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Are walkable places tech incubators? Evidence from Nebraska's 'Silicon Prairie'

Bradley Bereitschaft
University of Nebraska at Omaha, bbereitschaft@unomaha.edu

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ABSTRACT

This study examines the spatial association between science- and technology-related entrepreneurship and neighbourhood walkability in eastern Nebraska, often referred to as the northern 'Silicon Prairie'. Tech start-up firms are expected to gravitate toward more walkable or pedestrian-oriented urban locations to benefit from heightened social interaction, knowledge spillovers and a more vibrant, creative atmosphere. Data on start-up firms collected from the online database Crunchbase.com and a walkability index provided by the popular online service Walk Score® were used to evaluate the walkability–tech entrepreneurship nexus. The spatial relationship between walkability and firm location may have important implications for metropolitan areas seeking to incubate new firms and industries *in situ*, and potentially become leaders in new, innovative industries.

ARTICLE HISTORY

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KEYWORDS

start-up; walkability; walk score; innovation; creative city; firm location; tech firms; Silicon Prairie

INTRODUCTION

In the early 21st century, creative, knowledge and information-based work constitutes a vital and growing sector of the modern, 'post-industrial' US economy (Boschma & Fritsch, 2007; Florida, Mellander, & Stolarick, 2008; McGranahan & Wojan, 2007; Stolarick & Currid-Halkett, 2013). Information-based and creative-intensive occupations now represent about 30–35% of the US workforce (Florida, 2002, 2012), and the information/technology sector represents a sizeable and growing proportion of those jobs (US BLS, 2015). The creation and attraction of tech firms is therefore often a top priority for cities and city-regions aiming to expand their economic base.

Florida (2002, 2012) has argued that, in the new economy, firms follow high-skilled workers, and high-skilled creative workers seek out cities and neighbourhoods with vibrant street life, a tolerant atmosphere, and ample cultural and recreational amenities. Recent work in this area has shown that workers in 'creative-class' occupations (i.e., those who often require a high level of creativity such as art, science, information technology and engineering) have been migrating into centrally located, walkable urban neighbourhoods (Bereitschaft, 2014). These areas have the concentration of entertainment and social amenities particularly prized by creative workers (Bereitschaft, 2017). Walkable, high-amenity locales may therefore play a key role in the

CONTACT

(Corresponding author) bbereitschaft@unomaha.edu

Department of Geography/Geology, University of Nebraska at Omaha, Omaha, NE, USA

attraction and retention of a highly skilled, innovative workforce (Borén & Young, 2013; Zenker, 2009). Tech start-ups and other small firms may also be drawn to dense, walkable urban centres to benefit from economic agglomeration, where companies in close spatial proximity can more easily share (and sometimes steal) workers, ideas, knowledge and suppliers (Foord, 2013; Glaeser, 1999; Jacobs, 1961; Marshall, 1890). It is no surprise that productivity and innovation are generally higher in dense urban settings (Abel, Dey, & Gabe, 2010; Florida & Mellander, 2016; Knudsen, Florida, Gates, & Stolarick, 2007). The economic value of walkable spaces in particular can be observed through increases in the value of both residential (Cortright, 2009; Gilderbloom, Riggs, & Meares, 2015) and commercial (Pivo & Fisher, 2011) properties.

Recent qualitative analyses of creative/cultural quarters, clusters and hotspots generally support the notion that urban design and morphology can help facilitate the growth of creative industries. Using observations and photographic surveys of film districts in three separate cities, Costa and Lopes (2015) identified several elements of urban design that contributed to creative dynamics in cultural districts. These elements included heterogeneity in land uses and activities, ample sidewalks and other pedestrian zones, irregular street networks with short blocks, and historical buildings and architecture. Many of these same features were identified by Jacobs (1961) over five decades ago as generators of neighbourhood vitality. Durmaz (2015) similarly investigated the socio-spatial features that attract creative workers in the film industry to two creative clusters: Soho in London and Beyoğlu in Istanbul. The author concludes that 'many different layers, including physical, socio-cultural, perceptual and visual characteristics of place … contribute to the complexity and creative atmosphere of Soho and Beyoglu' (p. 102). Interviews of creative workers indicated that proximity, centrality and accessibility were among the key physical factors drawing them to these locations. Walkability was identified as a particularly strong positive factor in support of clustering and accessibility, as well as a facilitator of chance encounters and inter-company interactions. Other studies have likewise stressed the importance of face-to-face contact in knowledge spillovers, tacit learning, and social networking (Boschma, 2005; Storper & Venables, 2004).

Florida and Mellander (2016) observed that venture capital investment was higher in US metropolitan areas with greater overall densities and more social diversity. At a finer scale, Florida and King (2016) found that central urban neighbourhoods contain more significant clusters of venture capital investment than their suburban counterparts. Using the Toronto, Montreal and Vancouver regions as a case study, Spencer (2015) found that firms in 'creative industries' (e.g., film, music, radio, design, performing arts and independent arts) tend to cluster in dense mixed-use neighbourhoods near the urban core, while 'science-based industries' (e.g., pharmaceutical, software, computers, science research and medical laboratories) were more likely to be found in suburban settings. The authors suggest that this geography is primarily due to 'creative industries' relying more on inter-urban networks, which are facilitated by close spatial proximity and 'third places' (such as coffee shops and bars) that enable casual social interactions, while 'science-based industries' rely more on intra-firm interactions.

