MEASURING THE INFLUENCE THAT COMPONENTS HAVE ON PEDESTRIAN ROUTE CHOICE IN ACTIVATED ALLEYS

A Thesis

presented to

the Faculty of California Polytechnic State University,

San Luis Obispo

In Partial Fulfillment

of the Requirement for the Degrees

Master of City and Regional Planning and

Master of Science in Engineering, Transportation Planning

by

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June 2015

COMMITTEE MEMBERSHIP

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ABSTRACT

Measuring the Influence that Components Have on Pedestrian Route Choice in Activated Alleys

Samuel H Gross

This paper explores how cities have integrated formal planning into improving public space. Through a review of literature on the topic, this the paper identifies the potential design has to renovate narrow streets and alleys, within the public right of way. By preforming an assessment of plans and programs, this paper identifies the common themes or components that have been used by planners, architects, and engineers to improve the urban environment for pedestrians. Based on this information, a pilot study was created to measure the influence the most common components have on pedestrian route choice. The results are then compared to the information gathered from the assessed plans and programs. Suggestions for expanding the pilot study and other recommendations are presented upon the conclusion of this report.

ACKNOWLEDGMENTS

I would like to thank all the people that helped me with this project. Without you this would not have been possible.

Thank you to my adviser and committee chair, Dr. William Riggs, and my committee members Dr. Robert Bertini and Mr. David Winslow. Your advice, patience, and knowledge was vital to my education and the completion of this project.

I would like to thank those professors who have taken me under their wing and helped me grow as a professional and as a person over the years. Especially Dr. William Riggs, Dr. Robert Bertini, and Professor Chris Clark.

Thank you to my family, friends, and my girlfriend. Your support, love, and appreciation helped me through this project and through grad school. You have helped me maintain my sanity and stay as stress free as possible while completing these two masters' degrees.

Special thanks to those who helped me with the intercept survey for this project. Mom, Dad, Nanci, and Natalie. Standing in an alley talking to strangers about a topic you are not familiar with is a challenge. You were wonderful. I would not have been able to meet my deadlines without you.

Most importantly, I want to thank my parents. Without your support and encouragement, I would not be where I am today. I love you both so much.

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1. INTRODUCTION

Alleys come in many shapes and sizes. They go by many names (passages, lanes, courts, narrow streets, etc.). They can span as little as half a block or connect across intersections and traverse miles of city blocks. Regardless of their name or size, they all have the potential to be cozy public places that provide an escape from the hazards of city life. Alleys are simply narrow streets generally utilized by pedestrians or service vehicles between or behind buildings. In older city centers that were developed before the early 1900's, they were the standard streets utilized for moving people and goods on foot, horse, or bicycle. After the invention of the car, alleys were planned or converted for deliveries, maintenance services, emergency vehicles, and for parking. Many pedestrians, cyclists, and even autos use alleys for shortcuts and access points (Integrated Alleys, 2010). Alleys are more frequently shorter in length than streets that are built for through traffic. They also frequently cut standard blocks in half. Due to this, they can provide a more direct route for pedestrians and bicyclists. Many cities have taken advantage of the alleys within their jurisdictions. These cities have developed formal master plans and programs that enhance or "activate" alleys through renovations. This provides the potential needed to create safer more vibrant community spaces. These spaces can even provide an escape from the noise and dangers of the "urban jungle" through the creation of more natural environments.

This paper explores how cities have integrated formal planning into improving public space. Through a review of literature on the topic, this the paper identifies the potential design has to renovate narrow streets and alleys, within the public right of way. By preforming an assessment of plans and programs, this paper identifies the common themes or components that have been used by planners, architects, and engineers to

improve the urban environment for pedestrians. Based on this information, a pilot study was created to measure the influence the most common components have on pedestrian route choice. The results are then compared to the information gathered from the assessed plans and programs. Suggestions for expanding the pilot study and other recommendations are presented upon the conclusion of this report.

2. LITERATURE REVIEW OF ALLEY THEMES

Throughout history and literature, alleys have been known as dark dangerous and filthy places. British literature in particular, through stories such as Jack the Ripper, A Clockwork Orange, and Sherlock Holmes, has done a fine job of engraining this message into western culture. In literature and film, when a character heads into a narrow street, they are more often than not expected to become the next victim of a dark figure or met by a gang from such classics as Clockwork Orange or Green Street Hooligans. During the late 1800s and early 1900s, a lack of planning and safety precautions led London's narrow streets to actually be dark dangerous places. Today, London is still filled with narrows crisscrossing streets, but proper planning and safety improvements have made these streets increasingly safe and have improved environmental conditions (London DPT, 2003). England is not the only place where alleys have a negative connotation. In the United States, the term "Back Alley" is still used to describe a space where "immoral" objectives are attained. They have the reputation of being synonymous with illegal abortions, acquiring drugs, and the act of prostitution. Additionally, countless episodes of popular American television shows like Law & Order and CSI constantly place murders and corpses in alleyways. This reinforces the public's association between urban public space and crime.

There is potential to renovate the physical nature of narrow street space into safe and healthy environments. This requires proper planning and design. What fear would there be if that same alley was no longer dark or empty? What if these spaces were designed to be bright colorful and inviting? What if these space could break the norms generated over the last 75 years of auto oriented policy? Couldn't this spaces become a friendly, healthy, and direct route home? In recent years, planning efforts have grown to

challenge these norms and generate solutions. Assessment of current planning efforts can identify the potential that renovation can create for alley activation.

2.1 Potential in Activating Alleys

Alleys can be both destinations and passages. When properly planned, they can generate a safe and effective space. San Francisco's Planning department refers to activated alleys as "Living Alleys" and defines them as "narrow, low-volume traffic street[s] that [are] designed to focus on livability, instead of parking and traffic. Typically, this means creating a street primarily for pedestrians and bicyclists as well as space for social uses. Vehicles are typically still allowed access but with reduced speeds" (SF-Planning, 2015). There are many components necessary to plan an effective alley. Not every component or use applies to every alley, however, each has an application and each has its value and effect on human behavior that can be identified on a case by case basis. In order to understand its potential, one must first understand the history and background of alleyways.

Most alleys in the United States that were created after the invention of the automobile were designed for providing service access. They can be intended for garbage service, firefighting and emergency access, or for parking both bicycles and autos. The majority of New York is alley-less and therefore all waste pick up has been brought to the street. This creates an environment with obstructions and stenches that negatively impact pedestrian activity. Alleyways still need to maintain service uses, otherwise the main corridors can become cluttered and smelly. However, when converting an alley to pedestrian and or bicycle space there can be alternative locations for storing waste. Some cases have the ability to utilize indoor waste storage, but that is not always an option. When available, it removes noxious waste and odors from the daily walkway.

This can improve air quality and remove obstacles. There are other options that should be considered including bringing waste to streets that are primarily auto oriented as long as there is an adjacent pedestrian and bicycle oriented street available. Since people in autos are less effected by waste and odors than pedestrians and bicyclists, this is an acceptable alternative as long as it does not obstruct businesses and walkways. Other waste management options include mandating scheduled waste hours for when pedestrians are not present. Using coverings to keep waste out of public spaces is also a great alternative.

One of the defining factors of an alley are low auto traffic volumes. This valuable attribute has potential to be harnessed. Alleyway space can create a feeling of coziness and comfort built into the urban fabric. Separation from the noise and smog of autos can be a rare commodity in a dense city. The ability to find a public space with the coziness of an alley has so much potential for building community and healthy public space. This coziness can be harnessed by the size and spacing of the buildings adjacent to the alley. When buildings are setback, people can gain a feeling of emptiness, which defeats the point of an alley. By placing alleys between larger buildings and keeping them narrower than a two lane street, the alley can exaggerate its comfortable feeling.

One of the most important safety features of any public space is its visibility. According to the 1960's planner and journalist Jane Jacobs, in order to have a safe space there need to be "eyes on the street" (Jacobs, 1961). This means the street must be able to interact with the community around it. There need to be residents, workers, and other community members woven into the space who care about the neighborhood and its stewardship. Alleys will be safer if there are both businesses and residences in the segment. By placing people who care about protecting the wellbeing of their own space within the corridor, the place will attract more people and there will consequently be

more “eyes of the street” (Jacobs, J, 1961). For this to be applied to an alley, people need to be drawn into the space throughout all hours of the day. Otherwise, the space can become undesirable after dark. Ample lighting in an alley is a component that can assist in maintaining all hour pedestrian presence and allow the “eyes” to continue to do their job at night. In most alley spaces, it is appropriate to use lighting that is oriented to only shine on the street itself as to not disturb surrounding residents. These dark sky compliant lights are a valuable resource for alleys in neighborhoods with residences. These visibility techniques will create a more comfortable and safer space (Green Alley Handbook, 2010).

It is extremely valuable to make alleys accessible. This is not limited to just following ADA compliance. One of the most important parts of alleyways is that they provide a safer link or cut-through in otherwise long blocks. By designing alleys with features that attract pedestrians and bicyclists, the space will become safer as more people use the space. Painted bike lanes, proper integration with cross streets, and anchoring destinations within the alley have been used to bring people through the space. Alleys that contain access to shops, residences, activity centers are generally used more and are therefore safer spaces (Gehl & Syarre, 2013). Giving people a reason to visit the alley or creating a space that has components that influence pedestrians to direct their route through the alley are the best ways to increase the level of use.

The most appealing and utilized alleys have a sojourn function. A sojourn function causes people to stick around and utilize the street for activities like playing, exercising, and habituating. These attributes give people a reason to go to the alley apart from just passing through. This suggests that a space that provides people with space to sit, observe, or be active are more desirable (Igarta, D, 2012). This is the destination piece of the alleyway puzzle. By giving alleys their own identity and character, planning

practice suggests that people will be further drawn to use them more frequently. Some tactics used include giving them names and creating a unique recognizable design within the alley. These unique attributes and wayfinding techniques are meant to create curiosity and wonder in passersby, hopefully prompting them to be drawn into using the alley instead of another route.

Alleys have a history of being a home for artistic expression. This history should not be forgotten as the spaces becomes utilized within formal planning. Murals, sculptures, and living art are valuable components of any public space. Many alleys have large open walls that are perfect canvases. Commissioning these spaces to local street artists, whether formally or informally, provide great opportunities to influence people to walk through the alley. Cities like Philadelphia have dramatically improved the quality of life in their cities by encouraging and commissioning artists to paint murals (Muralarts.org, 2015). Events like gallery openings, art crawls (the art version of a pub crawl), and other events such as farmers markets are wonderful active uses that have been applied in alleys (Alley network project, 2014).

Due to an alley's narrow space, many have their own microclimates. They are generally more sheltered and protected from harsh elements such as extreme temperatures and high winds. Wider streets are less effective than alleys at protecting pedestrians and bicyclists from the elements. However, an alley has the potential to be utilized to create a cooler microclimate (providing an escape on hot days) or an escape from a heavy rain or strong winds. Every situation is unique but in all situations, vertical plant walls, planter boxes, ground plants, and trees have been used to contribute to creating a friendlier environment for pedestrians. In any case, it is very important to choose the right plants and the right space for the plants to occupy. Local arborist and horticulturists can assist planners in choosing the climate specific plants. Plants that pose hazards to those

traveling through the space should be avoided. For instance, despite the fact that cactus are drought tolerant and climate specific for the southwestern United States, it is not necessarily a good idea to plant them next to a bicycle path. Specifics for landscaping must be addressed in a case specific fashion in order to provide benefits at their full potential for use in alleys.

Bioswales (rain gardens) and permeable pavement have also been installed in spaces that have lower traffic volumes. This has the potential to filter rainwater and prevent flooding. In all cases, alleys have the potential to provide people with a connection to the natural environment and an escape from the urban jungle. Maintaining any features or components should be considered when designing alley activation. When these components are focused, specialized alleys can be generated.

2.2 Specialized Alley Case Studies

Some cities have decided to use alleys for a specialized use or to accomplish a specific goal. Three specializations have been identified in this study: connector network for pedestrians and/or bicyclists, social or public gathering spaces, and greenways or blueways. Through specializing the space, municipalities have identified a goal and placed a value on the alley space. Given the community's needs there are many options to specialize or generalize the uses of alleys.

2.2.1 A Connector Network

Alleys have been used as part of connector networks designed for transporting pedestrians and/or bicyclists. A connector alley can provide a safer and more interesting route. Having to travel around a full city block on foot or on a bicycle can deter people from walking or biking. Alleys, when activated, have potential to reduce travel times in half. Alleys can also dramatically reduce block lengths. Many individuals are deterred

from biking or walking and opt to drive simply because their route is not direct or the route travelled is shared with the danger and noise of autos. According to a Minetta Transportation Center study lead by Dr. Cornelius Norwosoo, Professor of transportation planning at Cal Poly, the most influential factors to a person choosing to walk or bike are the directness of the route and safety through proximity to autos (Nuworsoo, Cooper, Cushing & Jud, 2012). Alleyways provide a perfect opportunity to separate pedestrians and bicyclists from automobiles. They also offer more opportunities to provide a direct route. By creating safe alley networks that cut travel time in half and provide a space separated from the noise and dangers of autos, people are encouraged more to travel by foot or on bicycle.

