the signage/wayposting, and a general bulk amount of photos near certain warehouses both became evident in Figure 10b. This first pattern is among the most striking discoveries, as the signage/wayposting installed for ECoC 2008 acts as branding, promotion of cultural activities and provides directions. For the most part, they are located in expected areas of heavy traffic, and so they serve as an excellent proxy for tourists in the ADCA. Tate Liverpool was the ECoC 2008 media launch location, received funding during ECoC 2008, and hosted a record-breaking Klimt exhibition during ECoC 2008 (Liverpool Culture Company, 2009). Its location (housed in a restored warehouse) exhibits adaptive reuse, a tenet in cultural heritage management (Pintossi et. al., 2021). When compared with the Merseyside Maritime/International Slavery Museums (serving a similar role), the Tate Liverpool is featured more prominently in the literature and encompassed more overall photos. The crossing from Albert Dock to Pier Head is evidently highly trafficked. It is the closest crossing from the Museum of Liverpool (Pier Head side) to Tate Liverpool (Albert Dock side) and it is logical that

many tourists would choose to cross there. The location affords sweeping views of the River Mersey, the Three Graces, and the inner Albert Docks. The crossover area has a high concentration of Grade II-listed historical buildings, including one of the bridges, and Pier Head was renovated in the buildup to ECoC 2008 (UNESCO, 2003; Liverpool Culture Company, 2009). The Museum of Liverpool was constructed from 2005-2011, intended as a centerpiece for the area's revitalization (Liverpool Culture Company, 2009). It currently houses several works of art that were initially created as street art for ECoC 2008, most notably the "Banalamas". Its construction can be considered a high-profile effort by the city to ensure that the area's reputation as a cultural hub continues past 2008.

Key POIs in the study zone are linked both to natural high-traffic areas (Pier Head crossing, signage/wayposting in busy areas), and cultural offerings (Tate Liverpool, Museum of Liverpool). Due to its role as a bridge and viewpoint, the Pier Head crossing may have emerged a key POI regardless of ECoC 2008, but the Museum of Liverpool's construction and Tate Liverpool's cultural funding, along with other improvements in the area is likely to have increased its number of visitors. The signage/wayposting is perhaps the POI easiest to tie to the ECoC 2008, although it is not mentioned in the literature. It was installed in key locations in the run-up to the event to serve multiple key roles to tourists. The fact that they have emerged as POIs speaks to their importance to visitors as well as their good location. Tate Liverpool and the Museum of Liverpool are both cultural offerings but serve different roles for the purpose of this study. Tate Liverpool existed before ECoC 2008 and was renovated and given funding and a prominent role in the city's cultural landscape during the event. Its location is also tied more immediately to the area's built heritage, as it is housed in a repurposed warehouse. The Museum of Liverpool was opened 3 years after ECoC 2008, and yet still emerged as a key POI. This indicates success in the city's efforts to capitalize on the area's cultural reputation after ECoC 2008, and will be further analyzed in Section 5.3. To conclude, the key POIs generated can be linked to Liverpool's cultural tourism initiatives before, during and after ECoC 2008, as can a number of lesser POIs and hotspots. Comparing photos uploaded in the area year-by-year will allow visualization of tourist movement patterns over the timeframe in question. It will also enable inter-year comparison of the POIs, to further evaluate Liverpool's cultural tourism efforts.

5.2 ADCA inter-year trends

Figure 13 displays point-density heatmaps of photos in each year in the dataset, 2006 through the end of 2018. By using the pictures and their titles along with the literature and the area's event history, possible reasons as to changes in tourist movement patterns can be identified.