Spencer's (2015) observation that 'science-based industries' are more likely to be found in the suburbs contrasts with Florida and King's (2016) analyses of venture capital investment. However, Florida and King did not focus on a particular industry, and Spencer (2015) did not consider firm size or age. While larger science/technology firms, relying primarily on intra-firm interactions and learning, may in some cases prefer suburban settings, there is ample evidence that smaller, start-up firms in general tend to locate in denser urban environments to take advantage of agglomeration economies, inter-firm networks and knowledge spillovers. There remains the question, then: Are start-up firms in the science/technology industries more likely to be found in walkable, central urban locations as Florida and King's (2016) analysis suggests, or in more suburban locations as Spencer (2015) observed in large Canadian cities? The present study will address this question by examining the location of new (established within the previous 10 years, since 2009) science/tech start-up firms in Omaha and Lincoln, Nebraska, and determine whether they are more likely

to be found in walkable, central urban environments relative to more established science/tech firms, randomly selected firms and randomly selected start-up firms. This case study also aims to shed a light on the emerging geography of the 'Silicon Prairie' in Nebraska by examining the spatial distribution (location, size) of technology firms in the region. There has been little research on this emerging technology cluster, despite its strong potential to serve as a driver of economic growth within the region over the coming decades (Biery, 2017).

BACKGROUND: WALKABILITY AND INNOVATION

Nearly 60 years ago, Jacobs (1961) poignantly observed that the physical layout and makeup of the built environment appears to exert substantial influence on human behaviour and interaction. Urban districts that encourage walking and casual social interactions, she noted, tend to be safer and more socially and economically vibrant. Indeed, features as simple as moderate density, short city blocks, a mix of building ages, public space and mutually supportive land uses have been frequently associated with enhancing a neighbourhood's 'creative milieu' and economic dynamism (Martins, 2015; Powe, Mabry, Talen, & Mahmoudi, 2016; Rantisi & Leslie, 2010). Much of this effect has been attributed to the enhanced face-to-face interactions that these spaces support, allowing the formation of social and professional networks, knowledge spillovers, and, ultimately, innovation capacity (Dakhli & De Clercq, 2004; Glaeser, 1999; Marshall, 1890; Zheng, 2010).

Knowledge-based industries, particularly those in arts and design, are expected to benefit the most from dense, walkable urban environments with ample 'third places' (i.e., spaces apart from home and work such as coffee shops and bars that facilitate casual social interactions; Oldenburg, 1999) (Florida, 2002; Markusen, 2006; Rantisi & Leslie, 2010; Watson, Hoyler, & Mager, 2009). Spencer (2015) suggests that these 'creative' knowledge industries (e.g., film, music, radio, artists), as opposed to 'science' knowledge industries (medicine, software, computers, science research and development – R&D), rely more on divergent, rather than convergent thinking, in which 'there is no single answer to a problem and so many possible solutions are sought' (p. 886). The author contends that this pushes creative or cultural workers to develop a large web of relatively weak professional ties, which, presumably, could be accomplished to greater effect in compact and diverse urban environments. In agreement with this theory, both Spencer (2015) and Bereitschaft (2018a) observed that creative/cultural firms were more likely to be found in dense urban environments, while science/technology firms exhibited a preference for the suburbs. Other studies have examined the clustering of 'creative' industry firms, noting in detail the role the built environment plays in facilitating interactions both within and across industries (Costa & Lopes, 2015; Durmaz, 2015; Rantisi & Leslie, 2010; Martins, 2015).

The observation that science/technology firms exhibit a preference for less-dense suburban environments corresponds well with broader notions of the office park, corporate campus and university-feed research hubs, popularly embodied by Silicon Valley, the Research Triangle Park in North Carolina and Highway 128 outside Boston (Cummings, 2017; Felsenstein, 1994; Guzman & Stern, 2015). In addition to perhaps relying more on convergent thinking, where there is often a clear 'optimal' answer to a given problem, as well as fewer weak ties, a crucial difference between arts/design firms and science/technology firms is their size; science/technology firms on average have 2.5 times as many employees (Spencer, 2015). This suggests more interactions are likely taking place *within* science/technology firms, rather than between them, as may be the case for arts/design firms. Science/technology start-ups, however, are generally smaller in size, and therefore, like many arts/design firms, may rely more on external partners to facilitate knowledge transfer and acquire resources (Colombo, Grilli, & Piva, 2006; Gimenez-Fernandez & Beukel, 2017; Hite & Hesterly, 2001).

The need for close-knit collaborative environments may be particularly acute for start-up firms whose growth and success depends on tapping into local human capital, developing

supportive networks, initiating strategic alliances and acquiring both tacit (experience-based; Grant, 1996) and explicit (facts/theory-based) knowledge while exploring new innovative opportunities (Aharonson, Baum, & Feldman, 2007; Chrisman & McMullan, 2004; Katz & Wagner, 2014). As firms grow and mature, however, they may become increasingly inward-looking and less willing to assimilate external knowledge or exploit new technological changes (Almeida, Dokko, & Rosenkopf, 2003). Mature high-tech companies are also more likely to depend on national and international networks that extend well beyond the local (Huggins & Johnston, 2010; van Winden & Carvalho, 2016). It follows then that the spatial preference of smaller science/technology start-up firms should appear more like arts/design firms, locating in more walkable, social urban environments, rather than relatively insular office parks with fewer opportunities for local knowledge spillovers. Supporting this theory, Guzman and Stern (2016) have documented that high-quality entrepreneurship has increasingly taken root within central, urban neighbourhoods since the late 1980s.

