

A V-LINC Analysis of Chicago's ICT Cluster Ecosystem.

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Abstract

Chicago has a booming tech sector, which competes with firms based in the Silicon Valley's world renowned technology cluster (Saxenian, 1996; Porter, 1998b, 2000). However, Chicago was not identified in the US Cluster Mapping Project as having a strong IT cluster (US Cluster Mapping, 2015). The U.S. Cluster Mapping Project provides nationally consistent benchmark cluster definitions that can be used to assess the presence of clusters in regions across the USA. Additionally, an ICT cluster has not been identified by key economic policy organisations in the region, such as Chicago Metropolitan Agency for Planning (CMAP) or World Business Chicago (WBC). However, the information technology and telecommunications sectors in Chicago (CMAP, 2009) has shown growth and dynamism, and is a significant sector not only in terms of the jobs it creates directly but through supporting other sectors in Chicago, due to ICT's nature as a key enabling technology across all segments of the economy.

V-LINC, a methodology which identifies, records and analyses the linkages that firms in clusters engage in, is applied to the Information Communication Technologies (ICT) sector in Chicago, Illinois, USA. V-LINC was developed in Cork Institute of Technology to enrich academic literature on clusters. It provides visual information on the geographic footprint of cluster ecosystems and measures the business impact of cluster linkages. Through an understanding of the various linkages that firms in a cluster engage, targeted policy recommendations can be made to build on strengths and aid weaknesses.

As the Chicago ICT sector develops and expands it is important that industry players, business support organisations and policy makers understand how the ICT ecosystem operates both within Chicago as well as its external relationships forged beyond the city, so that collaboratively, they can deliver growth and employment through supportive policy.

Keywords: V-LINC, industry cluster, ecosystem, ICT, mapping.



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Introduction

This paper represents collaboration between the Cork Institute of Technology, University of Illinois at Urbana Champaign and Chicagoland Chamber of Commerce who partnered to apply V-LINC to the ICT specialisation in Chicago.

Although Chicago has a booming tech sector, one which competes with the most successful technology clusters globally - Silicon Valley (Saxenian, 1996; Porter, 1998b, 2000), it was not identified in the US Cluster Mapping Project as having an IT cluster (US Cluster Mapping, 2015). The U.S. Cluster Mapping Project provides nationally consistent benchmark cluster definitions that can be used to assess the presence of clusters in regions across the USA. Furthermore, an ICT cluster has not been identified by key economic policy organisations in the region, such as Chicago Metropolitan Agency for Planning (CMAP) or World Business Chicago (WBC). However, the information technology and telecommunications sectors in Chicago (CMAP, 2009) has shown growth and dynamism, and is a significant sector not only in terms of the jobs it creates directly but through supporting other sectors in Chicago, due to ICT's nature as a key enabling technology across all industries.

The paper begins with an explanation of V-LINC, a methodology which records, categorizes and measures the business importance of linkages that cluster firms participate in, along with the facility to show linkages on geographic maps of appropriate scale. Linkages between firms and other organisations are at the heart of how clusters function. Linkages are defined (Hobbs, 2010; p 221) as "relationships that enable exchange of goods, services, personnel, information, ideas, expertise, grants and other supports to business that occur between two or more parties, over a sustained time period." Next, the paper comments on the scale of the ICT industry in Chicago, then reviews findings from V-LINC analysis on the linkages of a sample of ICT firms in Chicago. The analysis includes: the distribution of linkages by category, by geographic scope, and by their business impact as recorded by company employees who engage in the linkages. V-LINC maps illustrate the linkages at different geographic scopes. Arising from the analysis a judgement is made about the extent of cluster activity in the ICT Sector in Chicago. The paper closes with recommendations on how to strengthen and support the ICT cluster in Chicago.

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V-LINC: Visualisation of Linkages in Networked Clusters

V-LINC¹ is a methodology for identifying, recording and analysing the linkages that firms in clusters engage in. It categorizes these linkages, and groups them by geographic scope: Local linkages, within Chicago; State linkages, outside of Chicago and within the State of Illinois; National linkages, outside of Illinois and within the USA; and International linkages, outside of the USA. Furthermore, V-LINC records the business impact of linkages based on the perceptions of firm personnel who engage in the linkages with other companies and organisations. Data for V-LINC analysis of linkages is collected by structured interviews of company personnel. Likert scale questions are employed to gauge the business impact of individual linkages. V-LINC maps give a visual representation of the relative reliance on local, State, National or international linkages of a company and when combined, of a cluster (Figure 2). V-LINC facilitates policy development at city, state and federal levels, through the aggregation of data from a sample of firms. Confidentiality of firms' linkages is maintained throughout.

V-LINC assigns company linkages to one of eight categories (Figure 1). Besides linkages along the supply chain, namely those which provide Inputs and Specialist Services to firms, and Output linkages which provide markets for goods produced, V-LINC adds five other categories of linkages: those with Industry Peers, with Industry Associations, with Research & Development partners, with Training partners and with Government Agencies. The linkage categories in V-LINC derive from Porter's (1990, 1998a and 1998b) discourse on the interactions and relationships of companies in a cluster.

V-LINC responses collected through structured interviews combine to reveal the business impact of linkages by expert company personnel. Likert scale responses convert qualitative judgments into quantitative data which are subject to further analysis. The importance of the linkages are recorded and scored between 0 and 40, then arranged into four business impact bands based on their importance: High (30 to 40), Medium (20 to 30), Low (10 to 20), or Tenuous (0 to 10). This enables V-LINC users to answer the question: at which geographic level and linkage category do clusters' most valuable linkages occur. Next, the rationale for applying V-LINC to the ICT Sector in Chicago is outlined.