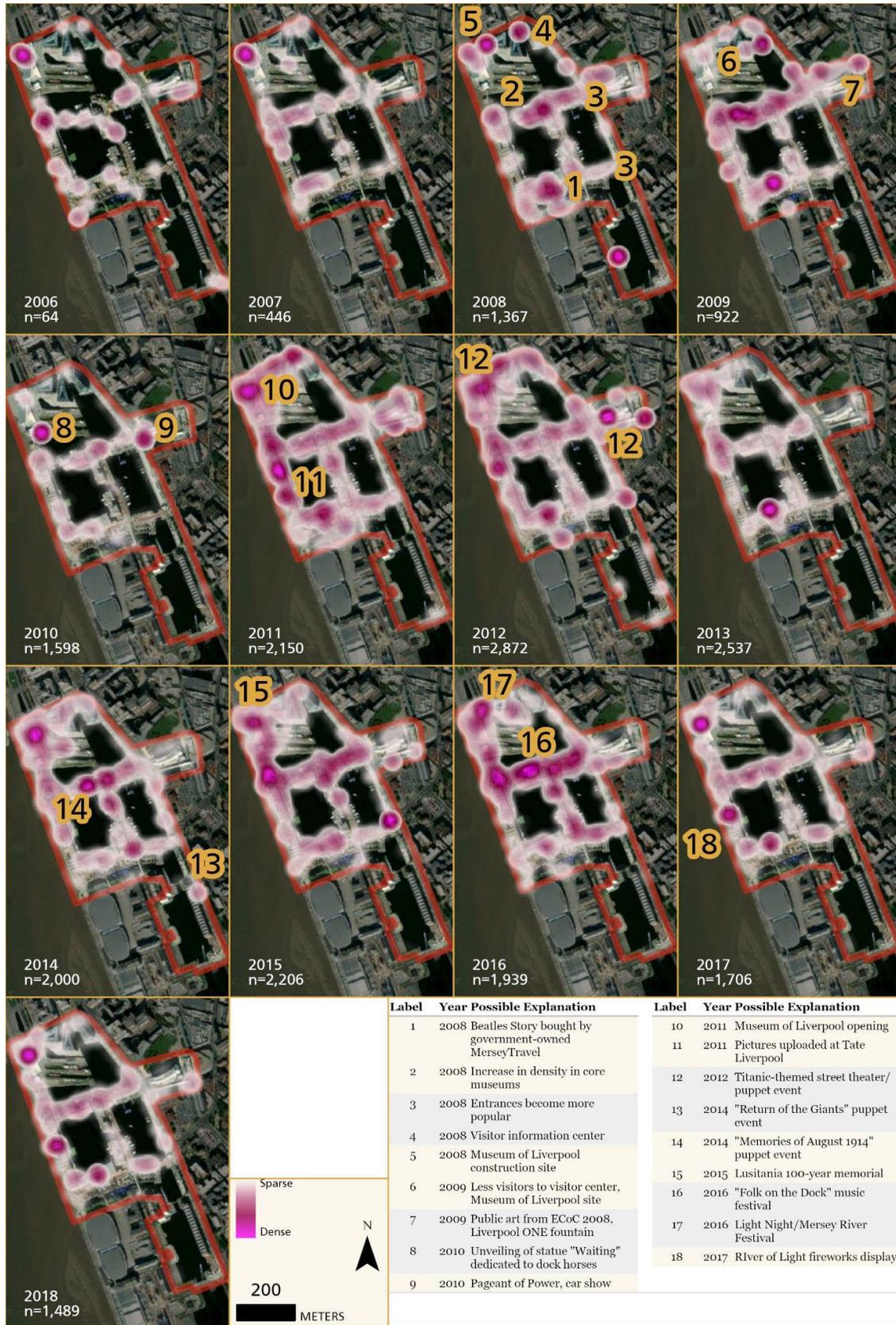


Figure 13. Point-density heatmap of Flickr photos tagged in ADCA, individual years from 2006-2019.

The most notable pattern from 2006 and 2007 is a consistent hotspot at the Museum of Liverpool construction site. 2008 has a 300% increase in tourists from 2007, and they are more distributed throughout the area. The core museum area (Tate Liverpool, Merseyside Maritime/International Slavery Museums) becomes more pronounced, as do the entrances and the visitor center (point 4). In 2009, it appears there were less visitors to the Museum of Liverpool construction site and the visitor center. Hotspots appeared in The Beatles Story and the southern part of Liverpool ONE (point 7). While 2010 has 676 more photos, they appear to be very clustered around points 8 (unveiling a statue) and 9 (a car show). In the following years, hotspots correspond to the Museum of Liverpool's 2011 opening (point 10) as well as giant-puppet events in 2012 and 2014, emulating 2008's La Princesse spider (points 12, 13 and 14). Throughout this timeframe, The Beatles Story remains relatively popular. Hotspots emerged in 2016 related to two festivals in the area and in 2017 related to a fireworks display.



Figure 14. Point-density heatmap of Flickr photos tagged in ADCA, year groupings from 2006-2019.

Figure 14 displays point-density heatmaps of photos in the dataset, with multiple years grouped together: 2006 and 2007, 2008, 2009-2011, 2012-2016, 2017 and 2018. The groupings were made at the researcher's discretion, to provide an alternate perspective and perhaps eliminate visual outliers. Pictures in The Beatles Story become more densely populated in each grouping. There is a presence of points at the Museum of Liverpool construction site before and including 2008, then a drop off, followed by a strong resurgence after the museum opened. As for the core museum area, there are a few points there prior to 2008 and more significant hotspots at the Tate Liverpool and the Merseyside Maritime/International Slavery Museums in 2008. In the years following, they remain hotspots, as does the area linking them. From 2012-16, the Tate Liverpool/Pier Head crossover area emerged as a densely-populated hotspot, as did the Museum of Liverpool and The Beatles Story. While not as densely-populated, this pattern can also be seen in the entrances.