By locating in more walkable urban neighbourhoods, start-up firms may also benefit from locating closer to potential workers as well as gaining the cache associated with certain addresses or neighbourhoods (Rault & Sarfati, 2015). Theories of human and creative capital suggest that well-educated, young professionals are likely to exhibit a preference for urban environments perceived to be vibrant and creative, with unique entertainment/cultural amenities and a more active social scene (Bereitschaft, 2014; Florida, 2012; Frenkel, Bendit, & Kaplan, 2013; Lawton, Murphy, & Redmond, 2013; Tallon & Bromley, 2004; Woldoff, DeCola, & Litchfield, 2011). The positioning of a new firm in a more walkable, urban setting with greater access to amenities and public transportation may thus be a selling point used to attract and retain top talent (Yigitcanlar & Dur, 2013). 'Physically compact, transit-accessible, and technically-wired' urban environments with a mix of land uses are also often the preferred location for so-called 'innovation districts', where business incubators and accelerators provide funding, resources and collaborative spaces for entrepreneurs and local start-ups (Katz & Wagner, 2014). Even where innovative firms choose less compact areas to maximize proximity to related business sectors and reduce rental costs, they are likely to benefit from more compact regional land use configurations and public transit investments that enhance accessibility (Hamidi & Zandiatashbar, 2018; Malizia & Motoyama, 2016).

Pedestrianism, and the act of walking, may also enhance creative productivity and innovative capacity more directly. Oppezzo and Schwartz (2014, p. 1142), for example, observed that participants who walked outside 'produced the most novel and highest quality analogies' relative to those who sat outside or walked inside on a treadmill. Other studies have suggested similar positive associations between cognitive ability and physical activity, particularly aerobic exercise (Blanchette, Ramocki, O'Del, & Casey, 2005; Kramer, Erickson, & Colcombe, 2006; Kubesch et al., 2003). Additionally, certain aesthetic and sensorial qualities of the built environment, such as historical architecture, varied streetscape features, and ever-shifting sights, sounds, and smells, may serve as sources of inspiration and insight, as well as reinforce a sense of place (Drake, 2003; Hutton, 2006; Lloyd, 2004; McCoy & Evans, 2002).

METHODOLOGY

Study area

This study focuses on the cities of Lincoln and Omaha, the two most populous cities and metropolitan areas in the state of Nebraska. Both may be considered mid-sized metropolitan areas, with Omaha the largest of the two (population of 934,000 versus 331,000; US Census Bureau 2017), while Lincoln serves as the state capital as well as the home of the University of Nebraska's flagship campus. The two cities are approximately 50 miles apart with adjacent metropolitan boundaries, and are linked primarily by Interstate 80, running east–west (Figure 1). Omaha

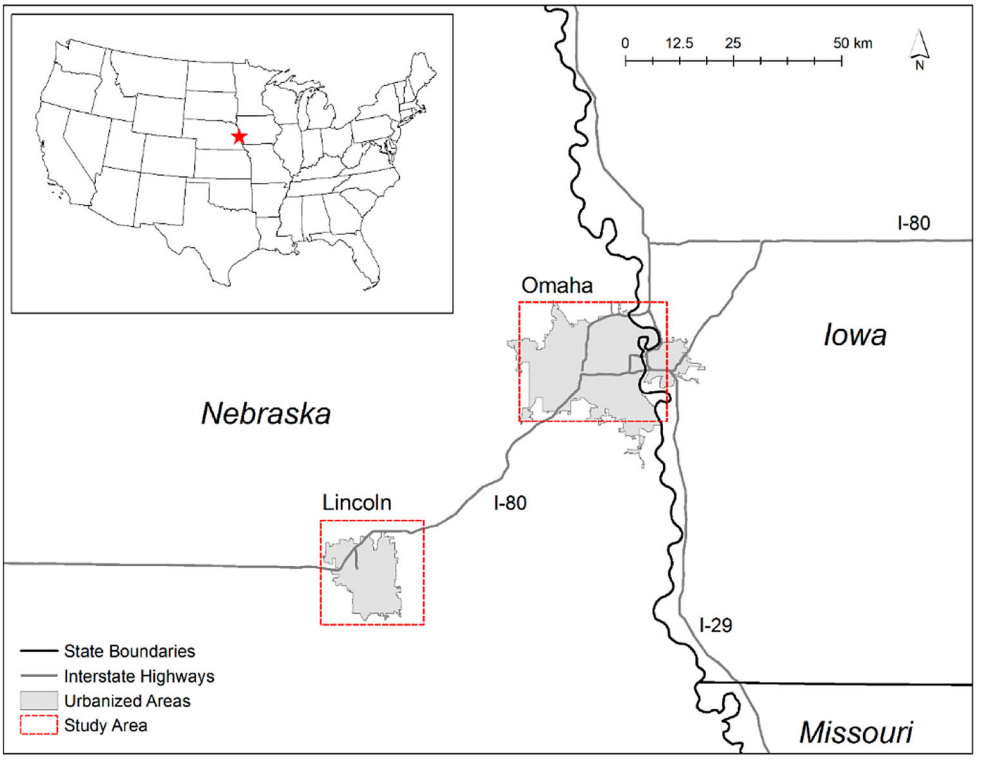

Figure 1. The study area encompassed the cities of Lincoln and Omaha in eastern Nebraska, USA.

also has access to I-29, running north–south, and an international airport. Both cities have diverse economies with particular strengths in education and healthcare services, trade and transportation, government, and business services (BLS, 2018). The region has garnered some media attention in recent years as one of the country's emerging technology hotspots, particularly for internet-based start-up companies seeking more affordable accommodations (CBS News, 2016; Eligon, 2012; Salter, 2017; WOWT, 2018). Computer, engineering and science occupations represent about 6.0% (about 30,000) of all employees in Omaha and 6.2% (about 12,000) in Lincoln, both above the national average (BLS, 2017). Omaha and Lincoln are home to a growing entrepreneurial ecosystem, with at least seven start-up incubators and/or accelerators. Incubators frequently provide workspace, training and networking opportunities and are typically non-profits, while accelerators focus on connecting start-ups with venture capital and often operate for-profit (Isabelle, 2013).