In an effort to provide a safer route for cyclist and to get people who won't cycle, for fear of sharing the road with autos, the cities of London and Hackney, England are taking a new approach. They are converting narrow, low traffic streets and alleyways into "quietways." These are auto free streets where the travel lane has been converted into a two-way bicycle path. So far, London has converted 12 such streets and Hackney has converted many more (O'Sullivan, F., 2014, March 10). Quietways are providing people with safer and more comfortable routes. This is influencing people to ride bicycles who would not otherwise have chosen that mode of travel. They also have the potential to increase pedestrian volumes. They are still in the planning phase of this project and are researching the best approach for how the "quietways" can intersect with auto streets. So far, they have been a huge success and they show a lot of potential for creating a connector network that develops a safer bicycle and pedestrian network, while not completely banning cars from an area.

Through this renovation, a bunch of small narrow confusing underutilized one-way alleys have been converted into connected two-way bicycle streets. Also, businesses have

been supported by offering more bicycle parking. Socially, local cyclists are starting to be considered equals with auto drivers. The streets are becoming more connected for pedestrians and bicyclists. The “quietways” truly are converting alleys into quieter cozier spaces. However, as great as these newly improved alleys are, they are not complete yet and cyclist are eventually dumped back on streets shared with autos. This is fine for experienced riders, but it is a frightening reminder to novice riders that streets are still auto oriented. This example shows a lot of potential, but needs to be expanded to access all areas of the city. The proposed plan, when completed will provide 60 miles of connected “quietways” throughout the city of London (O'Sullivan, F., 2014, March 10). Given proper planning for an entire network and utilizing the potential of alleyways, an urban core can become a safe place for pedestrian and bicyclist transportation.

2.2.2 A Social or Public Gathering Place

An alley can be a social of public gather space by highlighting the sojourn function. When planned with a social gathering place specialization, alleys become destinations themselves. These social alleys make great date destinations, are places to bring children or clients, and they provide incredible opportunities for building community. Social alleys can be lively and exciting or just simply a place to enjoy a cup of coffee or a beer. They can have live music, great food, nightlife, shopping, and/or art. These spaces build community, support local economies, and provide people with a place of expression and culture.

The city of Seattle, Washington, has taken advantage of the large network of alleys that converge on Pioneer Square. Pioneer Square is the city’s original downtown, a bustling city center with successful businesses. For a good part of the last century, autos were the primary users of the streets in Pioneer Square. Businesses have spread throughout

the city and the area has become less prosperous. Today, it is beginning to regain its original atmosphere and has well established car free zones. It is now home to successful bars, art galleries, and tech companies (Alley network project, 2014). By taking advantage of the scale of the buildings and the narrow alleys, the district has created one of the liveliest pedestrian zones in the country. By creating a safe environment that encourages activity, as well as pedestrian connectivity, the city has helped create a space that has built community and provided a space for cultural expression. The University of Washington hosts student design exhibits in the alley network and the Seattle Parks Department supports music events on weekend nights. Many other groups utilize the space because of its design and pedestrian orientation. Most regular events gather over 5,000 people (Alley network project, 2014).

The pedestrian environment in Pioneer Square's alleys is designed on a human scale. It draws people to the space, it has a strong visual presence, and it is well lit. It is easily accessible and houses daytime and nighttime businesses and activities as late as 2 am. The alleys are narrow with building architecture that is properly scaled to create a cozy alley feeling. The space has events and activities and gives people a reason to be there. It provides people with comfort and encourages people to stay in the alleys. The alleys are filled with plant life and the narrow streets shelter people from the elements. The Pioneer Square Alley Network has all the elements of an effective alleyway and that is what makes it full of life and makes the businesses prosper.

2.2.3 A Green Space

Cities, and the concrete they are primarily made of, separate people from their natural environment. Urban expanses of cement in cities create heat islands and negatively affect the quality of air, water, and soil. In some cases, urban development has created a

world where many people are never exposed to nature. Many people who live and work in the urban centers of the world live their lives without regularly seeing plants and animals other than a majestic planted street tree or a common house cat or dog, and the evermore common city rat. Air quality is generally lower in urban areas due to the lack of plant life, which absorb CO2, releases oxygen, and reduces greenhouse gases. Many urban ecosystems are left without the necessary filtering effects of creeks and marshes, leaving aquifers unreplenished and many people without the soothing sound of rivers and creeks. Many of these issues come from the lack of plants and inadequate drainage systems that send the majority of our water along the surface of roads or through pipes. This current system carries the street's contaminants, unfiltered, directly into natural water systems. This causes flooding and causes issues for both the human and natural environment. People have a need for biophilic cities that connect with green space. Those that are exposed to the natural environment tend to live happier healthier lives (Biophilic Cities, 1993). It is clear that many people are unable to gain any solitude or escape from the cement towers of the city. With more than half of the world's population living in urban environments, this is an issue of great significance. Poor environmental conditions, a lack of connection with nature, and a lack of environmental education grow more important as urban renewal brings more people into cities.

Alleyways have the potential to provide solutions to the lack of nature, water treatment, and solitude in the "urban jungle". By utilizing the microclimates and sheltered environments found in alleys, an oasis within the urban fabric can be developed. Climate specific plants and beautiful gardens can produce clean air and comforting natural space in alleys. Methods include using permeable pavement, bioswales (rain gardens and planters with open bottoms that filter contaminants from water before returning the water to the soil), and aggregate layers to allow water to filter back into the natural aquifers.

Cities have been using these techniques to prevent flooding and utilizing the natural systems to filter out harmful chemicals and oils that would otherwise flow into fragile stream, bay, and ocean ecosystems. These human designed systems can synthesize environments that allow people to connect with the natural world, while improving the quality of life and the health of a city's residents.

The city of Chicago has started a Green Alley Program. The goal of this program is to create a healthier urban ecosystem and reduce flooding. Chicago's alleyways outnumber those in any other American city (Nytimes.com, 2007). For the majority of them, they lack proper sewer connections and contribute to serious flooding issues throughout the city. The city is opting to use the Green Alley Program to create a storm water management system that doubles as an attractive public space and street. It's costing them far less than the cost of building sewer connections, and it has far more added benefits, including cheaper maintenance and water filtration (Green Alley Handbook, 2010). Their main tactic is to use permeable pavement systems. The city is making an effort to imitate the nature ecosystem and create a safer space. Dark sky compliant lighting is to be installed in all green alleys (Green Alley Handbook, 2010). This will help create a safe visible space, while helping to remove light pollution, which will allow more people to see the stars in the night sky while preventing lights from disrupting sleeping residents. The Chicago Green Alley Program's primary objective is to reduce flooding. In doing so, they will be reducing pollution, conserving water, and bringing plant life and nature to the urban core.

Activated alleyways, whether specialized or diversified, contain many built environment components. These have been applied in multiple formal planning applications across the country and throughout the world. In order to better identify the components

professional planners have been using in their tool kits, it was necessary to assess plans and programs on their content.

3. COMPONENTS USED IN ACTIVATING ALLEYS

3.1 Master Plan and Program Case Studies

In order to gain an understanding of current and past alley improvements, it was important to review and analyze plans and policies. Research uncovered various programs and master plans that aimed at discovering the full potential of alleyways. The alley plans and programs identified came in multiple forms. Alley master plans look specifically at alleys within an area or district. Green alley programs focus on hydrologic and biologic systems, and their engineering. Alley activation sections of district master plans were also assessed. In order to focus a wide lens on alleys, plans and programs where analyzed from across the country. Eighteen alleyway plans and programs were identified and assessed on the similarities and consistencies in their planning and implementation. Cases were taken from across the United States to gain national context. A case from Melbourne, Australia, (known for its public activated alleys) and two cases from London, England, (to shed context on how the city has dramatically changed the view of alleys built on history and literature) were also included to gain a western international perspective on formal alley planning. The list of plans and programs can be seen in Table 1.

Table 1. List of alley plans and programs assessed

Plan	Location	Year
Old Pasadena Streetscapes and Alley Walkways Refined Concept Plan	Pasadena, CA	1995
Chinatown Alleyway Master Plan	San Francisco, CA	1998
Fleet Street Courts and Lanes Design Strategy	London, England	2003
Places for People 2004	Melbourne, Australia	2004
Fort Collins Downtown Alleys Master Plan Report	Fort Collins, CO	2008
Dubuque Iowa Green Alley Program	Dubuque, IA	2009
Green Streets and Green Alleys Design Guidelines Standards	Los Angeles, CA	2009
Baltimore Alley Gating and Greening Program	Baltimore, MD	2010
Chicago Green Alley Handbook	Chicago, IL	2010
Vision for the Bank Area	London, England	2010
San Francisco Better Streets Policy Ordinance	San Francisco, CA	2011
Seattle's Integrated Alley Handbook, Activating Alleys for a Lively City	Seattle, WA	2011
Activating Urban Spaces, A Strategy for Alleys & Passages	Birmingham, MI	2012
Downtown Bozeman Alley Sketchbook	Bozeman, MT	2012
DC Green Alley Project	District of Columbia	2012
Downtown Pedestrian Alleyways	Pueblo, CO	2013
Baltimore Blue Alleys Program	Baltimore, MD	2014
SF Market Octavia Area Plan	San Francisco, CA	2015

The plans and programs identified in this project provide solid examples of the types of alley activation programs and plans found throughout the United States and the English influenced western world. Alley renovation plans and programs are not common. Very few cities have applied formal planning to alleys. The projects vary in purpose. Many are focused on water management strategies. Many are focused on improving safety, both crime and traffic related. Many also include architectural design and public space improvements for social interaction. The plans and programs studied were produced over a 20 year span, from 1995 to 2015.

The oldest plan studied was the “Old Pasadena Streetscapes and Alley Walkways Refined Concept Plan”. It is possibly one of the most comprehensive and successful plans. The Old Pasadena plan uses active space as key attractors. It incorporates event

space, shopping, and restaurants spread throughout the district to draw people into the alley network. The Old Pasadena Plan could also be considered one of the most effective at producing a complete network of alleys that connect the entire district. This is done through clear identification of where the alleys continue as they cross other streets. They use midblock crossings and wayfinding signage to direct people through the network. The meandering alleys are also lined with landscaping and shading from the sun. There is no water management in this plan. However, as this is a southern California city, rain is rare.

The green alley programs and plans are produced by either public works departments or transportation departments. The “Chicago Green Alley Handbook” is the model for alley water treatment in the United States. Every green or blue alley plan produced after the handbook was published in 2009 references the “Chicago Green Alley Handbook”. It is highly focused on water treatment and flood control, however, it also includes lighting and landscaping suggestions. All the programs or plans that have a water focus, which include the projects in Los Angeles, Dubuque, Baltimore, Washington DC, and Chicago, all encompass standards and initiatives that effect their entire city.

In larger cities, the non-water specific plans tend to encompass entire neighborhood or district areas. San Francisco, which is a city of distinct neighborhood districts, has two plans that where analyzed. Those plans along with the two plans from London and the Old Pasadena Plan, identify and activate the alleys within a specific neighborhood district area. The most recent plan, SF Market Octavia Area Plan, identifies all the blocks that could be identified as alleys. The plan successfully applies the majority of components. However, it does not do an effective job of connecting segments safely with other alley segments within the plan. The Melbourne plan and the Seattle plan both identify activation of alleys in the city’s entire urban core. Many of the smaller city plans

do the same thing. In smaller city or town settings, alley plans stretch across a single alley in the downtown core or take into consideration the entire urban core. The cities of Bozeman, Fort Collins, Pueblo, and Birmingham all have produced plans that activate alleys in their downtowns. These plans all place their primary focus on alleys that runs adjacent and parallel to their downtown's main street. These all have the same goal, which is to provide community space with restaurants or food trucks, landscaping, and places for people to sit or walk around safely. The plans analyzed, all utilized a variety of components.

The eighteen plans and programs in this study incorporated a combination of thirty-eight separate components and features. These have been combined in various combinations as tools to renovate and activate alleys. These components and features are listed in Figure 1. They are listed in order of how many different plans and programs they were found in.