¹ V-LINC is a hybrid methodology for cluster analysis developed by Byrne (2016). Byrne combines the 'Four i Linkage Scale' (Hobbs, 2010), network theory and visualisation techniques to map, trace and visualise cluster ecosystems. The V-LINC methodological framework, linkage categories and business impact bands are defined in Byrne (2016).

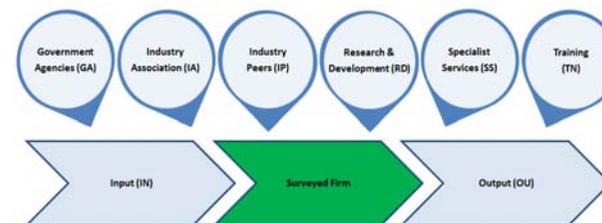


Figure 1: The Eight V-LINC linkage categories analysed for each firm.

The ICT Sector in Chicago

The Chicago region is globally competitive in the ICT sector with many of the nation's largest technology firms choosing to locate there. From 2006 to 2015, the number of web, mobile and e-commerce companies increased by 3,402 companies, a growth rate of 49.9% (WBC, 2015). The technology sector has been the fastest growing sector in the Illinois economy since 2011, and is predicted to double its size in the next decade, having been supported by servicing traditional industrial strong-holds in the state such as manufacturing, retail, finance and agriculture. State-wide, technology jobs have been growing at 1.6%, faster than the national average of 1.1% (The Economist, 2013). Jones, Lang and LaSalle (2015) state that significant development of Chicago's tech ecosystem in recent years has also led many entrepreneurs to choose to start and grow their businesses in Chicago rather than moving to traditional tech strongholds like the Bay Area.

Critical to its success, Chicago offers a highly educated labour pool of technology and entrepreneurial graduates coming out of Northwestern University, the University of Chicago, the University of Illinois and other world-class institutions across the Midwest. One problem that the ICT sector has experienced is persuading these graduates to stay in the region. The founders of Netscape, PayPal, Yelp and YouTube all studied at the University of Illinois but then left after graduation. The region is counteracting this brain drain with initiatives such as ThinkChicago: Lollapalooza competition (<http://www.thinkchicago.net/>) and the Chicago College Start Up Competition, which gives 10 winning businesses free access to office space and mentorship (Tullman, 2014). Both of these initiatives are supported by one the top start-up incubators worldwide, which is based in Chicago – 1871. 1871, started in 2012, plays a central role in the Chicago start-up community and was ranked first in the UBI Global list of top university-affiliated business incubators in 2015 (Wooten, 2015). The incubator is a 75,000-square-foot start-up hub located at the Merchandise Mart. Held up as a symbol of the city's bustling tech sector, 1871 offers a connection point for entrepreneurs, venture capitalists, academics and industry officials. 1871 forms part of the strong start-up ecosystem in Chicago, with organisations such as Built In Chicago, the Illinois Technology Association, and the Chicagoland Entrepreneurial Center. Furthermore, in 2015, Chicago ranked as the 5th largest and 11th fastest-growing tech market in the country (CBRE, 2015)

The region is also leading the way in industry-university collaboration with the establishment of UI Labs and the Digital Manufacturing and Design Innovation Institute (DMDI). The centre is focused on research and commercialization, and is a public-private partnership between the University of Illinois and more than 70 corporations and universities including Boeing and Illinois Tool Works — both locally headquartered Fortune 500 companies. UI Labs is located on Goose Island in a 94,000-square-foot facility and aims to solve complex challenges no one sector or player could address on their own.

The US Cluster Mapping Project launched in 2014, is led by Harvard Business School’s Institute for Strategy and Competitiveness, in partnership with the US Department of Commerce and US Economic Development Administration, established a new cluster mapping database based on academic research concerning industry clusters, competitiveness and regional business environments in the US - www.clustermapping.us. The project makes data available to both private and public organisations to assist them when making strategic investments, modernizing economic development strategies and better understanding their business environment (US Cluster Mapping Project, 2015). Applying the Cluster Mapping approach to metropolitan Chicago shows that the region is home to a diverse economy with a number of areas of specialization, measured by location quotient, in Biopharmaceuticals, Lighting and Electrical Equipment, Downstream Chemical Products, Metalworking Technology, and Marketing, Design and Publishing. The US Cluster Mapping Project found a high employment share in IT and Analytical Instruments in the Chicago region, with 36,108 employed in 2013. However, the analysis did not find a strong cluster in IT and Analytical Instruments in Chicago as it recorded a specialization (Location Quotient) of 0.74. Strong clusters are defined as those where the location quotient, i.e. the cluster’s relative employment specialization, puts them into the leading 25% of regions across the U.S. in their respective cluster category. The results suggesting no ICT cluster exists is counterintuitive to the growth and dynamism on the ground in the ICT sector in Chicago.

Furthermore, research by CMAP previously identified the region's freight (CMAP, 2013a) and manufacturing clusters (CMAP, 2013b), but did not identify an ICT cluster. In 2012, Chicago unveiled a new economic development strategy that was based on a study conducted by WBC, which is the city’s public-private economic development agency. The study was based on a series of reports by subcommittees that focused on the strengths and weaknesses of Chicago’s economy. The report identified ten strategies, which included a focus on specific industry clusters - advanced manufacturing, professional services etc. but not ICT. While the ICT cluster in Chicago has not been identified as a strong cluster, or for economic policy development, it is an important sector not solely for its own growth, but as it is a cross-cutting industry which affects growth and innovation in the other clusters in Chicago identified by the US Cluster Mapping Project, CMAP and WBC. Investigating the linkages that Chicago firms in the ICT cluster engage in can prove beneficial in understanding the cluster and developing policy recommendations for future growth.