With few natural or political barriers to expansion, Omaha and Lincoln exhibit relatively low-density and auto-centric urban development patterns over much of their territories. Both cities, and particularly Omaha, however, also feature several highly walkable neighbourhoods with either traditional or neo-traditional morphologies. They are each served by standard local bus systems; however, Omaha is in the process of adding a bus rapid transit (BRT) system along the busy east–west Dodge Street corridor. The BRT system (designated 'ORBT' for Omaha Rapid Bus Transit) is expected to link several key neighbourhoods and developments within Omaha's central axis, extending from downtown in the east to the I-680 expressway in the west.

The Omaha–Lincoln area, as the primary node of Nebraska's 'Silicon Prairie' technology cluster, represents in this case study a modestly growing, mid-sized US urbanized region offering a more affordable, though perhaps less connected and diverse, ecosystem for start-up enterprises

than the coastal markets of San Francisco–San Jose, Seattle or Boston. Emerging technology clusters outside these coastal hotspots have not yet received much attention in the literature. Yet, a number of mid-sized cities in the US interior – most notably 'college towns' with large research universities – have begun to incubate technology clusters of their own, while offering lower start-up costs and a much lower cost of living (Florida, 2018; Hathaway, 2018; The Economist, 2018). Though it may not be growing as fast as some, Nebraska's 'Silicon Prairie' represents one such emerging tech cluster in proximity to local research universities. The region also shares many of the morphological attributes common to post-industrial Midwestern cities, such as extensive, sprawling suburban areas punctuated with new pedestrian-oriented infill development and older, more walkable central neighbourhoods. Thus, while the Omaha–Lincoln area is far removed from the leading coastal tech corridors, it shares many similarities with other emerging tech markets and mid-sized urban regions, whose entrepreneurial success in emerging fields could have a substantial impact on their future economic growth.

Data collection and visual analysis

To determine whether start-up tech firms are more likely to locate in walkable urban locations relative to larger, well-established firms, and start-up firms in other industries, it was necessary to collect, process, map and analyse the spatial relationships between two sets of data: (1) firms within the Omaha–Lincoln region, including information on firm size, type, and location; and (2) neighbourhood walkability using the widely used Walk Score® (http://www.walkscore.com) metric. Data on start-up technology firms in eastern Nebraska were collected using the online database Crunchbase (http://www.crunchbase.com). As stated on its website:

> Crunchbase was founded to be the master record of data on the world's most innovative companies. We built a unique and scalable approach to data collection leveraging a strong community of contributors, the largest venture partner network, and in-house data teams armed with powerful machine learning.

Start-up firms were identified as those founded in the past 10 years (i.e., since 2009) and had fewer than 50 employees in 2018. Although Crunchbase features primarily technology-related firms, this includes a wide range of businesses that may only peripherally involve scientific/technological products. Thus, a search of the Crunchbase database was performed to identify 'core' science/tech firms within the areas of 'Software', 'Hardware', 'Internet Services', 'Science & Engineering', 'Biotechnology', 'Mobile', 'Apps', 'Data & Analytics', 'Information Technology' and 'Energy'. The search resulted in 121 firms in Omaha and Nebraska; however, a handful were eliminated upon closer inspection, most often because the firm had closed or been acquired. Home-based businesses were also eliminated. This left a total of 88 technology start-ups firms for analysis.

Data on the location of larger and more established tech firms and firms from other industries (randomly selected) were obtained from ReferenceUSA, an online business database available via subscription. Established tech firms were defined as those established prior to 2009 with 10 or more employees in 2018. Firms were selected based on North American Industry Codes (North American Industry Classification System – NAICS), and included 12 industry categories (Table 1). These categories were chosen to correspond, as well as possible, with those selected using CrunchBase. In addition to start-up and established science/tech firms, a sample of 100 randomly selected firms (of all sizes and industries) and 100 randomly selected start-up firms were also gathered from ReferenceUSA. Again, home-based businesses were not included. Although a larger random sample of firms could have been acquired, it was desirable to have a similar number of firms in each category, and 100 is in range of the 88 science/tech start-ups and the 138 established tech/firms identified within Omaha and Lincoln. Once the data were

Table 1. Industry classes from which established science/tech firms were identified.

NAICS	Description
511210	Software Publishers
516110	Internet Publishing & Broadcasting
519130	Internet Publishing/Broadcasting/Web Search Portals
541330	Engineering Services
541380	Testing Laboratories
541511	Custom Computer Programming Services
541512	Computer Systems Design Services
541713	Research & Development in Nanotechnology
541714	Research & Development in Biotech
541715	Research & Development in Physical/Life Sciences
927110	Space Research & Technology

Note: NAICS, North American Industry Classification System.

downloaded and processed, the location and attributes of each firm were mapped and analysed using ArcGIS 10.5 (ESRI, 2018).

The walkability of each firm location were determined using Walk Score's API. Walk Score is a popular and freely available walkability metric that has been used extensively by industry (particularly real estate) and in academic research (e.g., Bereitschaft, 2017; Duncan, 2013; Meltzer, 2014). With an easily interpretable score of 1–100, with 100 indicating maximum walkability, Walk Score is calculated using the locational density of common amenities such as coffee shops, restaurants, drug stores and schools, as well as local population density, block length and intersection density (Walk Score, 2018). In the United States, a walk score may be calculated for any latitude/longitude coordinate associated with a road network. The metric incorporates a distance-decay function in which features are assessed for any given point out to a distance of 1.5 miles, with closer features given more weight than those further away. Walk Score has been shown to provide a reasonable proxy of walkability across a number of cities and spatial scales (Brown et al., 2013; Carr, Dunsiger, & Marcus, 2011; Duncan, Aldstadt, Whalen, Melly, & Gortmaker, 2011). It is worth noting, however, that Walk Score is considered a macro-scale measure of walkability and does not directly consider street-level, micro-scale elements of the built environment such as the condition of the sidewalk, presence of street trees, or building set-backs that might also affect walkability (Bereitschaft, 2018b; Harvey & Aultman-Hall, 2016). Therefore, these elements will be examined and compared qualitatively in locations where firms cluster.