When examining the first 4 groupings, expected patterns emerge. Flickr was growing pre-2008, and Liverpool wasn't on the "tourist map" yet. The most densely populated area is the Museum of Liverpool construction site, not an attraction. ECoC 2008 brought diversity in movement; tourists visited attractions, the entrances, and the event visitor center (something noted by the Liverpool Culture Company). The years immediately following show what appears to be a "pullback" to the established tourism attractions: The Beatles Story and the core museum area, along with some areas of density related to cultural events. Post-opening, the Museum of Liverpool is the most popular destination in the ADCA, although the Tate Liverpool/Pier Head

crossing area attempts to rival it. The Beatles Story remains densely populated, as discussed in section 5.1. There is more traffic between the southern half of the ADCA (Albert Docks) and northern half (Pier Head), which may have increased traffic in the Pier Head crossover area. This would be logical, as visitors to the Museum of Liverpool would use the Pier Head crossover area as the shortest route to Albert Docks and its museums. The post-2015/16 declines that can be seen in every grouping are theorized to be a result of issues with Flickr, as the city’s inbound tourism grew until 2020 (Figure 4). This is further discussed in section 6.

5.3 POI inter-year changes

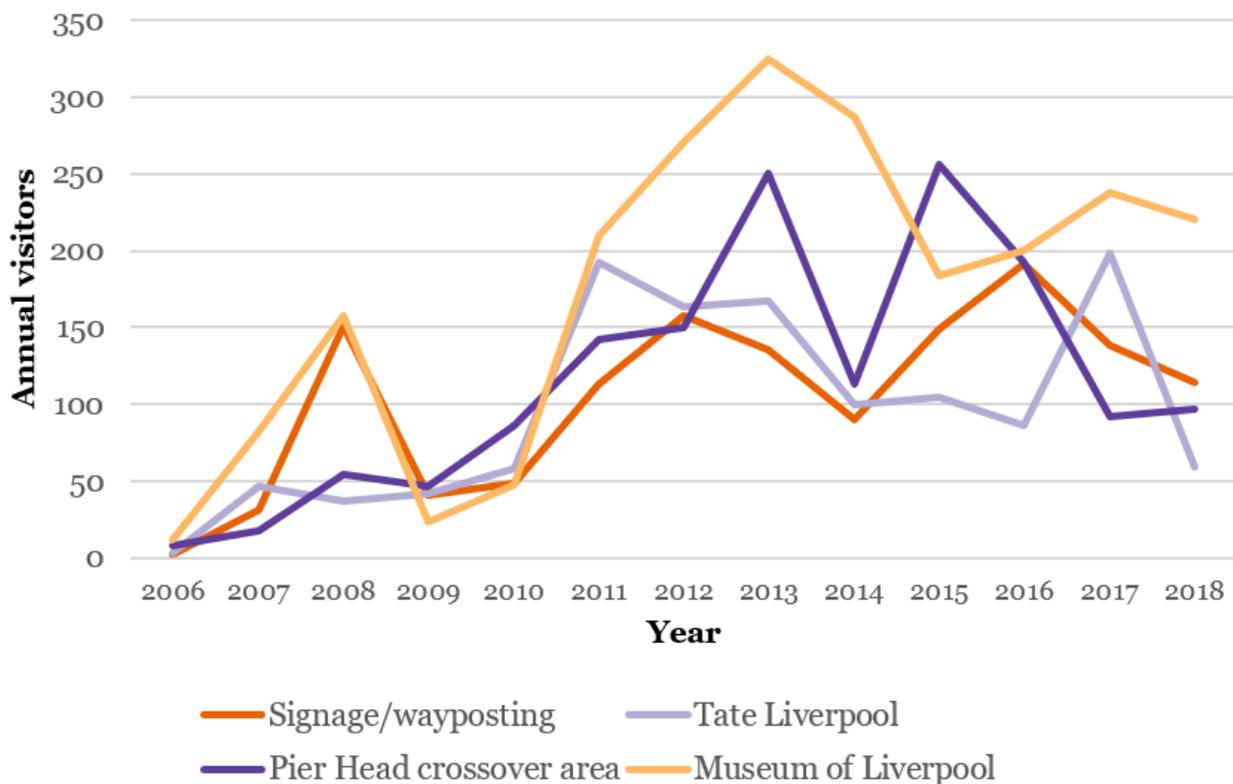


Figure 15. Annual distribution of Flickr photos tagged per key POI, 2006-2019.