This research has been funded through the ERASMUS+ International Credit Mobility - European Union’s Programme for Education, Training, Youth and Sport 2015-2016 in partnership with the University of Illinois and Chicagoland Chamber of Commerce. V-LINC has been applied to a sample of 10 ICT firms based in Chicago, with a specific focus on SMEs whose market is the Chicago region and Illinois State. Thirteen face to face meetings were held with personnel from these companies to gather information in regard to their key relationships. These meetings uncovered 341 firm linkages (Table 1). The term Respondent Firm Group (RFG) relates to the summation of data for the ten ICT respondent firms.

V-LINC Analysis Results: ICT Chicago.

Table 1 lists the firms who participated in the V-LINC analysis. It provides the percentage of linkages they report in each of the eight linkage categories along with the total number of linkages they engage in. It also distinguishes the total numbers of linkages per category for the cluster. Table 1 report’s that the most frequent linkages are in outputs which account for 33% of linkages reported; followed by inputs (19%) and specialist services (18%). This is not unexpected as firms exist due to continued development of revenues and customers. Inputs and services feed into firm’s product and service offering. The least frequent linkage categories are Government agencies and training at 4% and 5% of all linkages, respectively. This may indicate a disjoint with Government Agencies and training providers.

| Company | SIZE | GA | IA | IP | IN | OU | RD | SS | TN | Total (n) |
|--------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-----------|
| 3D Printer Experience | Micro (<10) | 7.4% | 18.5% | 3.7% | 7.4% | 25.9% | 3.7% | 14.8% | 18.5% | 27 |
| Big Marker | Small (<50) | 0.0% | 9.7% | 12.9% | 12.9% | 45.2% | 0.0% | 16.1% | 3.2% | 31 |
| CNXT | Micro (<10) | 3.2% | 3.2% | 0.0% | 19.4% | 41.9% | 9.7% | 19.4% | 3.2% | 31 |
| CPUrx | Micro (<10) | 4.3% | 8.5% | 14.9% | 23.4% | 21.3% | 4.3% | 14.9% | 8.5% | 47 |
| Gesture | Medium (50-250) | 0.0% | 12.0% | 12.0% | 24.0% | 40.0% | 8.0% | 4.0% | 0.0% | 25 |
| Hyla Soft | Medium (50-250) | 3.2% | 6.5% | 14.5% | 12.9% | 50.0% | 4.8% | 4.8% | 3.2% | 62 |
| Rico Enterprises | Small (<50) | 11.1% | 4.4% | 13.3% | 6.7% | 13.3% | 13.3% | 37.8% | 0.0% | 45 |
| SMB Helpdesk | Small (<50) | 0.0% | 17.9% | 0.0% | 32.1% | 39.3% | 3.6% | 7.1% | 0.0% | 28 |
| Steadfast | Small (<50) | 0.0% | 23.1% | 0.0% | 26.9% | 23.1% | 0.0% | 23.1% | 3.8% | 26 |
| YJT Solutions | Small (<50) | 5.3% | 10.5% | 10.5% | 21.1% | 26.3% | 0.0% | 21.1% | 5.3% | 19 |
| RFG Average | | 3.8% | 10.3% | 9.4% | 17.6% | 33.1% | 5.3% | 16.1% | 4.4% | 34 |
| Total (n) | | 13 | 35 | 32 | 60 | 113 | 18 | 55 | 15 | 341 |
| Most Populous (Rank 1-8) | | 8th | 4th | 5th | 2nd | 1st | 6th | 3rd | 7th | |

Table 1: Distribution of Linkages by Category and by Firm²

² Note to Table 1: The eight linkage categories are: Government agencies (GA); Industry association (IA); Industry peers (IP); Inputs (IN); Output (OU); Research & development (RD) Specialist service linkages (SS) and Training (TN).

Linkage categories by geographic Scope:

Geographic proximity of firms, local connections between firms with other firms or organisations and face-to-face interaction play a central role in cluster theory and are attributed with producing higher growth and innovation in clusters. Porter (1998a, p 226) believes, “a cluster is a form of network that occurs within a geographical location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions.” However, modern advances in communication and technology have impacted the need for geographic proximity and allow connected firms to be more widely dispersed across a region, or even countries. Firms may source inputs from multiple regions, may engage in R&D with research organisations in foreign countries, and sell into international markets. Therefore it is important to look at the geographic scope of linkage categories, and also the business impact of linkages which occur over different geographic scopes.

Table 2 and Figure 2 display the linkages reported at each geographic level for each of the eight linkage categories. Table 2 distinguishes the dominant geographic scope for each category and shows that 50% of output linkages in this study are within the state, whilst a further 44.2% serve the US market. Very few export linkages occur (6.2%) from these companies which indicates a lack of focus on exporting at present, which could be linked to the firm size in the RFG (Table 1), as smaller firms are less inclined to export than larger firms. When we examine the linkages of those firms who export their goods, a total of only seven International output linkages were reported for the RFG, and only three of the firms in the respondent group engage in these international links. Supports for access to international distribution channels can benefit the Chicago ICT sector as its firms grow.

| Geographic Scope | Local | State | National | International | Total (n) |
|------------------------|-------|-------|----------|---------------|-----------|
| Government Agencies | 61.5% | 15.4% | 23.1% | 0.0% | 13 |
| Industry Association | 74.1% | 2.9% | 22.9% | 0.0% | 35 |
| Industry Peers | 31.3% | 15.6% | 50.0% | 3.1% | 32 |
| Inputs | 21.7% | 11.7% | 53.3% | 13.3% | 60 |
| Outputs | 37.2% | 12.4% | 44.2% | 6.2% | 113 |
| Research & Development | 38.9% | 22.2% | 22.2% | 16.7% | 18 |
| Specialist Service | 36.4% | 5.5% | 56.4% | 1.8% | 55 |
| Training | 33.3% | 13.3% | 46.7% | 6.7% | 15 |
| Total (%) | 38.4% | 11.1% | 44.3% | 6.2% | 100% |
| Total (n) | 131 | 38 | 151 | 21 | 341 |

Table 2: Distribution of Linkage Categories by Geographic Scope

Similarly the majority of Inputs (53%) and Specialist services (56%) are also sourced from across the US, while the firms record 50% of their industry peer linkages with other firms outside of Illinois and within the US. Overall National linkages, those outside of Illinois but within the USA, are most frequent making up 44.3% of all linkages. It’s clear that there are pockets of the US important and heavily linked to the Chicago ICT sector on the West - Seattle, Portland, San Francisco, Los Angeles and San Diego, and on the East – Boston, New York, Philadelphia, Washington and Tampa.