By comparing the walkability associated with technology start-ups versus technology firms that are larger and more established, we aim to address whether start-ups specifically exhibit a preference for walkable locations, and whether this preference diminishes as firms become larger (in terms of number of employees) and more mature. Additionally, by comparing start-ups firms in the science/technology sectors to new and established businesses randomly selected from a variety of industries, we seek to address whether science/tech firms are preferentially located in more walkable urban environments.

Regression analysis

Following an initial analysis of variance (ANOVA) to determine whether significant differences in the mean walk score exist among start-up tech firms, established tech firms and non-tech start-ups, a binary logistic regression analysis was performed to assess the strength of walkability as a predictor of firm type (start-up versus established tech) when accounting for confounding variables. Control variables included distance from each firm to the central business district (CBD),

distance to the nearest start-up incubator or accelerator, proximity to the nearest Carnegie-classified research university, and the proportion of either all start-up or all established tech firms within a distance of 2 km of each firm. The latter variable provided a means to compare the degree of agglomeration among start-up versus established tech firms.

RESULTS

Walkability across firm types

An ANOVA revealed that the mean walk score of science/tech start-ups in Omaha and Lincoln ($\bar{x} = 66.9$) was significantly higher ($p < 0.001$) than for any other group of firms, and 20 points higher than for established tech firms ($\bar{x} = 46.8$) (Table 2 and Figure 2). The randomly selected set of 100 firms exhibited a mean walk score of 56.1, significantly lower than the science/tech start-ups, but significantly higher than the established tech firms. Finally, with a mean walk score of 53.3, the walkability surrounding the 100 randomly selected start-ups companies was significantly lower than that of science/tech start-ups firms. All four groups of firms exhibited a substantial range in walk scores, with upper values maxing out at 96 or 97 out of 100, and minimum values ranging from 0 to 13. Walk Score characterizes scores of < 50 as 'car dependent', between 50 and 69 as 'somewhat walkable', and > 70 as 'very walkable'. By this metric, all firm categories except established tech firms were located in 'somewhat walkable' areas. Start-up science/technology firms, however, fell only 3 points below the 'very walkable' threshold. This suggests that these companies were found most often in areas of the city in which some or most 'errands can be accomplished on foot' (Walk Score, 2018).

The location and spatial arrangement of start-up versus established science/tech firms relative to walkability in Omaha and Lincoln can be seen in Figure 3. Start-ups (those companies founded within the past 10 years and with fewer than 50 employees) were more frequently located in 'somewhat walkable' (walk score 50–69) and 'very walkable' (walk score ≥ 70) areas of the two cities according to Walk Score. In fact, a full 50% of science/tech start-ups across Omaha and Lincoln were associated with walks scores of ≥ 70, compared with just 18% of established firms. On average, science/tech start-up firms were also situated significantly closer to the CBD than established firms or randomly selected firms/start-up firms.

Logistic regression analysis: start-up versus established tech firms

In agreement with the ANOVA, the results of the binary logistic regression analysis suggest that significantly ($p = 0.009$) higher walkability is associated with start-up tech firms relative to established tech firms within the 'Silicon Prairie' when controlling for confounding factors (Table 3). Start-up tech firms also exhibited a stronger tendency to cluster, with a significantly ($p < 0.001$) higher proportion of tech firms located within a distance of two kilometres of another tech firm. In fact, start-up tech firms on average were within 2 km of 15.3% of all tech firms, while the corresponding proportion for established tech firms was less than half at 7.1. Walkability was also a stronger predictor of whether a firm was a start-up or established business than distance to the

Table 2. Walk scores for each firm category.

Firm type	*N*	Mean	SD	Minimum	Maximum	Subsets[a]
Tech start-ups	88	66.9	20.5	13	96	a
Established tech	140	46.8	22.5	0	97	b
Random firms	100	56.1	18.8	10	97	c
Random start-ups	100	53.3	22.2	0	96	bc
Total	428	54.6	22.3	0	97	

Note: [a]Different letters indicate that the mean walk score of two firm types are significantly different.

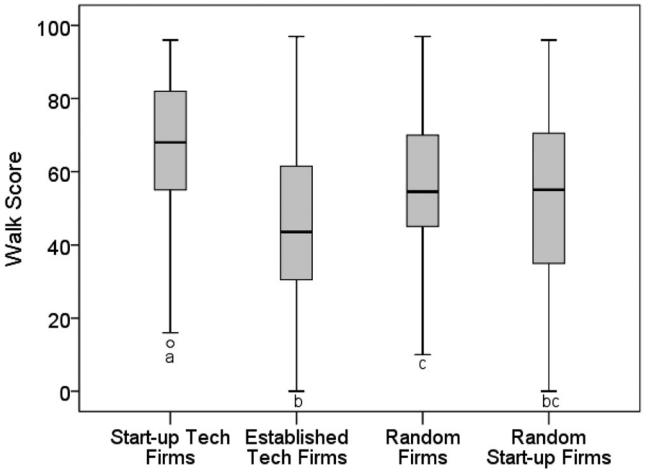

Figure 2. Mean and spread of walk scores for start-up and established science/tech firms, a random sample of firms, and a random sample of start-up firms in Omaha and Lincoln, Nebraska.
Note: Different letters at the base of the box plots indicate significantly different means.

CBD, closest incubator/accelerator or the nearest research university (all three variables were not significant in the regression model). The overall model was statistically significant ($p < 0.001$) with a Nagelkerke pseudo-$r^2 = 0.377$. Together, these results indicate that start-up firms in eastern Nebraska exhibited a spatial association with walkability that cannot be fully accounted for by proximity to the urban centre alone, nor the tendency to agglomerate closer to one another and to supportive incubators or universities.