Table 3. Rates of change for Liverpool and key POIs, 2006-2019.

Year	Liverpool	Signage/wayposting	Museum of Liverpool	Tate Liverpool	Pier Head crossover area
2006	N/a	N/a	N/a	N/a	N/a
2007	4%	1450%	583%	1467%	125%
2008	36%	387%	93%	-21%	200%
2009	-18%	-73%	-85%	14%	-13%
2010	8%	20%	109%	38%	83%

2011	1%	131%	338%	231%	65%
2012	6%	40%	29%	-15%	6%
2013	2%	-15%	20%	2%	67%
2014	-1%	-33%	-12%	-40%	-55%
2015	3%	66%	-36%	5%	127%
2016	3%	28%	9%	-18%	-25%
2017	2%	-28%	19%	130%	-52%
2018	8%	-17%	-8%	-70%	5%

The only POI that does not exhibit a rise in 2008, followed by a decrease in 2009 is the Tate Liverpool. The other three POIs follow this established pattern. All 4 POIs grew steadily from 2009 to 2011/12, appear to suffer a drawback, and then an up/down pattern. While the Tate Liverpool POI does not match the massive recorded increase in visitors during ECoC 2008, its pattern afterwards matches that of the recorded visitors. For some reason, Tate Liverpool suffered a decrease in visitors between 2012 and 2014/15. Directly comparing the cultural venues, the Museum of Liverpool took a lead it never relinquished after opening in 2011. Visitation to that POI grew 338% in 2011, where the overall city's inbound tourism only grew 1%. While both are considered premiere attractions, the Museum of Liverpool is free vs Tate Liverpool's £5-£25 exhibition fee (although the main collection is also free) and the Museum of Liverpool is ranked much higher on TripAdvisor's "Things to do" page (4th vs 42nd at time of writing), another indicator of its comparative popularity (n.d.). The signage/wayposting exhibited growth, albeit interrupted in 2009 and a dropoff between 2012-14. The Pier Head crossover area grew consistently until 2013, where its growth seemed to stall and hit a double top around 250 photos before dropping off a bit. All key POIs except for Tate Liverpool grew at a higher rate than the city as a whole in 2008, matching the Liverpool Culture Company's findings (2009). Conclusions from the key POI's inter-year behavior are unclear; there is a general trend of a local peak in 2008, followed by a dropoff and a climb, but as in the heatmaps, there appear to be issues affecting the accuracy after the mid-2010s. The most steady growth came from the signage/wayposting, which could speak to its enduring utility to visitors.

6. Conclusions

An attempt to answer the main question "*What was the spatiotemporal effect on tourist flows to and within the Albert Docks Conservation Area (ADCA), Liverpool related to the 2008 European Capital of Culture compared to surrounding years?*" and the subquestion "*How do the points of interest (POIs) generated match Liverpool's approach to capitalizing on the ECoC event to generate sustained cultural tourism?*" was made by using geotagged Flickr photos as a proxy for tourist footfalls.

The analysis revealed 14 clusters (lesser POIs) with 4 key POIs chosen based on their prominence in the cartographic analysis and the literature. A hypothesis to lesser POIs' raison

d'être is given in Figure 10. For the most part, the lesser POIs could be linked to buildings in the area. 4 were museums, 3 were historic buildings, 4 were areas likely to be frequented by tourists, and 3 were structures only tangentially related to tourism, if at all. The Museum of Liverpool was one of the highest-frequented tourist attractions, and core museum area (Tate Liverpool, Merseyside Maritime/International Slavery Museums) also had high rates of photos. The view from their location could be a possible secondary explanatory factor for most of the POIs generated. Certain clusters (3b, 9d) can be tied to cultural events hosted after 2008, which fits with Liverpool's long-term tourism strategy. By emerging as prominent POIs, the Museum of Liverpool and Tate Liverpool (and the other museums) also speak to the effectiveness of Liverpool's attempts to rebrand the ADCA as a cultural district. The signage/wayposting's emergence as a POI could show two things: 1) the signage/wayposting was located in highly trafficked places and 2) these are places that people take photos in. It cannot be determined if the signage/wayposting itself was the reason for their emergence, but they serve as an excellent proxy for gauging tourism to the area as a whole. Thus, their steady growth exhibited in Figure 15 may be the most accurate view of tourism to the area that emerged from this study. If that is the case, combined with the prominence of cultural reasons behind other POIs, it can be said that Liverpool's attempts are largely matched by the POIs generated. Certain areas emerge that may be irrelevant (cluster 7 is a carpark), but historic buildings, cultural attractions, and places naturally important for visitors to the area all emerge as POIs.