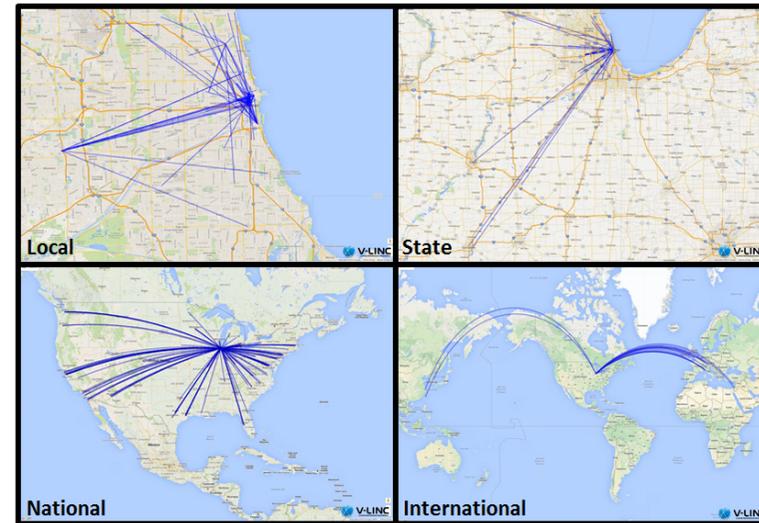


Figure 2: Chicago ICT Linkages by Geographic Scope.

Porter (1998b) places great emphasis on linkages to and support from organisations and businesses, within the locality. The word local or locally appears in each element of his diamond of local industrial clustering. If local linkages are critical to the functioning of a cluster, table 2 shows that local linkages make up 38% of all linkages reported in the study, the remaining 54% of linkages being divided between State (11.1%), national (44.3%) and international (6.2%) linkages. The firms have a large proportion of Government Agency (61.5%) and Industry association (74.1%) linkages within the Chicago area. The next section presents the business impact values attributed to each individual category.

The linkage maps in Figure 2 highlight the quantity of linkages in the Loop, the central business district of Chicago, Illinois. It is one of the city's 77 designated community areas and home to Chicago's commercial core, City Hall, and the seat of Cook County. The community area is bounded on the north and west by the Chicago River, on the east by Lake Michigan, and on the south by Roosevelt Road.

Business Impact Findings

Tables 3a to 3e show the percentage of linkages (by category) that fall into the business impact bands. The business impact of each linkage category relates to the business importance of individual linkages based on the perception of expert respondents involved with these linkages. Table 3a shows the combined business impact results for all linkages, whilst tables 3b to 3e, break the data into local, State, National and international linkages.

In table 3a, it is apparent that when the proportions of High and Medium linkages are combined Inputs (93% in High and Medium linkages) are rated of highest impact, followed by specialist services (87%) and outputs (85%). As a company's customers and suppliers are central to the success of the firm this is not surprising. In seven of the eight linkage categories, the majority of linkages are in the top two business impact bands (e.g. high and medium bands); overall 79% of all linkages reported were in these bands. Industry peer linkages, formal and informal relationships with other companies in similar or related industries, are rated of least importance to the firms with 54.1% of linkages in the Low and Tenuous categories.

| Category | GA | IA | IP | IN | OU | RD | SS | TN | Total % | Total (n) | |
|-----------------|----------|-------|-------|-------|-------|-------|-------|-------|---------|-----------|-----|
| Business Impact | | | | | | | | | | | |
| High | 30 to 40 | 38.5% | 8.6% | 15.6% | 38.3% | 48.7% | 11.1% | 43.6% | 26.7% | 35.5% | 121 |
| Medium | 20 to 30 | 23.1% | 57.1% | 31.3% | 55.0% | 36.3% | 55.6% | 43.6% | 53.3% | 43.7% | 149 |
| Low | 10 to 20 | 30.8% | 28.6% | 40.6% | 6.7% | 15.0% | 33.3% | 12.7% | 20.0% | 18.8% | 64 |
| Tenuous | 0 to 10 | 7.7% | 5.7% | 12.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 2.1% | 7 |
| Total (n) | | 13 | 35 | 32 | 60 | 113 | 18 | 55 | 15 | 341 | 341 |

Table 3a: Business Impact by Linkage Category

It is also interesting to assess the business impact accorded to linkages at each geographic scope. Table 3b focuses on the business impact of 131 local linkages in Chicago. The most important linkages at the local level, i.e. most linkages reported in the high or medium business impact bands, are Input (100%), Training (100%) and Output (88%) linkages. It's important to qualify these results with the fact that 27% of Input linkages (n=13), 37% of Training (n=5) and 33% of inputs (n=42) are reported at local level. The majority of Government Agency and Industry Association linkages are recorded with local organisations, the connections are relatively important to the firms with 63.5% of Government Agency and 69.2% of Industry Association linkages in the top two quartiles. On the opposite end of the importance scale 50% of Industry Peer and 43% of Research and Development linkages are reported in the Low and Tenuous business impact bands.