Examining start-up 'hotspots'

The spatial disjunction between start-up and established science/tech firms is visually evident when mapping firm size (Figure 4). Start-up firms cluster primarily in downtown Lincoln and

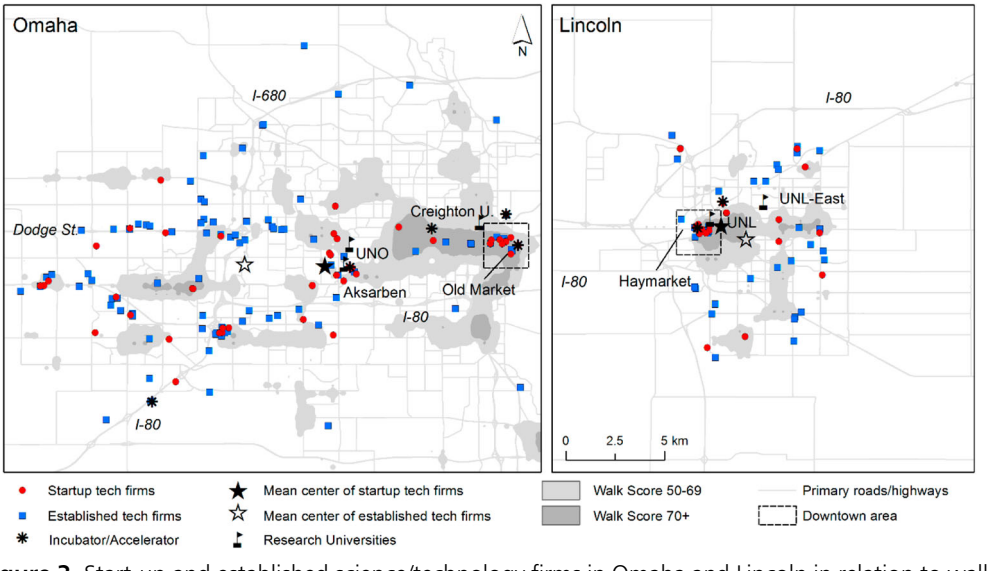

Figure 3. Start-up and established science/technology firms in Omaha and Lincoln in relation to walk scores.

Table 3. Results of the binary logistic regression model with type of firm (established tech = 0, start-up tech = 1) as the dependent variable.

	B	SE	Wald	Significance	Exp(*B*)
Constant	−2.595	0.709	13.407	0.000	0.075
Walk score	0.022	0.008	6.709	0.010	1.022
Distance to central business district (CBD) (km)	−0.025	0.059	0.182	0.669	0.975
Distance to incubator (km)	−0.148	0.095	2.454	0.117	0.862
% Firms within 2 km	0.116	0.028	17.315	0.000	1.116
Distance to university (km)	0.071	0.080	0.782	0.377	1.074

central, south-east and downtown Omaha. Located within 2 km of Creighton University (with top-rated medical and business programmes), The Mastercraft incubator and The Start-up Collective accelerator, start-ups within Omaha's downtown cluster are well positioned to take advantage of nearby resources as well as inter-firm collaborations. This spatially compact cohort comprised 15 (28%) of the 53 firms and approximately 150 (21%) of the 700 employees of science/tech start-ups in Omaha. Although not located directly within the Old Market historical warehouse district, Omaha's downtown start-ups were all within convenient walking distance (about 1 km) of this social/entertainment hub known for its trendy restaurants, specialty retail stores, cafés and coffee shops. The Old Market is arguably the liveliest and most walkable of Omaha's downtown districts, yet much of the CBD and surrounding neighbourhoods are undergoing a resurgence in residential and retail development (Soderlin, 2017; Gonzalez, 2018). A series of mixed-use projects just north of downtown (an area known locally as 'NoDo') have contributed to the area's rising vitality and walkability.

In Lincoln, start-up activity in the science/tech sector was heavily concentrated within the pedestrian-oriented urban core. The majority (20 of 35 firms; 57%) of Lincoln's 'downtown start-ups' were located squarely within, or immediately adjacent to, the city's popular repurposed warehouse district known as the Haymarket. Like the Old Market in Omaha, the Haymarket contains a dense concentration of small businesses with a primarily vertical mixed-use configuration (i.e., retail on the ground floor, offices and residential spaces above). The Haymarket is well known locally for its vitality and walkability, with unique and historic nineteenth century architecture and signage that lend to the neighbourhood's sense of place. The area offers many of the features generally considered conducive to walkability including cobblestone streets that reduce automotive speed, transparent storefronts, short blocks, contiguous frontage with good enclosure and plenty of third places for mingling (Adkins, Dill, Luhr, & Neal, 2012; Ewing, Hajrasouliha, Neckerman, Purciel-Hill, & Greene, 2016; Ewing & Handy, 2009). The Haymarket is also home to the NMotion accelerator, which provides US$20,000 in venture capital, collaborative work space and other resources for start-ups, and the main campus of the University of Nebraska at Lincoln is within a 5–10-min walking distance, providing ready access to students, faculty and research facilities.