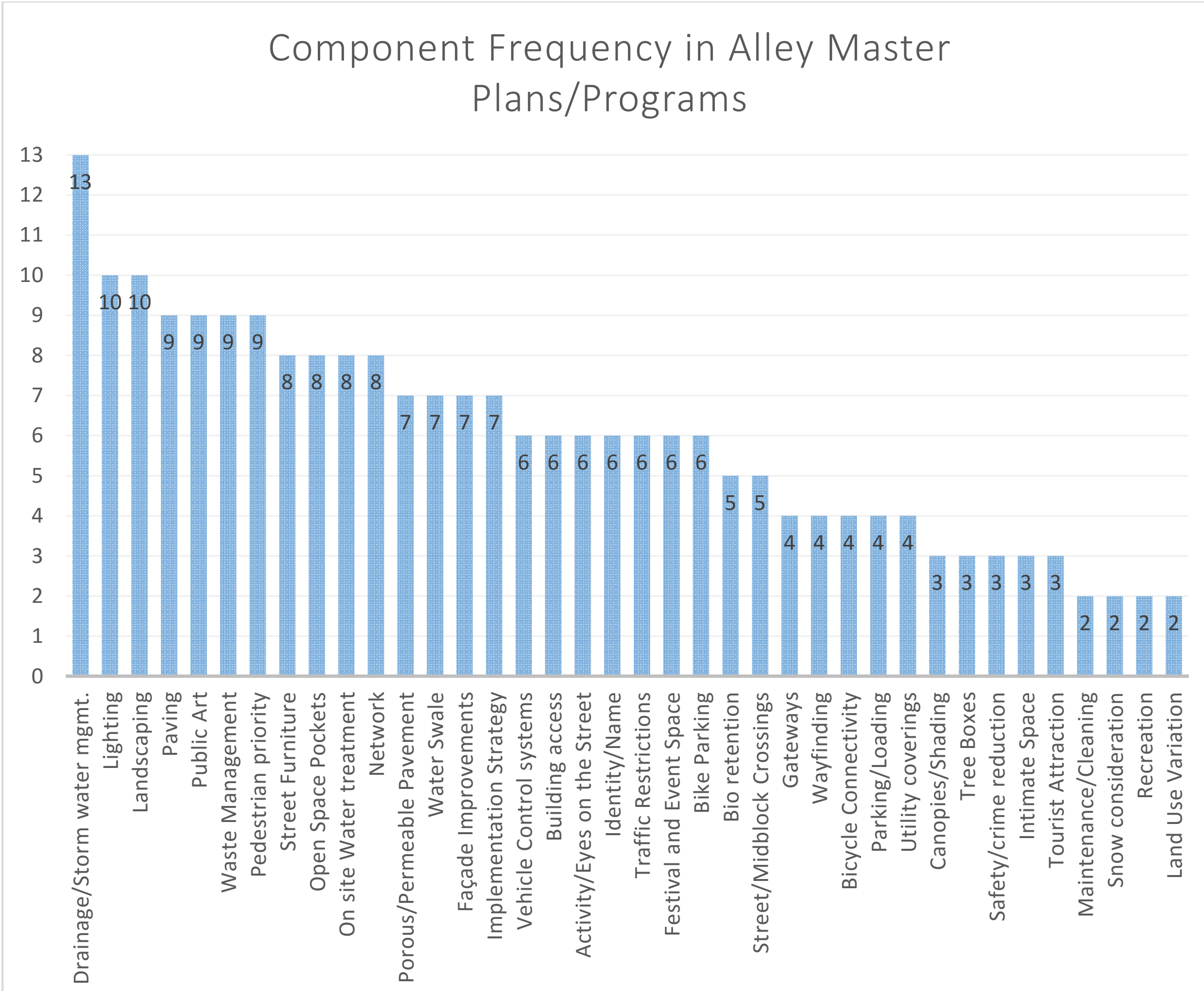

Figure 1. Components and features with the number of plans they are found in, out of the 18 alleyway plans explored in this study.

Many of these components have similar purposes, especially those used as water treatment methods. The thirty-eight components and features are defined with a brief description of what qualified the plan as containing the component are listed below.

- Drainage/Storm water mgmt. – Any method for addressing water runoff and preventing flooding during storms.
- Lighting – Illumination of the street through lamps, hanging lights, or other forms of street lighting.
- Landscaping - Trees, flowers, gardens, hanging plants, green walls, etc.

- Paving – A specific identification of required pavement type such as textured, painted, pavers, pavement, or asphalt.
- Public Art – Inclusion of murals, graffiti (commissioned or not), mosaics, sculptures or any other art form as part of public space.
- Waste Management – A program for reducing odors, visual trash, or bins through allowing trash bins out only during certain hours (for example only immediately before pickup followed by immediate removal or through the use of covered and contained trash bins or dumpsters).
- Pedestrian priority – Presenting the alleys as clearly pedestrian oriented space, wide sidewalks or lack of sidewalks and a clear designation to notify drivers that the pedestrians have priority to walk in the center of the street (i.e. woonerf).
- Street Furniture – The use of seating and other furniture such as benches, chairs (with or without tables), or other objects for sitting or using as a counter such as stones, wood, plastic, etc.
- Open Space Pockets – A small plaza or extended sidewalk built for people to stay and walk around in. Often having activity space present such as a parklet, stage, exercise station, or other use.
- On site Water treatment – Any water moving or holding feature built with the distinct purpose of filtering water on site before allowing it to enter the drainage system.
- Network – Ability of space to move people through an area via purposefully connected segments. A direct use of addressing mobility and access for the district or area as a whole, not just the individual segment.
- Porous/Permeable Pavement – Pavement where water is allowed to travel between or through the street surface before the water is allowed to be moved via an aggregate base below the surface. Used instead of drains and traditional piping.

- Water Swale – An open top pipe or trench used to move water. Sometimes containing plants to filter water as it moves. (Referred to as a Bioswale when containing plant life).
- Façade Improvements – The changing of a building wall to improve the space. Usually includes adding building entrances and windows to the building, providing a clean coat of paint, or other remodeling of a wall. This is done because more activities occur in front of buildings where the façades have "open and varied character compared to [those] that [are] closed and monotone" (Gehl, 1936).
- Implementation Strategy – Master plans that contained strategies and for making the plan a reality. Those that had a budget and financial plan for the project, filed for or presented permits, changed the zoning code and general plan to reflect the project, etc.
- Vehicle Control systems – Incorporating ways to physically control vehicle traffic volumes and speeds. This includes the use of bollards, chicanes, and prioritizing the right of way to pedestrians and bicyclists through signs and streetscape design methods.
- Building access – A component of an active façade. Allowing access to the building from the alley gives people an additional reason for being in the alley.
- Activity/Eyes on the Street – The application of creating a space that provides a mix of uses in a space to ensure people are watching the space at all hours. This also involves giving people ownership and stewardship of the space so they feel responsible. Also providing the ability for people in the adjacent building to be engaged in the space and have the ability to see and speak to passersby.
- Identity/Name – Having a unique name and identify for the activated section of the street. Having an identity as not just another block on a long street, but a clear place

within the street. Examples include Alley 49 in Oakland, Bell Street Park in Seattle, or Jack Kerouac Alley in San Francisco.

- Traffic Restrictions – These include one way traffic, vehicle restrictions during certain hours, low speed limit (e.g. 15 mph or less), service vehicles only, etc.
- Festival and Event Space – The use of farmers markets, concerts, art gallery showings, “Open Streets”, or other events within the street right of way.
- Bike Parking – Presence of a bicycle corral or well identified bicycle parking.
- Bio Retention – Also known as rain gardens, bio retention is the use of plants as a water filter between the street and the drain.
- Street/Midblock Crossings – The use of crosswalks and warnings to safely direct pedestrians across the street and connected street segments in a safe manner. (Midblock crossings need special attention and must be highly visible and provide drivers with proper warning from a safe distance).
- Gateways – The use of signs, statues, archways, and other physical features to clearly identify the start and finish of an alley segment or the continuation of an alley network. (e.g. Drottninggatan [Queen Street] in Stockholm).
- Wayfinding – Including the signage and mapping as a way to orient and direct people through public space.
- Bicycle Connectivity – The use of the alley as a bike route or path that encourages bicycle flow.
- Parking/Loading – Including designated space for parking or loading of vehicles within the alley plan.
- Utility coverings – Covering utilities with a secure metal box, preferably one that is attractive and painted.

- Canopies/Shading – Features such as trees and canopies used to provide protection from the sun and rain.
- Tree Boxes – Planter boxes for trees. Can be raised bed or level with sidewalk surface (a component of landscaping).
- Safety/Crime reduction – A plan that has the purpose of being a method for improving safety and reducing crime.
- Intimate Space – Providing space designed for one-on-one or small group interaction. Can be a pocket or a seating area with a clear purpose of providing a space to talk and interact with another person.
- Tourist Attraction – The use of the alley space as an attractor for out of town visitors.
- Maintenance/Cleaning – Incorporation of a maintenance and/or street cleaning program.
- Snow consideration – Incorporation of measures for addressing snow and ice removal.
- Recreation – Space built to encourage recreational activities.
- Land Use Variation – Having multiple land uses within the same alley block.

3.2 Co-occurrence Analysis

The components and features listed in the previous chapter were compared and tested in a co-occurrence analysis. This identified which components and plans were found together in the same plan or program. This comparison can be seen in the “theme co-occurrence matrix” in Table 2.

This analysis showed that certain themes are more commonly associated with others. The eleven most commonly used themes overlapped with each other fairly frequently. This shows how the components are related to each other in current planning projects and programs. Further study needs to assess the value components have when accompanied with other components.

Table 2. Co-occurrence matrix showing each component and how frequently it is found with other components in the 18 assessed alley plans and programs.