| Category | GA | IA | IP | IN | OU | RD | SS | TN | Total % | Total (n) | |
|-----------------|----------|-------|-------|-------|-------|-------|-------|-------|---------|-----------|-----|
| Business Impact | | | | | | | | | | | |
| High | 30 to 40 | 37.5% | 3.8% | 10.0% | 46.2% | 52.4% | 14.3% | 20.0% | 40.0% | 30.5% | 40 |
| Medium | 20 to 30 | 25.0% | 65.4% | 40.0% | 53.8% | 35.7% | 42.9% | 60.0% | 60.0% | 48.1% | 63 |
| Low | 10 to 20 | 25.0% | 30.8% | 50.0% | 0.0% | 11.9% | 42.9% | 20.0% | 0.0% | 20.6% | 27 |
| Tenuous | 0 to 10 | 12.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.8% | 1 |
| Total (n) | | 8 | 26 | 10 | 13 | 42 | 7 | 20 | 5 | 131 | 131 |

Table 3b: Business Impact by Linkage Category - Local Linkages

Table 3c presents the business impact data for 38 linkages that occur across the State of Illinois (and outside the city of Chicago), 79% of which are in the top two business impact quartiles. In contrast to the local linkages, at a State level 100% of Industry Peer and 75% of Research and Development linkages are reported in the High and Medium business impact bands.

| Category | GA | IA | IP | IN | OU | RD | SS | TN | Total % | Total (n) | |
|-----------------|----------|-------|------|-------|-------|-------|-------|-------|---------|-----------|----|
| Business Impact | | | | | | | | | | | |
| High | 30 to 40 | 50.0% | 100% | 40.0% | 14.3% | 50.0% | 0.0% | 0.0% | 50.0% | 34.2% | 13 |
| Medium | 20 to 30 | 0.0% | 0.0% | 60.0% | 71.4% | 35.7% | 75.0% | 33.3% | 0.0% | 44.7% | 17 |
| Low | 10 to 20 | 50.0% | 0.0% | 0.0% | 14.3% | 14.3% | 25.0% | 66.7% | 50.0% | 21.1% | 8 |
| Tenuous | 0 to 10 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0 |
| Total (n) | | 2 | 1 | 5 | 7 | 14 | 4 | 3 | 2 | 38 | 38 |

Table 3c: Business Impact by Linkage Category – State Linkages

The most populace geographic scope is at a National level, where the business impact of the 151 linkages is displayed in Table 3d, 79% of which are reported to be of high or medium business impact. Approximately 75% of the National linkages are reported across the value chain type linkages, inputs, output and specialist services. Specialist Service (97%) linkages followed by Inputs (93%) and Outputs (80%) are again reported to be the strongest connections at this geographic scope. Additionally, US industry peers are held in low regard by the respondents, with 68% of these linkages found in the low and tenuous bands.

| Category | GA | IA | IP | IN | OU | RD | SS | TN | Total % | Total (n) | |
|-----------------|----------|-------|-------|-------|-------|-------|-------|-------|---------|-----------|-----|
| Business Impact | | | | | | | | | | | |
| High | 30 to 40 | 33.3% | 12.5% | 12.5% | 43.8% | 44.0% | 25.0% | 64.5% | 0.0% | 40.4% | 61 |
| Medium | 20 to 30 | 33.3% | 37.5% | 18.8% | 50.0% | 36.0% | 50.0% | 32.3% | 71.4% | 38.4% | 58 |
| Low | 10 to 20 | 33.3% | 25.0% | 43.8% | 6.3% | 20.0% | 25.0% | 3.2% | 28.6% | 17.2% | 26 |
| Tenuous | 0 to 10 | 0.0% | 25.0% | 25.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 4.0% | 6 |
| Total (n) | | 3 | 8 | 16 | 32 | 50 | 4 | 31 | 7 | 151 | 151 |

Table 3d: Business Impact by Linkage Category - National Linkages

Table 3e reports business impact for the 21 international linkages. Over two thirds of the international linkages are made up by the output and input categories and the majority of these linkages are reported in the high and medium impact band. Output and Input connections are focused on Europe – Ireland, UK, Germany, Italy and Cyprus, and Asia – China and Taiwan. International links with research and development are viewed as important to the respondent firms, with 67% in the High and Medium bands.

| Category | GA | IA | IP | IN | OU | RD | SS | TN | Total % | Total (n) | |
|-----------------|----------|------|------|------|-------|-------|-------|------|---------|-----------|----|
| Business Impact | | | | | | | | | | | |
| High | 30 to 40 | 0.0% | 0.0% | 0.0% | 25.0% | 57.1% | 0.0% | 0.0% | 100% | 33.3% | 7 |
| Medium | 20 to 30 | 0.0% | 0.0% | 0.0% | 62.5% | 42.9% | 66.7% | 100% | 0.0% | 52.4% | 11 |
| Low | 10 to 20 | 0.0% | 0.0% | 100% | 12.5% | 0.0% | 33.3% | 0.0% | 0.0% | 14.3% | 3 |
| Tenuous | 0 to 10 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0 |
| Total (n) | | 0 | 0 | 1 | 8 | 7 | 3 | 1 | 1 | 21 | 21 |

Table 3e: Business Impact by Linkage Category – International Linkages

Table 4 reports the number and percentage of linkages reported in each of the business impact bands for each geographic scope, to compare the overall business impact of linkages at each geographic scope. Porter (2000) believes ‘once a cluster forms, the whole group of industries becomes mutually supporting. Benefits flow forward, backward, and horizontally,’ therefore, it is important to look closely at the business impact of local linkages. Local linkages account for 131 of the 341 reported, 30.5% (n=40) of which are reported as highly significant, however this is the lowest proportion of linkages reported in the High business impact band when compared with State (34.2%), National (40.4%) and International (33.3%) scopes. The respondent firms engage in more linkages across the US (n=151) than at any other geographic scope. Respondents seem less likely to engage in international linkages which are at further distances (possibly because these links are harder to form and maintain). However, international linkages are reported as being more important or beneficial to the respondent firms with 85.7% of International linkages appearing within the high and medium impact bands.