Outside the downtown core, Omaha hosts two additional start-up hotspots: one centrally located in close proximity to the University of Nebraska at Omaha (UNO) and Aksarben mixed-use neighbourhood, and one in the more suburban south-west quadrant where an office park adjoins Interstate I-80. Since the closure and dismantling of the Aksarben horse racetrack in the mid-1990s, much of the Aksarben neighbourhood has been entirely rebuilt as Aksarban Village, a new urbanist-style infill development with a mix of retail, entertainment, office space and housing (including dormitory housing for UNO students). Because the area has grown rapidly over the last few years, Walk Score may not fully represent the current walkability of the area or its potential in the near future (the walk score of the Aksarben-Elmwood Park neighbourhood is 55 as of November 2018). The area is certainly being designed with walkability in mind, however: buildings face the street with limited setbacks, sidewalks are wide and punctuated with trees

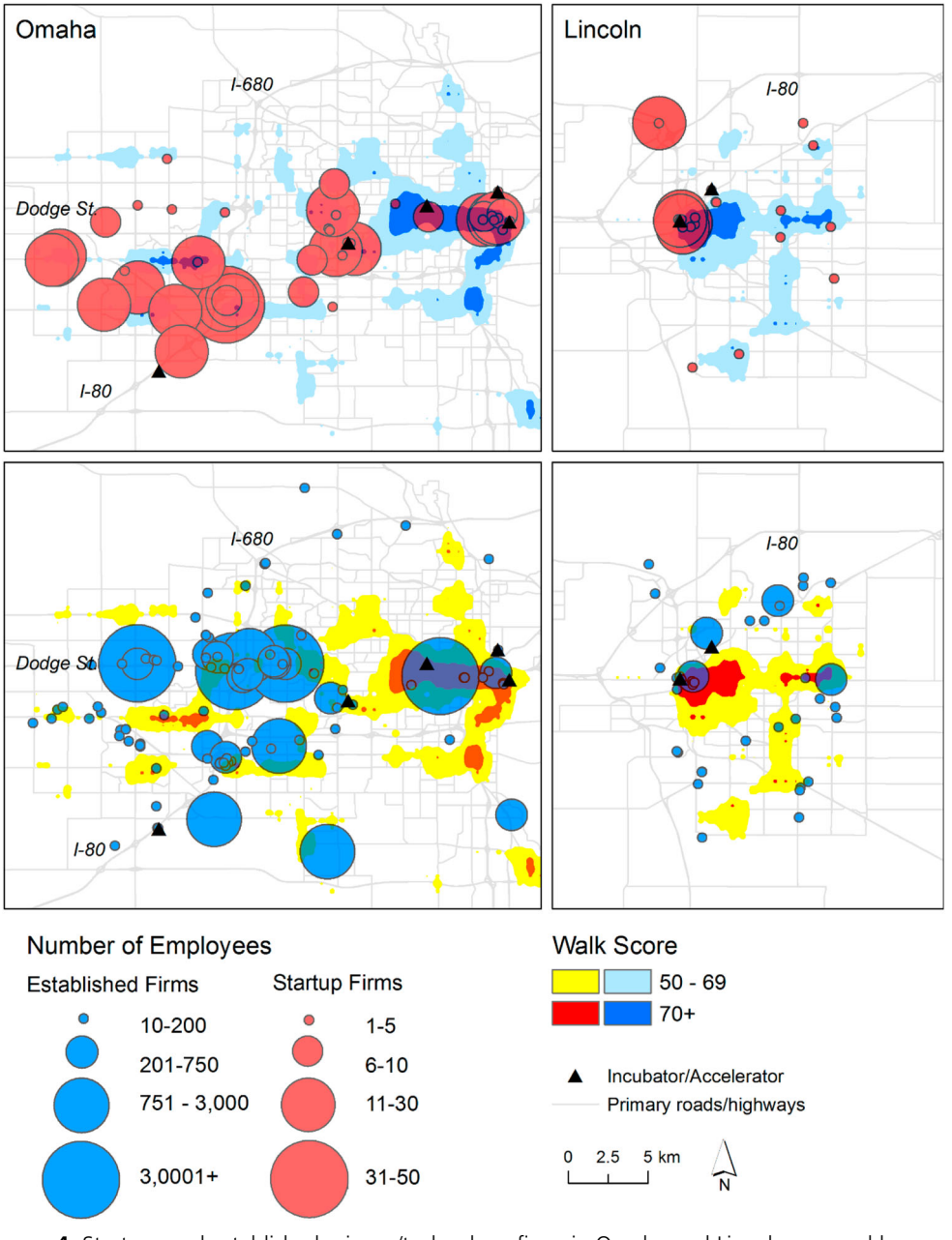

Figure 4. Start-up and established science/technology firms in Omaha and Lincoln mapped by number of employees.

and pedestrian benches, a small but versatile park and plaza hosts a farmers' market, concerts and other neighbourhood events, and a complementary mix of residential, retail and office space helps ensure some activity throughout much of the day and evening. 'The Village' currently boasts two coffee shops and several varieties of bars and restaurants and that serve well as third places. Additionally, the adjacency of UNO's south campus (i.e., 'Scott Campus') featuring the University's School of Business and College of Science and Technology, in combination with the nearby

Innovation Accelerator and Scott Technology Center start-up incubators, enables enhanced access to technological resources and expertise. About 20% of the science/tech start-ups in Omaha could be found within 2 km of the UNO campus. Aksarben Village is also close to the centroid for all science/tech start-ups in Omaha identified in this study (Figure 3).

Although not as significant of a cluster, five science/tech start-ups were located within a suburban office park near the I-80 and I-680 beltway interchange in Omaha. The office park is also home to 11 of the 99 established science/tech firms identified in Omaha. Less centralized than the commercial corridor near Dodge St. and I-680 (another epicenter of established science/tech firm activity), this area offers relatively affordable office space with good accessibility to the metro via I-80 and the adjacent L Street arterial avenue. Notably, the established science/tech firms here are smaller than average and thus, like the nearby start-up firms, may not be able to compete with the larger established firms 5 km north near the Dodge St./I-680 interchange. Both areas are highly auto-dependent with walk scores mostly < 50. There are several restaurants and coffee shops in walking distance of the I-80/L Street office park; however, most are drive-through fast-food chains strung along four-lane roadways and surrounded by broad parking lots or embedded within suburban retail strip-malls. The office buildings themselves are generally low rise (i.e., one to four stories) with extensive surface parking lots, substantial setbacks and few, if any, sidewalks to connect one another or to nearby retail areas.