	Lighting	Public Art	Landscaping	pedestrian priority and connectivity	Open Space Pockets	Paving	Street Furniture	Drainage/Stormwater Management	Implementation Strategy	Waste Management	Network	Façade Improvements	Identity/Name	Festival and Event Space	Bike Parking	Vehicle Control systems	Building access	Activity and people present	Traffic Restrictions	Street/Midblock Crossings	Wayfinging	Bicycle Connectivity	Utility coverings	Parking/Loading	Water Swale	On site Water treatment	Gateways	Cannopies/Shading	Intimate Space	Tourist Atraction	Safety/crime reduciton	Porous/Permiable Pavement	bioretention	Reuse of excess street space	Tree Boxes	Land Use Variation	Snow consideration	Maintenance/Cleaning	Recreation	
Lighting		9	9	9	8	8	7	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	2	1	1	0	10
Public Art	9		8	8	8	7	7	6	6	6	6	5	5	6	6	4	5	5	5	5	4	4	4	3	3	3	3	3	3	3	1	2	2	2	2	1	1	0	0	9
Landscaping	9	8		8	8	6	6	7	6	6	6	6	6	3	5	5	5	4	5	4	3	3	4	4	4	4	3	3	3	3	3	3	3	3	1	2	1	1	0	10
pedestrian connectivity and priority	9	8	8		7	6	7	6	6	6	7	5	6	6	6	5	5	5	3	4	4	4	3	3	3	3	2	3	3	3	2	2	2	2	2	2	1	1	0	9
Open Space Pockets	8	8	8	7		6	6	6	5	5	5	5	5	6	5	3	5	4	4	4	3	3	4	3	3	3	3	3	3	3	2	2	2	2	1	1	1	0	0	8
Paving	8	7	6	6	6		6	7	8	7	6	5	5	4	5	5	4	5	4	4	4	3	4	4	3	2	3	2	3	2	3	1	2	2	2	1	1	1	1	9
Street Furniture	7	7	6	7	6	6		6	5	5	4	4	5	5	6	4	5	5	5	3	4	4	3	2	4	3	2	3	2	3	3	2	3	2	3	1	1	0	1	8
Drainage/Stormwater Management	7	6	7	6	6	7	6		7	5	5	5	4	4	4	5	4	3	3	3	3	2	4	4	7	7	3	2	3	2	4	6	5	3	2	2	2	2	1	13
Implementation Strategy	7	6	6	6	5	8	5	7		7	3	4	4	3	4	4	3	4	4	4	4	2	3	4	3	2	3	1	1	1	2	1	2	2	2	1	0	1	1	7
Waste Management	7	6	6	6	5	7	5	5	7		5	4	4	4	4	3	4	5	4	4	3	3	3	4	2	1	3	2	2	2	1	0	1	2	2	1	0	1	1	9
Network	7	6	6	7	5	6	4	5	3	5		4	3	4	3	3	2	4	3	4	2	3	3	3	2	3	2	2	3	2	2	2	2	2	1	2	1	1	0	8
Façade Improvements	6	5	6	5	5	5	4	5	4	4	4		3	5	3	3	3	4	2	3	2	2	3	2	4	4	1	2	3	2	1	3	3	3	1	1	1	0	1	7
Identity/Name	6	5	6	6	5	5	5	4	4	4	3	3		4	4	4	4	3	3	2	3	2	3	2	2	1	1	2	2	2	3	1	1	1	1	2	1	1	0	6
Festival and Event Space	6	6	3	6	6	4	5	4	3	4	4	5	4		4	2	4	4	3	3	2	3	3	2	3	3	1	3	3	3	1	2	2	2	1	1	1	0	0	6
Bike Parking	6	6	5	6	5	5	6	4	4	4	3	3	4	4		4	5	4	4	2	3	4	2	2	3	2	2	3	2	3	2	1	2	1	2	1	1	0	0	6
Vehicle Control systems	5	4	5	5	3	5	4	5	4	3	3	3	4	2	4		3	2	2	2	3	2	2	2	3	2	1	1	1	1	3	2	2	1	2	2	1	2	0	6
Building access	5	5	5	5	5	4	5	4	3	4	2	3	4	4	5	3		3	4	1	2	3	2	2	3	2	3	3	2	3	2	1	2	1	1	1	1	0	0	6
Activity and people present/Eyes On the Street	5	5	4	5	4	5	5	3	4	5	4	4	3	4	4	2	3		4	2	2	4	2	1	2	2	1	3	3	3	1	1	2	2	1	1	1	0	1	6
Traffic Restrictions	5	5	5	3	4	4	5	3	4	4	3	2	3	3	4	2	4	4		2	3	3	1	1	1	1	3	2	2	2	1	0	1	2	1	0	0	0	0	6
Street/Midblock Crossings	5	5	4	4	4	4	3	3	4	4	3	3	2	3	2	2	1	2	2		3	1	3	2	1	1	1	0	1	0	0	1	0	1	2	0	0	0	0	5
Wayfinging	4	4	3	4	3	4	4	3	4	3	2	2	3	2	3	3	2	2	3	3		1	2	1	1	0	1	0	1	0	1	0	0	1	2	0	0	0	0	4
Bicycle Connectivity	4	4	3	4	3	3	4	2	2	3	3	2	2	3	4	2	3	4	3	1	1		1	1	2	2	1	3	2	3	1	1	2	1	1	1	1	0	0	4
Utility coverings	4	4	4	3	4	4	3	4	3	3	4	3	3	3	2	2	2	2	1	3	2	1		2	2	1	1	1	2	1	1	1	1	1	1	1	1	0	0	4
Parking/Loading	4	3	4	3	3	4	2	4	4	4	3	2	2	2	2	2	2	1	1	2	1	1	2		2	1	2	1	1	1	1	0	1	1	1	1	0	1	0	4
Water Swale	3	3	4	3	3	3	4	7	3	2	2	4	2	3	3	3	3	2	1	1	1	2	2	2		6	1	2	2	2	2	4	5	2	2	1	1	0	1	7
On site Water treatment	3	3	4	3	3	2	3	7	2	1	3	4	1	3	2	2	2	2	1	1	0	2	1	1	6		1	2	2	2	2	6	5	2	1	1	1	0	1	8
Gateways	3	3	3	2	3	3	2	3	3	3	2	1	1	1	2	1	3	1	3	1	1	1	1	2	1	1		1	1	1	1	0	1	1	0	0	0	0	0	4
Cannopies/Shading	3	3	3	3	3	2	3	2	1	2	2	2	2	3	3	1	3	3	2	0	0	3	1	1	2	2	1		2	3	1	1	2	1	0	1	1	0	0	3
Intimate Space	3	3	3	3	3	3	2	3	1	2	3	3	2	3	2	1	2	3	2	1	1	2	2	1	2	2	1	2		2	1	1	2	2	0	1	1	0	0	3
Tourist Atraction	3	3	3	3	3	2	3	2	1	2	2	2	2	3	3	1	3	3	2	0	0	3	1	1	2	2	1	3	2		1	1	2	1	0	1	1	0	0	3
Safety/crime reduciton	3	1	3	2	2	3	3	4	2	1	2	1	3	1	2	3	2	1	1	0	1	1	1	1	2	2	1	1	1	1		2	2	0	1	2	1	1	1	3
Porous/Permiable Pavement	2	2	3	2	2	1	2	6	1	0	2	3	1	2	1	2	1	1	0	1	0	1	1	0	4	6	0	1	1	1	2		4	1	1	1	2	1	1	7
bioretention	2	2	3	2	2	2	3	5	2	1	2	3	1	2	2	2	2	2	1	0	0	2	1	1	5	5	1	2	2	2	2	4		2	1	1	1	0	1	5
Reuse of excess street space	2	2	3	2	2	2	2	3	2	2	2	3	1	2	1	1	1	2	2	1	1	1	1	1	2	2	1	1	2	1	0	1	2		0	0	0	0	0	3
Tree Boxes	2	2	1	2	1	2	3	2	2	2	1	1	1	1	2	2	1	1	1	2	2	1	1	1	2	1	0	0	0	0	1	1	1	0		0	0	0	1	3
Land Use Variation	2	1	2	2	1	1	1	2	1	1	2	1	2	1	1	2	1	1	0	0	0	1	1	1	1	1	0	1	1	1	2	1	1	0	0		1	1	0	2
Snow consideration	1	1	1	1	1	1	1	2	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	0	1	1	0	1	1	1	1	2	1	0	0	1		1	0	2
Maintenance/Cleaning	1	0	1	1	0	1	0	2	1	1	1	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	1		0	2
Recreation	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	1	0	0	0		2
	10	9	10	9	8	9	8	13	7	9	8	7	6	6	6	6	6	6	6	5	4	4	4	4	7	8	4	3	3	3	3	7	5	3	3	2	2	2	2	

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4. OBSERVING THE VALUE OF COMPONENTS

Observational study has been the traditional method for understanding how people use public space. This method has value in understanding this relationship but still leaves other questions unanswered. Various qualitative assessment methods exist as part of the observational study process. The SF Planning Department has developed its own “Do It Yourself Survey for Living Alleys” as part of their “Living Alley Toolkit” (‘Living Alley Toolkit’, 2015). It was developed based on Jan Gehl’s book, “How to Study Public Life.” It gives anyone the ability to assess an alley based on the public life survey. It takes into account the street’s physical condition such as the street’s dimensions and a qualitative assessment of connectivity, accessibility, safety, aesthetics, and sustainability; it looks at the street’s pedestrian, vehicle, and bicycle volumes and also allows the assessor to consider how people use the street. Additionally, it encourages the assessor to “measure and draw the key dimensions and elements” observed within the space. Other methods include interviews with those people who use the space. This includes passersby, business owners, and shopkeepers, as well as residents.

There is a need for planners to look back on projects and see how successful they have been. As more living or activated alley master plan renovations are implemented, it will be easier to understand their impacts and understand the values these components have. In order to accomplish this, the studies must better utilize the tools already at the disposal of planners.

There is currently a lack of justification for which components have the biggest influence on drawing people into activated alleys. At this point, planners can only suggest that activated alleys are more attractive to pedestrians because of observations such as increases in pedestrian volume and observations of pedestrians staying for longer

periods of time. This does not provide a definitive answer to what specific component influenced the pedestrian to come to that place. If planners have a tool to rate the influence of each component it may become easier to convince decision makers and public works departments of the value alley projects have in increasing pedestrian volumes in alleys. It would also allow planners to simulate the effect their plans have prior to implementation. A study to identify the influence that the most common components have on pedestrian route choice could help generate the data necessary to create this tool.

5. COMPONENT VALUE IN PEDESTRIAN BEHAVIORAL MODELING

Micro-level modeling simulations are most commonly used in station and terminal design however it has direct application in identifying the route choice for pedestrians through activated alleys. It has the capability of incorporating the barriers in streets and the utility of the components within the activated alley. Pedestrian movement can be measured as the flow of individuals in a fluid like motion. Similar to a river, volume and speed can be used to predicted change in movement. Multiple stages are used to predict how and where pedestrians will move. This movement is based on pedestrian behavior. By measuring and modeling pedestrian behavior, it is possible to predict how a pedestrian will move through a network given various barriers, attractors, and risks. This knowledge can provide planning professionals with a micro-level assessment of what components will attract pedestrians to an alley. These models have the ability to predict pedestrian movement base on attractors and detractors.

“Pedestrians are expected cost minimizers: they schedule their activities, choose the activity areas and the routes connecting these activity areas simultaneously to maximize the expected utility of their efforts.” (Hoogendoorn, S. & Bovy, P. 2002). By integrating the utility or value of a component, these models can predict a pedestrian’s route choice. Obstacle, preferred walking areas, pedestrian infrastructure components, the locations of various activity possibilities within and area, and demand patterns are all currently considered when modeling pedestrian behavior. This process allows for a simulation to generate the movement of pedestrians within a given timeframe. However, there is a lack of information available to accurately assign attraction values to the components.

Once the value of components have been established it will be possible for planning professionals to use pedestrian behavioral modeling software as a tool to improve alleys.

The alley being planned could be built using micro-level simulation software. The components could then be tested as to how they will influence pedestrian route choice in and around the alley. Data still needs to be collected in order to know the true value the components have as attractors and barriers. Intercept surveys are most effective way to collect this type of data. This method of data collection provides an opportunity to collect demographic information, origin and destination information, and will allow values to be assigned to components based on how much they influence route choices.

By performing an intercept survey along a designated segment, it is possible to question individuals on the factors that made them choose that route. The hope is that this process will uncover unconscious decisions that pedestrians use in route choice. This will be of great importance in future research on the effects alley components have on route choice and other micro-level behavioral decisions. From this data collection it will then be possible to model the attractors and barriers that effect a pedestrian's short range route choice. This will provide researchers a better understanding of the impact that an alley activation or its various individual components have on the connectivity of the network as a whole.

6. INFLUENCE OF COMPONENTS ON PEDESTRIAN ROUTE CHOICE

6.1 Methodology

Are the most commonly used components used by professionals to activate alleys held in the same regard by pedestrian users? And, to what degree do each of the components influence a pedestrian’s behavior to choose to make the alley segment part of their route? To answer this question, a pilot study was developed to gain an understanding of the subject and identify evidence for further research.

The pilot study was developed with the intention to catch pedestrians who had already decided to choose an activated alley as part of their route. The thought being, if a person could be caught immediately following the conscious or unconscious decision to walk down an activated alley, the pedestrian would have a reference to help them articulate what had influenced that decision.

The survey was pre-tested on five individuals in order to discover the best wording and method for collection. The test demonstrated that a few words had to be changed from those used in the master plan analysis, as not everyone had an understanding of what each component meant or the word choice was not inclusive enough. For instance, “building access” had to be changed to “amenities such as the coffee shop” in order to be more inclusive and fit the context of the chosen location for the pilot study. “Pavement” needed to be accompanied by “its quality and design”. Also, “drainage” needed to be written as “drainage/storm water management/flood control” and “On site water treatment” needed to be written as “Rain gardens/on site water treatment”. The final wording and full survey can be found in Appendix A. The test also discovered that it was more efficient and that people better understood the questions when they were administered by a proctor who transcribed their answers instead of having the interviewee fill out the form themselves.

Linden Alley between Gough St. and Octavia St. in San Francisco was selected as the location for the pilot study. This narrow alley's renovation was designed by Winslow Architecture in 2006. It is well known by those within the Hayes Valley neighborhood and has multiple anchors within the segment including two coffee shops, an architecture firm and back entrances to a number of businesses. The street's layout and design of the activated section of the alley are seen in Figure 2. The site contains examples of the majority of physical components identified in the plan and program review. The pilot study was performed on Tuesday, May 26th 2015. Data was collected between 8:30 am and 7:00 pm. Two surveyors were present for most hours of the day. Each person who passed through the plane, from either direction, marked by the red line in Figures 2 and 3 was asked to participate in the study.