As far as the spatiotemporal flows are concerned, tourists trended towards cultural offerings. Pre-2008, there was limited activity, but during the event, there was diversity in photo locations throughout the ADCA. There was an expected-pullback in the years immediately following, and a resurgence a few years later. Cultural events hosted in these years, some of which were direct callbacks to ECoC 2008, featured as prominent hotspots. When the Museum of Liverpool opened, it was a consistent hotspot, as was the core museum area from 2008-2016. The Beatles Story's consistent popularity leads to the conclusion that if a city has something with a cultural legacy as transcendent as the Beatles, they should make full use of it in their tourism marketing. Post-2015, there is an apparent decrease in tourism to the area, but that may be attributed to Flickr rather than the ADCA, as Liverpool and the museums in question continued to grow until 2020 (Figures 4 and 5). However, the apparent overall success of Liverpool's rebranding of the ADCA cannot be denied. Visits to cultural hotspots grew 300% in 2008, and exhibited a sustained increase in the years following. Maintaining the area's cultural scene post-2008 was a major goal of Liverpool, the success of which can be seen in most of the post-2008 maps in Figure 13. Visits to the area proxied by the signage/wayposting exhibit a similar pattern to Liverpool's official numbers until 2015, and has a greater rate of change for many years than the city as a whole (Table 3). This pattern is exhibited in most years for most of the key POIs. This all leads to the conclusion that tourism to the ADCA grew at a faster rate than Liverpool as a result of cultural initiatives in 2008, and Liverpool's efforts to maintain the area's cultural scene in the years after have been met with enthusiasm by tourists.

However, there are issues with the reliability of the dataset, especially post-2015. Flickr's rise was from 2005 to 2012 or so, and there were major issues regarding a takeover and the potential deletion of photos in 2016 (Christant, 2019). This could be a potential explanation for the errors apparent post-2015 in this study. This also might suggest that using Flickr photos for this research method is only appropriate for events dating between the mid-2000s and the mid-2010s, although it is unclear if Flickr has experienced a resurgence post-takeover. However,

this timeframe fits perfectly with the goal of studying tourist movement patterns before, during, and after ECoC 2008. This study prefers Flickr over Instagram because Instagram was not widely used in 2008 and Instagram does not geotag accurately.

The methodologies of Hu et. al. (2015) and Ibrahim (2020) prefer HDBSCAN over k-means or DBSCAN clustering. Ibrahim (2020) states that k-means clustering forms circular clusters of similar size and is not resistant to outliers, and that DBSCAN requires a known search distance prior to clustering. K-means clustering is a similar method to DBSCAN, that requires a set number of clusters to conduct analysis, but arguably provides a finer level of detail when analyzing on a smaller scale (Höpken et al., 2020, p74-75). Höpken et al. (2020, p74) advocate for using both methods to analyze the same data, using the “number of clusters found by DBSCAN... for k-means”. They warn that “k-means is sensitive to outliers, [and recommend using] a distance-based outlier detection [in data cleaning]” (Höpken et al., 2020, p74). They also recommend using an Average Nearest Neighbor tool to generate values for parameters needed to run the DBSCAN tool (Höpken et al., 2020, p73).

Further research could include the exhibition centre/arena complex or Liverpool ONE, due to their apparent relevance to ECoC 2008. This study could be extended to cover the whole of Liverpool. Doing this on a larger scale would give the researcher more room for interpretation and sometimes, more likelihood of identifying the reason behind an inter-year change. Larger POI areas would give larger sample sizes which may give more accurate readings in Table 3. This methodology is very transferable to any similar situation around the world, caveated with the more Flickr photos uploaded to an area, the more useful it is.

The most logical recommendation to the current planning problems (see Sykes & Ludwig, 2015; Moss, 2020) would be to pay heed to the importance of heritage-based development to increasing tourism. Proposed developments that threaten the city’s built heritage should be altered to work in tandem with the heritage. The area’s historic landscape and the cultural events are important to attracting tourists. This is a topic of great significance to many cities struggling to balance conservation and development (Bandarin & van Oers, 2012). Liverpool’s strategy worked. Thus, current developments that threaten the city’s heritage would be wise to incorporate it instead.

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