DISCUSSION

The results of this case study of Nebraska's 'Silicon Prairie' appear to reconcile the seemingly contradictory observations made by Spencer (2015) that science/tech firms are more likely to be found in suburban areas, and the findings by Florida and King (2016) indicating that central urban neighbourhoods are loci for venture capital investment in technology start-ups. Established science/tech firms were indeed more likely to be found in suburban areas with low walkability (in line with Spencer); however, start-ups in these industries have a stronger propensity for locating in walkable neighbourhoods (in line with Florida and King), many also in close proximity to university campuses and/or start-up incubators/accelerators. Furthermore, science/tech start-ups were associated with significantly higher walk scores, on average, than both randomly selected firms (of all sizes, ages, and industries) and randomly selected start-ups (of all industries). Owing to the potential benefits of locating in more walkable neighbourhoods, it was expected that start-ups would be associated with significantly higher walk scores, though it is interesting that this appears to pertain more to some industry sectors, including science/technology and creative/cultural industries (Spencer, 2015), than others. It may be that smaller knowledge-based/creative firms in general, whether they are more science, technology or art/design oriented, rely more heavily on the inter-firm interactions, tacit knowledge transfers and labour sharing that urban neighbourhoods can more readily facilitate (Audretsch & Feldman, 1996; Keeble & Nachum, 2002; Rault & Sarfati, 2015).

The results presented here also tend to corroborate, on a more detailed, localized scale, recent findings by Hamidi and Zandiatashbar (2018), suggesting a positive relationship in the United States between innovation productivity (based on awards for R&D innovation) and neighbourhood walkability across a nationwide sample of metropolitan census tracts. However, they also observed a negative relationship between neighbourhood compactness and innovation productivity, suggesting that start-ups may be seeking out less compact but more affordable areas of the city that still offer some walkability and high degree of proximity to other related firms. This tendency was visible here in the Nebraska case study as well, with several start-ups clustered alongside established science/tech firms in a less centralized, and more affordable, office park in south-west Omaha.

The Aksarben neighbourhood in Omaha and the Haymarket/Downtown area in Lincoln both exhibit several attributes of so-called 'innovation districts', despite no formal designation as such. Katz and Wagner (2014, p. 1) define innovation districts as 'geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators'. The authors note the evolution of such districts in a diverse spectrum of cities across the United States, including Midtown in Atlanta, the Cortex in St. Louis, and the I.D.E.A. District in San Diego. As with these locales, Aksarben and the Haymarket are characterized by pedestrian-oriented design and human-scale development, are each near research institutions (i.e., UNO and the University of Nebraska Medical Center in Omaha, and the flagship campus of the University of Nebraska at Lincoln), and house large, established tech firms such as Microsoft and HDR in Aksarben and Hudl in the Haymarket, as well as start-up incubators and accelerators. With two start-up incubators in close proximity, and within walking distance of the Old Market entertainment district and Creighton University, downtown Omaha and the adjacent 'NoDo' area may also be emerging as a proto-innovation district, albeit more in line with the spatially diffuse Midtown–Downtown innovation corridor model in Atlanta than the smaller scale and more tightly woven Cortex district in St. Louis. As in other regions struggling with the out-migration of college-educated young professionals (i.e., 'brain drain'), the development of a supportive entrepreneurial ecosystem within the Omaha and Lincoln area may be one strategy to stave off such loses while generating new economic growth (Florida, 2006; Landry, 2000; Ruggles, 2018).

It is recommended that future work delve deeper into the potential connections between walkability and human-scale development and start-up/entrepreneurial activity using qualitative methods such as interviews and surveys. While this study presented a strong spatial and statistical correlation between start-ups and walkability, testing theory regarding the precise casual mechanisms for this relationship would involve collecting first-hand accounts from the owners and employees of start-ups similar to Costa and Lopes (2015) and Durmaz's (2015) investigations of 'creative' industry workers and urban design. Specific questions may be asked about the role of different urban design features in site selection relative to other spatial, economic and social considerations. The quantitative measure of walkability used here (i.e., Walk Score) could also be supplemented using additional, finer scale quantitative or qualitative data gathered from walking audits, surveys or other methodologies. As a mid-sized metropolitan region with a relatively young high tech ecosystem dwarfed by those in San Jose or Boston, the patterns of start-up activity in relation to urban form in the Omaha–Lincoln area is unlikely to reflect fully patterns of entrepreneurial activity observed elsewhere. The generalizability of these findings may thus be limited to similarly sized urban regions with a comparable variety of neighbourhood densities and typologies. An examination of the walkability–entrepreneurial nexus in other city-regions higher and lower in the urban hierarchy, and with varying degrees of entrepreneurial activity and urban morphologies, is advisable.

While additional studies are warranted, it is increasingly clear that a shift toward denser, more walkable, mixed-use urban spaces offer gains in technological innovation and economic growth that may compliment numerous benefits to human health, social life and the environment (Litman, 2003; Rogers, Gardner, & Carlson, 2013; Sallis et al., 2016). With recognition of these benefits, and shifting demographics leading to greater demand for urban living (Ehrenhalt, 2012; Moos, 2016), even those environments that historically have been constructed around the automobile have begun to incorporate more traditional urban design features (Malizia & Motoyama, 2016). The auto-centric and office-dominated Research Triangle Park in North Carolina, for example, will soon take on a more mixed-use character with the addition of a new retail 'town centre' and over 1000 residential units (RTP, 2018). Despite advances in telecommunications, the need for proximity and face-to-face interaction to propel innovation within today's rapidly evolving knowledge/information-based economy has perhaps never been greater.

Cultivating dense, walkable and human-scale urban spaces may be an effective way to boost a region's innovative ecosystem, while also advancing other key facets of urban liveability.

DISCLOSURE STATEMENT

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