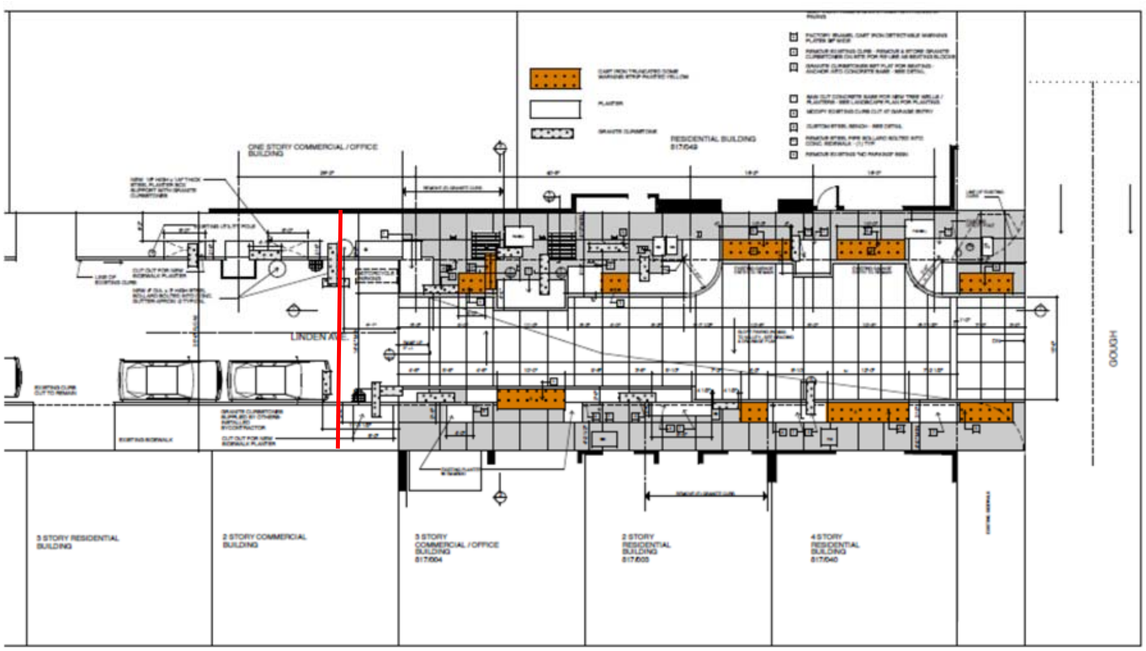

Figure 2. Linden Alley Design aerial view (Sf-planning.org, 2015)

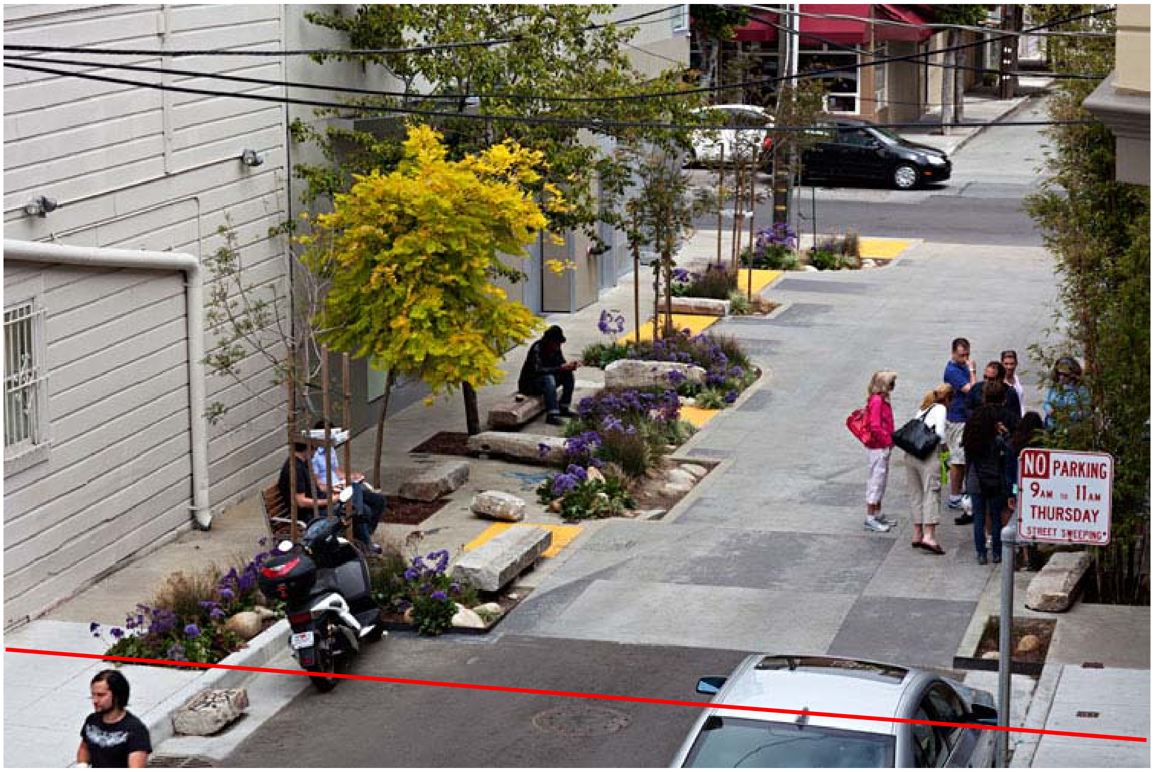

Figure 3. Image of Linden Alley (Hayes Valley Voice, 2013)

The following day, May 27th, the survey was performed on Ivy St., an alley two half-blocks from Linden Alley, at the intersection of Octavia St., during the same time period. The goal was to discover if people traveling in an adjacent alley, that had not been activated, would answer with different influence values. However, only 3 people were traveling on Ivy St., of which 2 were surveyed. This sample was too small to draw any conclusions. Although, it does suggest that without any anchors or components found in an activated alley, pedestrians are less likely to choose Ivy St. Alley as a route. (Ivy St. is planned for renovation as an activated alley as part of the Hayes Octavia Area Plan).

6.2 Demographics

Seventy samples were collected on Tuesday, May 26th. They account for about 1/4th of the people that were present in the alley during the study time. The pedestrians surveyed in this pilot study were of a relatively fair representation of the San Francisco

population found in recent years. This is not a very diverse population. The population interviewed was 59% male and 41% female. Ten percent were age 18-24, 51% were age 25-35, 30% were age 35-54, and 9% were 55 and over. None of those surveyed had not finished high school. The highest level of education for 5% of those surveyed was a high school diploma, for 13% it was some college no degree, for 3% it was an associates degree, for 58% it was a bachelors degree, for 19% it was a post graduate degree, and 2% preferred not to answer.

6.3 Results

It was important to understand the purpose of the pedestrian's trips. One-third of those surveyed were either coming from or going to work. For just under a third, the trip's purpose was for a meal or to grab some coffee. It is very possible that some of those who were grabbing a meal or coffee were also on their way to or from work. From observation, it was clear that most of those who did not participate in the survey, but were also on the street were there in order to visit the Blue Bottle Coffee shop on the segment or were in too much of a hurry to stop. This was especially evident before 10 am and from noon to 2 pm. This is just more evidence that amenities are anchors and attractors in any public space. The rest of those surveyed were there for social, shopping, or other reasons like walking their dogs or exploring.

In order to understand how familiar people were with the space and to understand how familiar people were with the street, the survey asked pedestrians how often they make a trip that involves walking on that block of Linden Alley. 57% of the respondents said they were there more than once a week. It was not marked in the data collection, but surveyors noted that many of those surveyed were on that block of Linden Alley five days a week. Many worked on the street or used it to get to work each day. Many also

planned their route to work to involve stopping for coffee on their way to work each morning. Thirteen percent said they were on that block closer to once a week, 6% once a month, 8% less than once a month, and 16% said it was their first time on that block.

Those surveyed were asked why they chose to walk down the street. Half said it was the most direct route, 34% said it was due to the design of the street, 4% said it was because the street was safe, and 12% said it was for another reason such as the dog chose their route, they wanted to avoid “homeless” people (4 of those interviewed were clearly identifiable as transient houseless people) or because the street was quiet.

The main portion of the survey was to identify how much pedestrians felt the components influenced their route choice. In order to assess this, they were asked to rate each component. A rating of 0 meant it had no influence whatsoever, a rating of 10 meant it was extremely influential. The most influential component was noted as “amenities”, with an average rating of 7.74. The second most influential component was noted as the “directness and connectivity of the route” with a rating of 7.61. The third most influential was “landscaping”. The full list and their value can be seen in Figure 4 and Table 3.

There were a few components that had substantial differences between male and female ratings. Males rated the “directness and connectivity of the route”, “street art”, “available open space”, and “street furniture” substantially higher than females. Females rated “shade/sunshine”, “pavement”, and “street lighting” substantially higher than males.

People were also asked to rate a 20th influence of their own choosing if they believed there was something that had not been mentioned. Most people did not provide another influence and stated that the survey was comprehensive and had covered everything. Of

those who did mention an additional influence, the most common write in, with 3 people each, were “nostalgia/memory” and “presence of homeless”. Other influences worth noting include “how quiet the street is”, and services such as restrooms, drinking fountains, and the variety of what the street has to offer.

After rating all 19 components, respondents were asked what the top 3 influencing components were. “Amenities”, “directness and connectivity”, and “landscaping” were chosen as being in the top three influences most frequently, which makes sense as they also are rated as being the top 3 influential components. However, some people responding to this question did not choose their highest rated influences as being their top three most influential factors. More details and information about other components can be seen in Table 3.

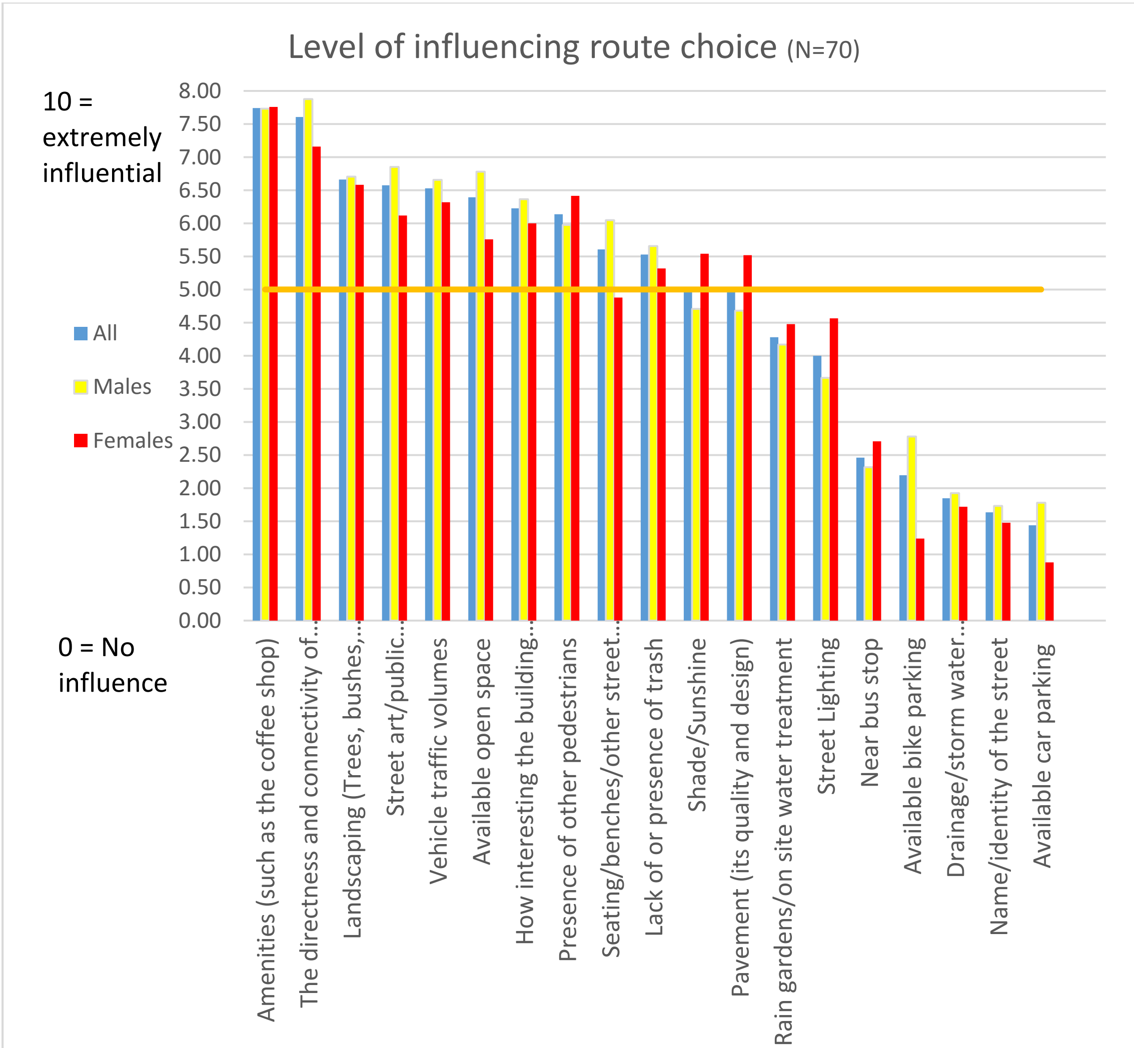

Figure 4. Rating level of components for influencing pedestrian route choice to include alleys.

*If the survey was performed during or immediately following a rain storm, drainage would likely be much more influential.