| Geographic Scope | Local | State | National | International | Total | |
|------------------|----------|-------|----------|---------------|-------|--------|
| Business Impact | | | | | | |
| High | 30 to 40 | 30.5% | 34.2% | 40.4% | 33.3% | 121 |
| Medium | 20 to 30 | 48.1% | 44.7% | 38.4% | 52.4% | 149 |
| Low | 10 to 20 | 20.6% | 21.1% | 17.2% | 14.3% | 64 |
| Tenuous | 0 to 10 | 0.8% | 0.0% | 4.0% | 0.0% | 7 |
| Percentage | | 38.4% | 11.1% | 44.3% | 6.2% | 100.0% |
| Total (n) | | 131 | 38 | 151 | 21 | 341 |

Table 4: Business Impact by Geographic Scope of Linkages

Key Connectors

Figure 3 illustrates the key connectors in the Chicago ICT sector. The key connectors are those organisations who connect the cluster. They are identified through the number of linkages they have with respondent firms and the importance of those linkages to respondents is reported in Table 5.

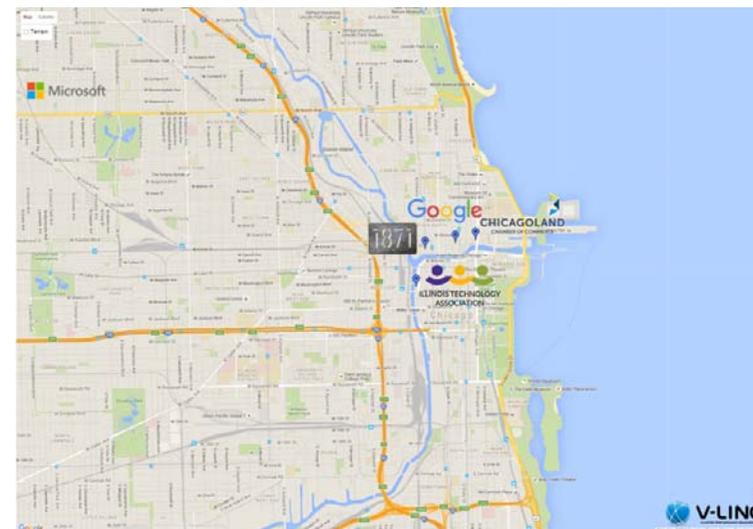


Figure 3: Key Connectors Chicago ICT Sector.

| Key Connector | Chicagoland Chamber | Microsoft | Google | ITA | 1871 | |
|------------------|---------------------|------------|------------------|------------------|------------|------------------------|
| High | 30 to 40 | 10% | 67% | 20% | 0% | 75% |
| Medium | 20 to 30 | 90% | 33% | 60% | 80% | 25% |
| Low | 10 to 20 | 0% | 0% | 20% | 20% | 0% |
| Tenuous | 0 to 10 | 0% | 0% | 0% | 0% | 0% |
| Total (n) | | 10 | 9 | 5 | 5 | 4 |
| Linkage Category | | 8 IA, 2 OU | 5 IN, 2 IP, 1 TN | 3 IP, 1 IN, 1 SS | 4 IA, 1 RD | 1 TN, 1 OU, 1 IA, 1 SS |

Table 5: Business Impact of Key Connectors Chicago ICT Sector.

In terms of the key connectors identified in the Chicago ICT sector, there are strong linkages to industry associations, inputs and industry peers. The standout industry associations linked to the RFG are the Chicagoland Chamber of Commerce and ITA - Illinois Technology Association, with the Chamber having twice as many connections to the RFG and being viewed as more important i.e. 100% of linkages to the Chamber were reported in the High and Medium bands.

Microsoft and Google are linked to the RFG as both key suppliers (inputs) and industry peers with complementary and competing products. Both organisations are reported to be well respected by the RFG, as partners, platform integrators and re-sellers. Another interesting inclusion in the linkage data is the strong connection with 1871, which is recorded as extremely valuable to the RFG. Following in the footsteps of successful tech hubs such as Boston, local universities and private groups have partnered to open tech centers to breed the next generation of startups.

Does an ICT Cluster in Chicago exist?

Comparing Chicago ICT cluster with Porter's (1998b) Competitive Diamond of Local Clustering is useful to identify if the determinants of a cluster are apparent in the region. Firstly, in relation to the reliance on local input factors, it is apparent that the firms in Chicago have some local suppliers of inputs and specialist services. However, the majority of these are sourced from the national level (Table 2). Likewise in regard to demand conditions, these firms serve sophisticated and demanding customers, with the V-LINC findings showing empirically that these customers are predominantly local to Chicago and spread across the US. Cluster theory is subtle on the question of reliance on export sales. A high and stable proportion of exports are positive for clustering, however, an over-reliance on the State market (Table 2) may represent a lack of focus on the potential of the US and international markets or alternatively a lack of access to them. In Chicago's case, their firms are having an impact across the US - future pursuit of global markets is essential to drive growth and development as the State market is small when compared with its US and international counterparts (Feser et al., 2008).

A third determinant of Porter's cluster model refers to firm strategy and rivalry: there should be vigorous competition but also cooperation among local rivals. While a large portion of ICT firms surveyed in Chicago do compete directly with each other, there is also a large degree of co-operation through the Chicagoland Chamber of Commerce, Illinois Technology Association and support for co-working spaces. Porter (1998a) notes that industry peer linkages with other companies within the same sector are key drivers of a cluster in regard to innovation and economic growth, as they provide competitive pressure for firms to be innovative and creative. Table 2 reports that 15 industry peers are recorded across Local and State (Chicago and Illinois) levels respectively, suggesting collaboration presently. Local and State Industry Peer linkages were also reported as the most important geographic scopes respectively (Table 3).