Table 3. Rating level of components for influencing pedestrian route choice to include alleys.

Count	Frequency as a top 3 pick	Component	Ave	Male Ave	Female Ave	Difference (Red = males gave higher rating, highlighted have STDEV between males and females > than 0.5)
14	30	Amenities (such as the coffee shop)	7.74	7.73	7.76	0.03
11	27	The directness and connectivity of the route	7.61	7.88	7.16	0.72
3	26	Landscaping (Trees, bushes, flowers, etc.)	6.66	6.71	6.58	0.12
5	15	Street art/public art/murals/sculptures	6.58	6.85	6.12	0.73
13	11	Vehicle traffic volumes	6.53	6.66	6.32	0.34
9	11	Available open space	6.39	6.78	5.76	1.02
12	7	How interesting the building facades/walls are	6.23	6.37	6.00	0.37
7	15	Presence of other pedestrians	6.14	5.98	6.42	0.44
8	9	Seating/benches/other street furniture	5.61	6.05	4.88	1.17
6	11	Lack of or presence of trash	5.53	5.66	5.32	0.34
19	2	Shade/Sunshine	5.02	4.71	5.54	0.83
4	4	Pavement (its quality and design)	5.00	4.68	5.52	0.84
10	0	Rain gardens/on site water treatment	4.28	4.17	4.48	0.31
2	6	Street Lighting	4.00	3.67	4.57	0.90
18	2	Near bus stop	2.46	2.32	2.71	0.39
16	0	Available bike parking	2.20	2.78	1.24	1.54
1	0	Drainage/storm water management/flood control	1.85	1.93	1.72	0.21
15	1	Name/identity of the street	1.64	1.73	1.48	0.25
17	2	Available car parking	1.44	1.78	0.88	0.90

Some components are rated substantially higher than others. Those components with a rating over 5 most likely have a higher value in influencing pedestrians than those components with a rating lower than 5.

7. COMPARISON OF PLANS AND PROGRAMS WITH PEDESTRIAN INFLUENCE RATINGS

One goal of the pilot study was to assess if the alley plans and programs were placing an emphasis on features that influenced pedestrians to choose to use the space. Figure 4 shows the 20 most frequently found components in the alley plans and programs with their influence rating. Some ratings cover two alley master plan components. For instance, “presence of pedestrians” was used to rate both “festival and event space” as well as “activity/eyes on the street”. “Pavement” was also used to rate the influence of both “paving” and “porous and permeable pavement”. Implementation strategy could not be rated as it is a part of the planning process and clearly implementation is necessary before any component could ever have an influence. Near bus stop and available car parking were used in the survey to create consistency and prevent bias ratings toward “bike parking”, which is one of the 20 most commonly found components in the alley plans and programs.

“Landscaping” looks to be well established as both a key influence and a commonly used feature in alley planning, found in 10 of the 16 plans. “Public art’s” influence is also highly rated and it is found in 9 of the 16 master plans. “Name/identity” is one of the top 20 components found in plans, but it is only found in 6 of the 16 master plans. It was also not highly rated as being influential. The same goes for “Bike Parking”, which was not expected to have a high influence for pedestrian route choice and would probably have a high rating for bicycle route choice, but that is another study altogether.

There are also multiple discrepancies. “Amenities”, which was used to represent building access, was rated as having the highest influence and yet it was only found in 6 of the 16 alley master plans. That suggests that, given a larger sample with similar results, planners should focus more attention on providing building access to amenities in order

to influence more pedestrians to use an alley. On the other extreme, lighting is present in 10 of the 16 master plans and yet was not highly rated as being influential. This may be due to the fact that Hayes Valley, where the study was performed, is considered a safe neighborhood and because it was performed in daytime and within a month of the longest day of the year. This study would need to be performed in a wide variety of neighborhoods, at night, and in different seasons to truly understand the true value and influence lighting has. The variability and commonalities between all components can be seen in Figure 4.

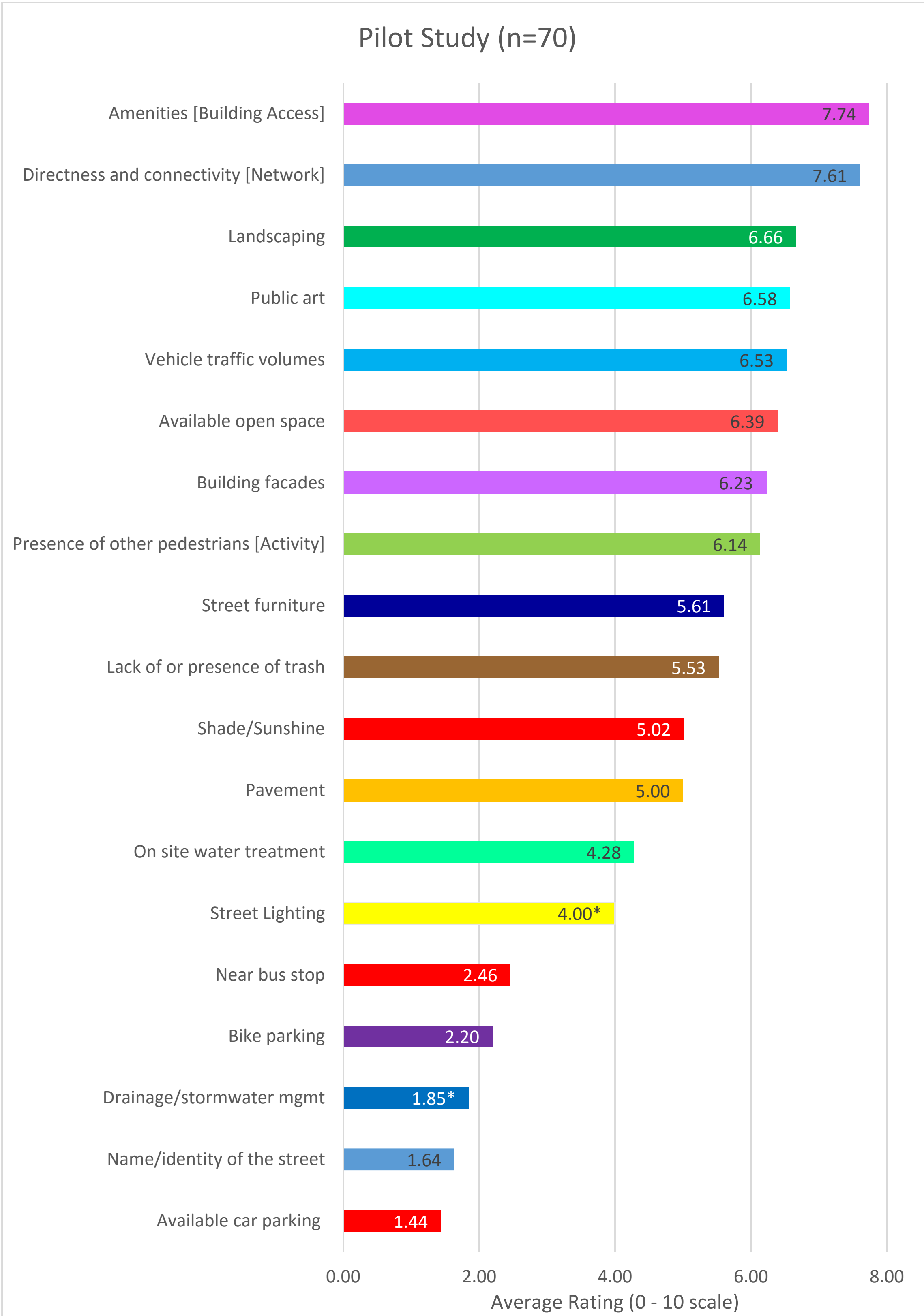

Figure 5. Average pedestrian route choice influence rating.

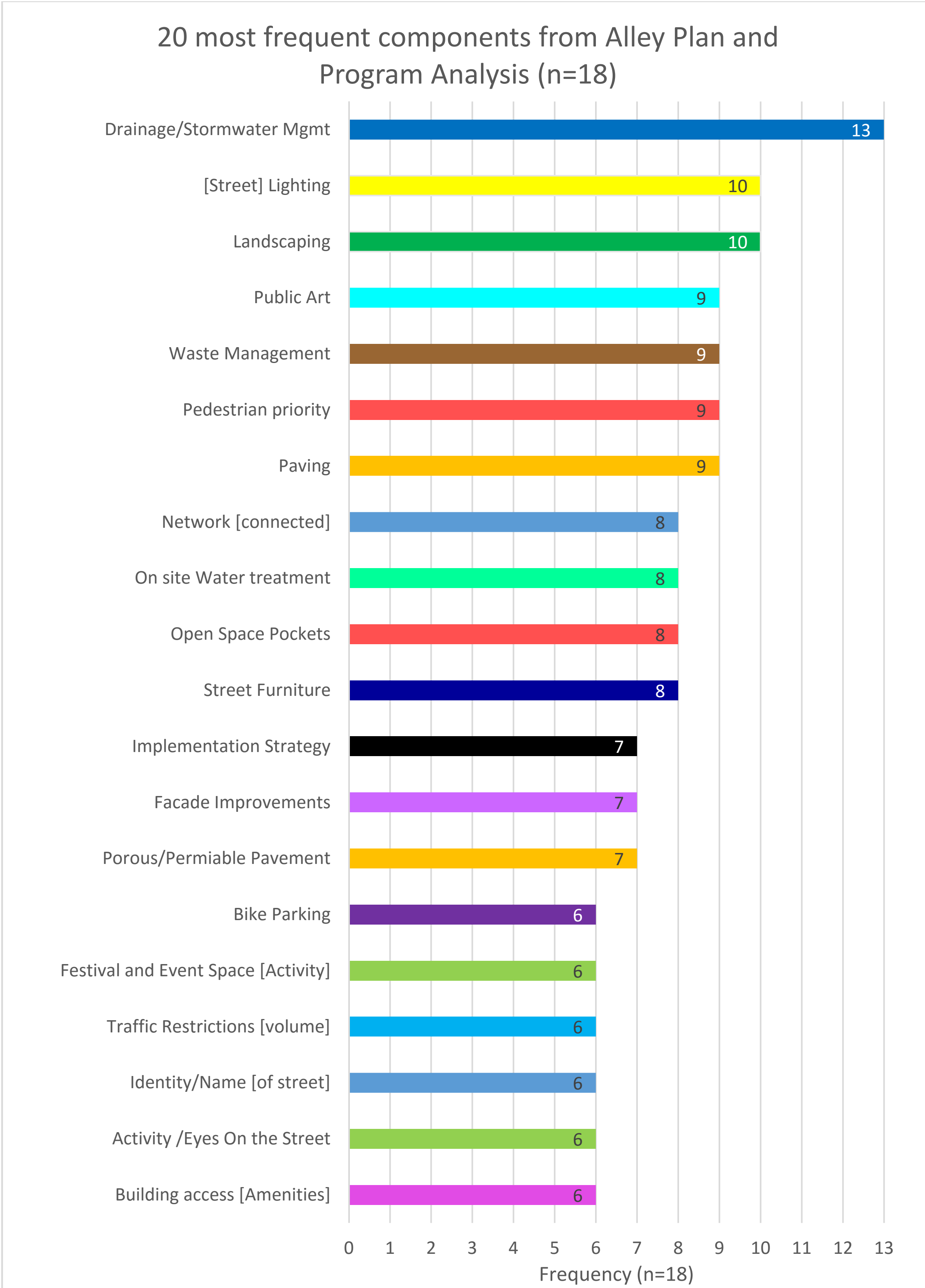

Figure 6. 20 most frequent components found in the 18 alley plans and programs.

*Daytime; *Not Raining

8. RECOMMENDATIONS AND FURTHER STUDY

Further exploration is needed to generate enough data to formulate definitive results to the study. Currently the pilot study does not have enough data to draw conclusions. The study would need to be performed in many more alley settings. The pilot study data was biased because it was performed in a safe wealthy neighborhood in San Francisco, during a drought, only during the daytime within a month of the longest day of the year, and only during one weekday. Due to this the data does not prove influence values that would be relevant across the country. Further studies that covered different seasons, times of the day, cities, types of neighborhoods, and days of the week need to be performed to gain the information necessary to draw any real conclusions. Then the data could be presented as in the results section of this study, at that point conclusions could be made. This data could then be tied into improving other behavior studies and information systems.

Once adequate data is gathered, and generated to represent the national pedestrian and bicycle riding populations the average influence rating of each component could be used by planners to make informed decisions and prove the need of various components. Also, this type of data could be used for pedestrian behavior modeling. A study could be done to add the influence rating to components so that they can be used as attractors in the virtual model. This would allow the modeling software to be more accurate in measuring human behavior and the route choice of pedestrians.

9. CONCLUSION

This study shows that alleys have a lot of potential to contribute to a more active and safe pedestrian environment. There is far more research that could be done on this subject. Based on the pilot study, the most influential factor to a person choosing to walk was the directness of the route. By choosing to walk in the alley in the first place, those interviewed were already removing themselves from the proximity of autos. Safety and vehicle traffic volumes were highly rated but neither were in the top three. This is consistent with the Mineta Transportation Institute study. There is clearly more data necessary to draw definitive conclusions. However, the pilot study did give a general idea of what influences pedestrians.

More research is necessary to identify the true value of each component. However, it is clear that activating and renovating alleys has an effect on pedestrian route choice. The most likely influence being active space. By having an activity to do or purpose within an alley, pedestrians are more likely to incorporate the alley into their route. The other components may improve the experience and add to the attraction and attractiveness of the alley.

Cities across the United States and around the world are beginning to see the great potential alleys and the other space between buildings have to pedestrians and other users. This space has value for transportation, the environment, and the community. The question still remains as to what components are the most beneficial. Hopefully this research will lead to further study that can identify the components' values and has produced the information necessary to encourage further exploration in the possibility that alleys have.

BIBLIOGRAPHY

Activating Urban Space: A Strategy for Alleys & Passages. (2012). Retrieved March 2014, from http://www.bhamgov.org/document_center/Planning/Master_Planning_Docs/Strategy_for_Alleys_and_Passages.pdf

Alley network project. (2014). alleynetworkproject.com. Retrieved February 25, 2014, from http://alleynetworkproject.com/

Alleys | Forgotten New York Forgotten New York. (2014). Forgotten New York. Retrieved February 25, 2014, from http://forgotten-ny.com/category/alleys/

Archive.baltimorecity.gov,. (2010). General Services / Alley Gating & Greening Program. Retrieved January 2015, from http://archive.baltimorecity.gov/Government/AgenciesDepartments/GeneralServices/AlleyGatingGreeningProgram.aspx

BiophilicCities. (1993). BiophilicCities. Retrieved February 25, 2014, from http://biophiliccities.org/what-are-biophilic-cities/

Blue Water Baltimore,. (2014). Blue Alleys. Retrieved January 2015, from http://www.bluewaterbaltimore.org/about/programs/blue-alleys/

Chinatown Community Development Center,. (1998). Chinatown Alleyway Master Plan. San Francisco.

City of Los Angeles, Sanitation Department,. (2009). Green Streets and Green Alleys Design Guidelines Standards.

City of Melbourne,. (2004). Places for People. Melbourne.

Cityofdubuque.org,. (2009). Green Alley Program. Retrieved January 2015, from http://www.cityofdubuque.org/DocumentCenter/View/18045

Cityoflondon.gov.uk,. (2010). Retrieved January 2015, from https://www.cityoflondon.gov.uk/services/environment-and-planning/environmental-enhancement/strategies/Documents/vision-for-the-bank-area-1-part-6.pdf

DC Green Alley Project. (2012). Retrieved January 2015, from http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/ddot_green_alley_projects_factsheet.pdf

Downtown Bozeman Partnership,. (2012). Downtown Bozeman Alley Sketchbook. Bozeman.

Gehl, J., & Svarre, B. (2013). How to study public life.

Green Alley Handbook. (2010). Chicago Department of Transportation. Retrieved March

17, 2014, from http://www.cityofchicago.org/dam/city/depts/cdot/Green_Alley_Handbook_2010.pdf

Green Alley Handbook. (2010). Chicago Department of Transportation. Retrieved March 17, 2014, from http://www.cityofchicago.org/dam/city/depts/cdot/Green_Alley_Handbook_2010.pdf

Green Alleys. (2010). City of Chicago ::. Retrieved February 25, 2014, from http://www.cityofchicago.org/city/en/depts/cdot/provdrs/street/svcs/green_alleys.html

Green Futures Research and Design Lab,. (2011). Seattle's Integrated Alley Handbook, Activating Alleys for a Lively City. Seattle: University of Washington.

Hayes Valley Voice,. (2013). Market & Octavia Living Alley Project - Hayes Valley Voice. Retrieved 6 June 2015, from http://hayesvalleysf.org/market-octavia-living-alley-project/2013/06/

Hoogendoorn, SP, & Bovy, PHL (2002). Normative pedestrian behaviour theory and modelling In Michael A.P. Taylor (Ed.), Transportation and traffic theory in the 21st century (pp. 219-245). Oxford: Pergamon, Elsevier science.

Igarta, D. (2012). Livable Streets where People Live. German Marshal Fund of the United States. Retrieved February 25, 2014, from http://www.gmfus.org/wpcontent/blogs.dir/1/files_mf/1355328089Igarta_LivableStreets_Dec12_web.pdf

Integrated Alleys. (2010). - Define Alley, Please. Retrieved February 25, 2014, from http://integratedalleys.tumblr.com/post/971203571/define-alley-please

Jacobs, J. (1961). The Death and Life of Great American Cities. New York, NY: Random House, Inc.

Kriscenski, A. (2015). CHIGAGO'S NEXT LEAD: The Green Alley Project. Inhabitat.com. Retrieved March 17, 2014, from http://inhabitat.com/chicagos-next-lead-the-green-alley-project/

London, Department of Planning and Transportation,. (2003). Fleet Street Courts and Lanes Design Strategy. London.

Matrix Design Group,. (2013). Downtown Pedestrian Alleyways. Pueblo: Pueblo Urban Renewal Authority.

Mill Street Planning. (2014). Mill Street Planning. Retrieved February 25, 2014, from http://dsdauphin.wordpress.com/

Muralarts.org,. (2015). Mural Arts Program | Mural Arts Program. Retrieved 7 June 2015, from http://www.muralarts.org/

Nuworsoo, C., Cooper, E., Cushing, K., & Jud, E. (2012). Integration of Bicycling and

Walking Facilities into the Infrastructure of Urban Communities. Retrieved 9 March 2014, from http://transweb.sjsu.edu/PDFs/research/2906-Bicycling-and-Walking-Facilities-Urban-Communities.pdf

Nytimes.com,. (2007). In Miles of Alleys, Chicago Finds Its Next Environmental Frontier - New York Times. Retrieved 14 February 2014, from http://www.nytimes.com/2007/11/26/us/26chicago.html

O'Sullivan, F. (2014, March 10). London's Plan to Move Cyclists to Side Streets. Atlantic Cities. Retrieved March 16, 2014, from http://www.theatlanticcities.com/commute/2014/03/londons-plan-move-cyclists-side-streets/8598/

Russel + Mills Studios,. (2008). Fort Collins Downtown Alleys Master Plan Report. Fort Collins: Fort Collins Downtown Development Authority.

Saulny, S. (2007, November 25). In Miles of Alleys, Chicago Finds Its Next Environmental Frontier. The New York Times. Retrieved March 21, 2014, from http://www.nytimes.com/2007/11/26/us/26chicago.html?_r=0

Sf-Planning,. (2015). Market and Octavia Area Plan. Retrieved January 2015, from http://www.sf-planning.org/ftp/files/Citywide/Market_Octavia/Market_and_Octavia_Area_Plan_2010.pdf

Sf-planning.org,. (2011). Better Streets San Francisco. Retrieved January 2015, from http://www.sf-planning.org/ftp/betterstreets/index.htm

Sf-planning.org,. (2015). San Francisco Planning Department: Market Octavia Living Alleys. Retrieved 7 February 2015, from http://www.sf-planning.org/index.aspx?page=3510

Tenderloin National Forest. (2011). Luggage Store Gallery. Retrieved February 25, 2014, from http://www.luggagestoregallery.org/tnf/

The Central London Grid. (2014). Cycling Grid and Quietways. Retrieved March 16, 2014, from http://www.rbkc.gov.uk/environmentandtransport/transportandstreets/cyclingandwalking/cyclinggridandquietways.aspx

The City of Pasadena,. (1995). Old Pasadena Streetscapes and Alley Walkways Refined Concept Plan. Pasadena, CA: The City of Pasadena.

The Pyramid Center. (2014). Amenities - Redwood Park. Retrieved March 17, 2014, from http://www.thepyramidcenter.com/leasing/amenities_redwoodpark.html

Vole O'Speed. (2014, February 13). Response to the Central London Cycle Grid consultation. Retrieved March 16, 2014, from http://www.voleospeed.co.uk/2014/02/response-to-central-london-cycle-grid.html

APPENDICES

A. Survey, What Influences Pedestrian Route Choice in Alleys?

Survey Informed Consent & Questions:

Hello! Dr. William Riggs and Master's Candidate Sam Gross from the City and Regional Planning Department at Cal Poly, San Luis Obispo, are doing research on what influences route choice. The goal is to help better understand why people walk in alleys.

Please help us by filling out the survey below, by doing so you are saying it is okay to use your data (i.e. that you consent). It will take only about 5-10 minutes and will help us work to improve the walking environment. You are not required to participate and can stop at any time. All of your answers are confidential and you may skip any question you prefer not to answer.

There are no risks anticipated with your participation in this study. Potential benefits from your participation include a better understanding of alley design on urban environments.

If you have any questions about what we are doing, or want the results, contact Dr. William Riggs via email at wriggs@calpoly.edu. If you have concerns about how the study was conducted, you may contact Dr. Steve Davis, Chair of the Cal Poly Human Subjects Committee, at (805) 756-2754, sdavis@calpoly.edu, or Dr. Dean Wendt, Dean of Research, at (805) 756-1508, dwendt@calpoly.edu.

Thank you very much for your participation. Please keep a copy of this consent form for your reference, if you would like one. We really appreciate it.

Date:

Day of week:

Time:

1. Where are you walking from? (If you are walking from where you parked your car or bike, or from where a bus, taxi or other vehicle dropped you off, please note the drop off or bus stop location as your answer.)
   Please write down the address or nearest cross streets
   ____

2. Where are you heading? (If you are walking to where you parked your car or bike, or to where a bus, taxi or other vehicle will pick you up, please note the pick up or bus stop location as your answer.)
   Please write down the address or nearest cross streets
   ____

3. What is the purpose of this walking trip?

o Coming or going to your place of work
o Social
o For a meal
o Shopping
o Other____________________

4. How often do you make a trip that involves walking down this block?

o More than once a week
o Once a week
o Once a month
o Less than once a month
o This is my first time here

5. Why did you choose to walk down this block / alley?

o This is the most direct route (If you believe this is the most direct route between where you began walking and your destination or if you believe this is the most direct route to or from another mode of transportation that you are using on this trip please choose this answer)
o The design of the street
o Safety
o Another reason (please specify):_____________________________

6. Please rate each component or factor on their level of influencing your decision to walk down this block of Linden Lane. (0 no influence at all, 10 extremely influential)

- Drainage/storm water management 0 1 2 3 4 5 6 7 8 9 10
- Street Lighting 0 1 2 3 4 5 6 7 8 9 10
- Landscaping (Trees, bushes, flowers, etc.) 0 1 2 3 4 5 6 7 8 9 10

- Pavement (its quality and design) 0 1 2 3 4 5 6 7 8 9 10
- Street art/public art/murals/sculptures 0 1 2 3 4 5 6 7 8 9 10
- Lack of or presence of trash or dumpsters 0 1 2 3 4 5 6 7 8 9 10
- The presence of other pedestrians 0 1 2 3 4 5 6 7 8 9 10
- Seating/benches and other street furniture 0 1 2 3 4 5 6 7 8 9 10
- Available open space 0 1 2 3 4 5 6 7 8 9 10
- Rain gardens / on site water treatment 0 1 2 3 4 5 6 7 8 9 10
- The directness and connectivity of the route 0 1 2 3 4 5 6 7 8 9 10
- Interesting building facades/walls 0 1 2 3 4 5 6 7 8 9 10
- Vehicle traffic volumes 0 1 2 3 4 5 6 7 8 9 10
- Amenities such as the coffee shop 0 1 2 3 4 5 6 7 8 9 10
- The identity/name of the street 0 1 2 3 4 5 6 7 8 9 10
- Available bike parking 0 1 2 3 4 5 6 7 8 9 10
- Available car parking 0 1 2 3 4 5 6 7 8 9 10
- Near your bus stop 0 1 2 3 4 5 6 7 8 9 10
- Shade/Sunshine 0 1 2 3 4 5 6 7 8 9 10
- Other_________________________ 0 1 2 3 4 5 6 7 8 9 10

7. Now go back and circle the top 3 factors that made you walk down this block / alley.

8. Are there any components or factors not mentioned in this survey that similar spaces in the urban environment would benefit from? _________________________

9. What is your gender? (Circle answer)
   Female | Male | Other | Prefer not to say

10. How old are you? (Circle answer)
    18-24 | 25-34 | 35-54 | 55+ | Prefer not to say

11. What is you highest level of education? (Circle answer)
    12th grade or less | Graduated high school or equivalent (ex. GED) | Some College, no degree | Associates degree | Bachelor’s degree | Post-graduate degree | Prefer not to say

12. Do you have other comments or things you’d like to tell us about why you chose to walk down this block / alley? ____

B. A Review of Pedestrian Behavioral Modeling

REVIEW OF PEDESTRIAN BEHAVIORAL MODELING

A paper

by

Samuel H Gross

March 2015

ABSTRACT

This paper examines methods for modeling pedestrian connectivity within a network. Historically, connectivity has been measured based on the connectivity of the whole network. After traditional methods are identified this paper explores how micro-level simulation can model pedestrian behavioral choice within the network and their effect on localized connectivity. This will allow for the modeling to show how pedestrians respond to barriers, attractors, and risks. Discrete Mode Choice Modeling, Space Syntax, route choice modeling and Normative Pedestrian Theory are explored along with the tools for modeling. The goal of this is to provide knowledge and research methods in order to model the impact activated alley components have on pedestrian route choice as an attractor.