With regard to the fourth determinant, of competitive local clustering: related and supporting industries, the picture in Chicago's ICT specialisation show strong connections locally and at a State level with 49% of the 341 linkages operating across Illinois. Only in three linkage categories are the largest proportion of linkages reported inside the State of Illinois: Government Agencies (77%), Industry Associations (77%) and

Research & Development (61%). For Government Agencies and Industry Associations linkages the most important linkages were within Chicago. Although, for Research & Development, local linkages were least important with National, State and international linkages viewed as more significant, in that order.

This research brings the authors to the conclusion that solid foundations required for an ICT cluster are in place in Chicago. The overall ICT sector is extremely diverse, with large MNCs and an abundance of Micro and Small firms addressing different segments of the sector including Internet of Things (IOT), Cyber-security, 3D Printing and system integration. Many firms however, do not have the scale at present to compete on a national and global level, the authors believe that focus is required to drive the growth of SME's related to these thematic areas. These smaller firms face scaling challenges and the supports of a European type cluster organisation could enhance their opportunities to grow significantly.

The authors believe that whilst the US – State and Federal policy system is very different to the European cluster focused model which operates across a number of the most competitive countries in Europe (including: Denmark, France, Germany and Norway), a thorough understanding of the V-LINC results of the ICT ecosystem in Chicago can identify cluster type policy actions to strengthen and support ICT in Chicago. These policy recommendations are outlined in the next section.

Policy Recommendations

Having reviewed the policies adopted in previous reports (CMAP, 2009; Brookings Institution, 2011; WBC, 2012 and CMAP, 2014) at city and State level, the following policies aim to develop the Chicago ICT sector.

Develop a cluster organisation with responsibility for the ICT sector in Chicago.

The researchers propose developing a cluster organisation with the responsibility of supporting and facilitating the growth of the SME ICT cluster in Chicago. This would require the provision of financial supports at a City level to develop a functioning cluster organisation. This further supports the specialisation identified in Information Technology and Telecommunications in Chicago (CMAP, 2009).

ICN (2014) suggest that a cluster organisation can have a significant influence on strengthening collaboration in a cluster, through implementation of effective innovation policy. Figure 4 and Table 3b, show scope for a cluster organisation to support interactions and collaborations between firms in the ICT sector. Fifteen out of the 22 industry association linkages reported were with the Chicagoland Chamber of Commerce and the Illinois Technology Association. These organisations are heavily networked in the ICT sector and could collaborate to develop a European type cluster organisation to represent the ICT sector.

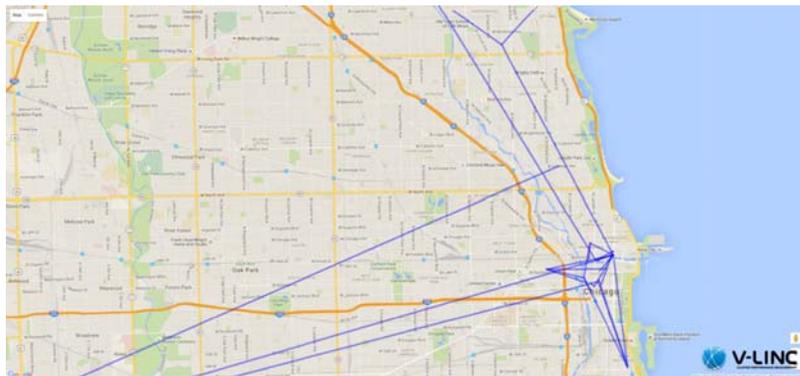


Figure 4: Local Industry Association linkages in Chicago's ICT sector.

The need for such an organisation stems from the requirements of the firms working in the sector but also dovetails with the strategy for Economic Growth and Job creation in Chicago. CMAP (2014, p. 16) suggests “strategies targeting clusters of regional specialisation can help address the fragmentation and unfocused investment that sometimes undermines the emergence of new marketable products and technologies.”

The lack of Government Agency linkages reported by the RFG at a local level (table 3b), suggest that the SMEs involved in the study, find it more difficult to make connections with Government Agencies. Only 6 of the RFG had connections with local Government Agencies. A cluster organisation would provide a voice for SME's by lobbying for their shared interests or mentoring e.g. when dealing with larger firms who dominate the marketplace. It may also provide the means to solve common problems, for example to create a system of shared services such as training and educational short courses.

1. Prioritization of facilitating research and development B2B linkages as well as with academia.

The authors recommend that there is a need to assist firms operating in the ICT sector in Chicago, to innovate and develop through increased R&D activity not only with academia and research institutions, but also through industry collaborations. R&D linkages were the 3rd least frequent linkage category in the study, with just 18 linkages reported - a mixture of academic institutions, industry associations and firms. Eleven R&D linkages are reported within the State of Illinois, all but two of these are with academic Institutes and Universities, the others with industry associations. Only one of these connections is of High importance to the RFG highlighted in red, located in the loop (Figure 5). Critically, no R&D linkages within Illinois exist with private firms and this is an area that needs to be addressed.

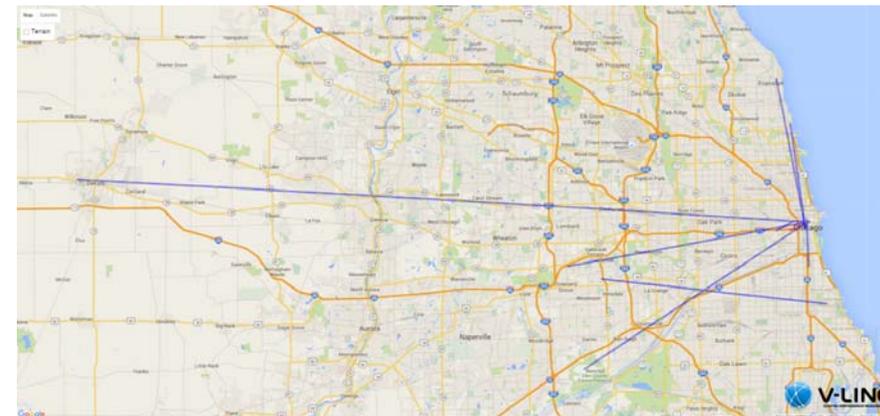


Figure 5³: Local and State Research & Development linkages in Chicago ICT.

Funded co-operation projects between ICT firms, and firms from other sectors, in Chicago can stimulate increased R&D linkages and innovation. An example of a best practice European co-operation project programme is that used in Clusterland located in Upper Austria. Co-operation projects have been used by the region since 1998 and have proven to be an effective and efficient method for SMEs to strategically differentiate themselves (TMG, 2014). To be eligible for government funding, a minimum of three companies participate in the project and at least one of those should be an SME.

Results from Clusterland show that: 77% of firms continue to co-operate after projects end; 89% of the projects either would not have been realized without subsidies, or would have had significantly lower expectations. Firms discover that pooling competencies enable firms to overcome barriers, such as limited funding, lack of management resources and technological competencies. Such programmes train SMEs to undertake larger R&D projects at national and European levels.

The Clusterland R&D co-operation project model, facilitated by a cluster organisation in Chicago, may be the conduit needed for realising more B2B market focused connections and opening connections internationally for the ICT sector.

³ Note to Figure 5: The red lines are Research & Development linkages reported in the High business impact band (>30 to 40), the blue lines indicate linkages in the Medium, Low and Tenuous bands.

2. Facilitate and Focus on the Internationalisation of Chicago ICT Firms through mechanisms such as the Business Roaming Agreement and the BeWiser project.

Metro Chicago Exports is a collaboration between the seven counties in Northeastern Illinois (Cook, DuPage, Kane, Kendall, Lake, McHenry and Will) and the City of Chicago to increase exports from small and mid-sized enterprises (SMEs) and to support regional job growth www.metrochicagoexports.com/. The ICT sector in Chicago is constituted by a specialisation (CMAP, 2009) of predominantly SME firms whom for future growth will have to look at international markets to expand their growth.



Figure 6: International Output Linkages Operated by Chicago ICT Firms.

Table 3e and Figure 6 present the output linkages at an international level and their business impact for the Chicago ICT respondent firm group. Only six percent of the 113 output linkages reported in the study are recorded at an international scope. A cooperative development plan is needed to help SMEs and micro enterprises make international connections. The Chicagoland Chamber of Commerce through their collaboration with the Cork Institute of Technology and the University of Illinois at Urbana Champaign through the ERASMUS+ International Credit Mobility are in a position to be able to facilitate the creation of linkages through the BeWiser project (www.be-wiser.eu), and partnership with CyberForum's⁴ Business Roaming Agreement.

⁴ Cyberforum is the largest regional high-tech cluster in Germany with over 1000 members, CyberForum, for more information see <http://www.en.cyberforum.de/home>

In terms of utilising the BeWiser project, two actions within the Joint Action Plan can be used to support international linkage development for the Chicago ICT sector 1) The V-LINC matchmaking portal on the consortium website <http://bewiserconnect.cit.ie/> allows Chicago based participants to connect with the seven Be Wiser partner ICT clusters across Europe to engage with them in terms of markets for their products/services, future joint ventures or research areas of interest. 2) The Business Roaming Agreement (BRA) <http://clusterize.org/> is a service provided by the German ICT cluster CyberForum. Clusters sign up to the agreement to provide their facilities and office space as a soft landing platform for member firms of other clusters to use when visiting their region, when developing markets or making research connections for their firm. In exchange the host cluster's member firms can utilise the facilities and hot desk in the offices of other clusters who sign the BRA abroad. Fifty seven locations are currently available through the BRA, across 32 different countries. Chicagoland Chamber of Commerce is in a position to sign this agreement to bring benefits to its member firms in terms of soft landing for internationalisation.

Closing Remarks

This paper has described and applied the V-LINC methodology for identifying and analysing the linkages that ICT firms in Chicago engage in. If Illinois and Chicago are to sustain the success of the sector through growth and expansion in the global marketplace, change is required to address the problems identified.

The analysis of the ICT sector in Chicago shows evidence of fledgling research, development and innovation linkages, however if a fully functioning cluster is to develop in Chicago, which could have an impact on economic growth, there is a need for increased competition and co-opetition. Skills requirements will need to be addressed for the sector to ensure a flow of talent exists to drive and nurture the sector. Many tech centers and networking spaces exist within Chicago that can provide supports to budding entrepreneurs, however, growth for these firms can be exponential through out of state and international sales. Chicago needs to strategically strengthen and expand the ICT sector. To do so it is imperative that its ICT firms are linked more vigorously with international markets, regarding output, innovation and consumer preferences. Internationalisation based on solid city and State supports is critical in this regard. A formalized cluster organisation to work with and support members can be invaluable as ICT firms seek to grow and expand.

Future research may analyze other market segments within the broader ICT market to assess their specific requirements within a cluster e.g. IOT and Cyber-security firms. Another consideration is the long term funding model for a proposed cluster organisation, in European regions public financing is available to supporting a cluster organisation in its first 2-3 years of existence (CEBR, 2014; ECO, 2013; Byrne, 2016). Longer term the cluster organisation should look towards a model of self-financing or a mixture of public and private financing through the provision of activities and services to members.

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