INTRODUCTION

Connectivity is an important part of any transportation network. Pedestrian networks are no different. According to Michael Southworth, Professor of Urban Design and Planning at the University of California Berkeley, there are "six criteria … for design of a successful pedestrian network: (1) connectivity; (2) linkage with other modes; (3) fine grained land use patterns; (4) safety; (5) quality of path; and (6) path context." (Southworth, 2005). Connectivity is determined by the presence of pedestrian infrastructure such as sidewalks, crosswalks, and other paths and the continuity of these elements throughout a given area. The degree of continuity of the pedestrian space and the lack of barriers to the pedestrian is what determines access within the network. Pedestrian connectivity can be determined give proper analysis of data. The challenge with measuring this is that there is far less data available for pedestrians than other modes. Additionally, travel distance has a greater impact on pedestrian mode choice than other modes. Pedestrian travel distance must be measured in a way that considers the actual walking distance of the trip. This means taking into account barriers and crossing locations. As pedestrians are not constrained by normal traffic patterns, they have more options as to how they travel but they are also exposed to other factors that influence route choice. Route choice is effected directly by the density of intersections and the length of blocks, as well as by micro-level behavioral decisions such as safety and the relation to barriers and attractors. "Barriers to pedestrian access such as cul-de-sacs and dead end streets, or busy arterials, railroad or power line rights-of-way, rivers, or topographic features must be minimized" in order to create a successful pedestrian network. (Southworth, 2005). In most locations, where the land uses and transportation systems have already been developed it can be a challenge to overcome these barriers. There has also been little research done on how to determine the value of attractors,

elements or components of the built environment. There are many traditional measurements of network connectivity and a few methods for predicting pedestrian behavior. If the built environment can be measured for its network and micro-level connectivity it will be possible to determine how components of the built environment effect pedestrian behavior within the network.

TRADITIONAL NETWORK CONNECTIVITY MEASUREMENTS

Early cases of traditional methods for measuring pedestrian network connectivity were used to prove the value grid systems have for pedestrian access. The images in FIGURE 1 have been used in many publications to express the need to increase pedestrian connectivity through grid systems. There are many methods for measuring pedestrian connectivity. Traditionally these methods look at the network area as a whole and calculate the connectivity within the area.

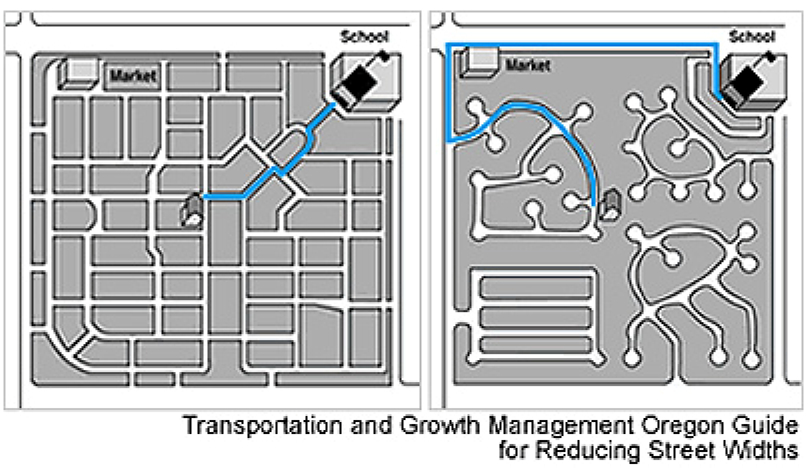

Figure B.1. Standard image expressing the benefit connectivity has for pedestrian transportation

Average Block Length

Shorter blocks are better for active transportation modes. (Dill, J. 2004) They allow pedestrians and bicyclist a more direct route and can reduce the distance one must travel. By calculating the average block length within the network area, it is reasonable to state that networks with shorter average block lengths have a higher level of connectivity.

Mean Block Size (Area)

Using the same principle as block length, block size recognizes that a block has to dimensions not just the length of one segment. Areas with smaller mean block size have higher network connectivity. The images in FIGURE 2 show how to networks with the same block area can have different average block lengths.

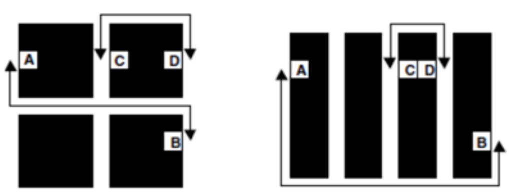

Figure B.2. Block area vs block length (Dill, J. 2004)

Block Density

Calculating the number of census blocks per square mile is another method used to measure connectivity. This can also be calculated by the number of physical street blocks exist in a square mile. The general idea being the more blocks within an area, the higher connectivity a pedestrian will have to get between the blocks.

Intersection Density

This is “measured as the number of intersections per unit of area” generally a square mile. The idea being that the more intersections the higher connectivity.

Street Density (Area of streets/Total Area)

This is measured by taking the square footage of streets space and dividing that by total area it encompasses. This has been used to calculate connectivity, but does not hold much weight for use with pedestrians as pedestrians do not have access to the entire street. It is possible to rebrand this measurement technique for pedestrian use by measuring walkable area density.

Connected Intersection Ratio

Also known as Connected Node Ratio, a Connected Intersection Ratio is the “number of street intersections divided by the number of intersections plus cul-de-sacs” (Dill, J. 2004). A higher value ratio means less cul-de-sacs, which in theory means a higher level of connectivity. However this does not consider the possibility of a pedestrian cut through existing at the end of the cul-de-sac.

Link-Node Ratio

A Link-Node Ratio is a calculation of the number of links per nodes within an area. The idea is that more links (street segments) compared to nodes (intersections) means there are more route choices and there is most likely a shorter travel distances needed to get between destinations. A higher ratio of links to nodes means higher connectivity.

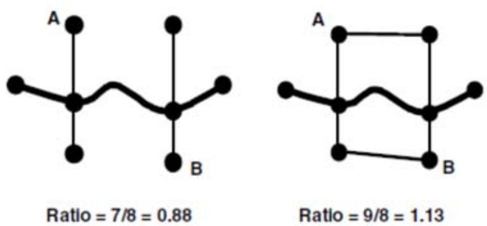

Figure B.3. Two link-node ratios expressing connectivity (Dill, J. 2004)

Percent Grid

Also known as Grid Pattern or Percent four-way intersections, the Percent Grid can be calculated to measure connectivity. This simply measures how much of the street network is a grid. This can be done either by calculating the area that is covered by a grid and dividing it by the total plan area or by taking a count of four-way intersections (which suggest the presence of a grid pattern) and dividing this by the number of total intersections in the network. Both methods produce similar outcomes. The closer the percentage is to 100 supposedly means that there is more connectivity.

Pedestrian Route Directness or Accessibility Index

This is a ratio of the actual distance it take for the pedestrian to reach their destination compared to the distance to the destination as the crow flies. This can be used to measure the ease of connection within a network or to measure the how connected a location is to various amenities. This is one of the calculations used by the *Walkability Score.* The closer the ratio is to 1 the more connected the location is to the network or to another point. The closer the length of actual walking distance is to the length of the direct distance, the more connected the two points are.

These macro-scale methods provide a broad picture of the network's connectivity as a whole. These tools can be used in order to understand general barriers that may prevent

pedestrian travel as a transportation mode. However, they do not identify actual barriers or their localized effects. They do not predict the movement of pedestrians within the network and the do not take into account the effects that safety and components of the built environment have on pedestrian behavior.

Pedestrian travel patterns are different from those of other modes. Pedestrians do not always take the most direct or shortest path. It is valuable to understand the factors that go into pedestrian behavior in order to help transportation professionals predict travel patterns and route choices so they may improve the pedestrian network This will allow transportation professionals to plan and design streets for pedestrian traffic. This is vital in order to understand how to create safe quality connected paths for pedestrians. In order to do so barriers, attractors, and high risk locations must be identified. Modeling with microlevel simulation can provide this valuable missing information.

MODELING TECHNIQUES FOR MICROLEVEL SIMULATION

By measuring and modeling pedestrian behavior, it is possible to predict how a pedestrian will move through a network given various barriers, attractors, and risks. This knowledge will provide transportation professionals with a micro-level assessment of network connectivity. Once identified it will then be possible to consider what factors, other than distance effect pedestrian network connectivity. Four methods and tools for measuring and modeling pedestrian behavior in transportation have been identified. They are Discrete Mode Choice, Space Syntax, Route Choice Model, and the Normative Pedestrian Theory. The theory behind each will be explained and the methods of data collection and modeling through their calculations will be presented.

Discrete Mode Choice

A discrete choice model is a disaggregate behavioral model, which is used to forecast an individual's movement choice. This model considers walkable space and predicts an individual's movement, assuming they have a predetermined destination, and predicts how the immediate environment will affect their movement. It was originally developed to predict pedestrian behavior and movement for research in "crowd evacuation management, panic situation analysis, and safety issues in the development of intelligent transportation systems (Antonini, G. 2005)." It has since then been utilized to predict walking behavior.

As pedestrians move through space it is possible to predict their movement. By viewing pedestrians as a flow of individuals in a fluid like motion, similar to a river, volume and speed can be used to predicted change in movement. Multiple stages are used to predict how and where pedestrians will move. This starts with the overlay of a grid onto the walkable area available to pedestrians. This way each pedestrian can be seen as a point in motion on a 2D plane. These pedestrians can be modeled to move based on probability of movements. With modern modeling and virtual reality this can then be represented in a 3D environment.

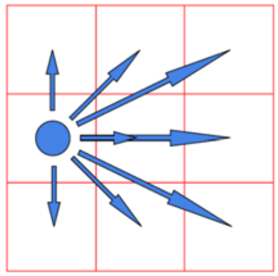

Figure B.4 an example of a static grid used to convey possible movements (Antonini, G. 2005)

Pedestrian behavior models include a destination choice model, a route choice model, and a collision avoidance model. Destination is hard to predict as pedestrians choose their destination based on what they have planned to do. In this model the destination is assumed. However, using software primary and secondary destinations can be selected based on shortest path simulations. Part of the method is to model the network, marking nodes as entrance point into or departure point from the network. Each link represents a walkable space (sidewalk, crosswalk, etc.) Any movement can then occur between any two nodes over any of the designated walkable segments.

Fixed obstacles are then established on the grid as locations that no pedestrian can move onto. Attractors can also be placed with the given social force they have on the pedestrian's movement. Attractor can be art, music, window shopping, etc.

Route choice is then calculated by following a utilization maximization problem that calculates the objective of the pedestrian.

"The *objective characteristics Xlk* of the link *l* are transformed into subjective perceptions or evaluations by means of a functional relationship *fk*:

$xlk = fk\{Xlk\}, k = 1, 2, ...,K.$

After that, the *subjective utility* $U(l)$ is obtained as an algebraic combination of the subjective values:

$U(l) = h(xlk), k = 1, 2, ...,K.$

Likewise, the route's utility equals:

$U(r) = h'(U(l); dr), l \in r$

where *h_* is another algebraic function and *dr* is the total subjective distance associated with route *r*. The pedestrian will choose the route that will maximizes his subjective utility." (Antonini, G. 2005)

Using the route with the highest utility for that pedestrian the localized behavior can then be predicted through calculating possible movements within the route. Based on the speed and velocity a pedestrian is traveling, the location of their destination, and the relation to objects such as other pedestrians, (obstacles and attractors around the pedestrian) the simulation can predict the probability of immediate movements. The process also considers the effects of avoiding collisions and the effects that crowds have on pedestrian speeds.

The process then creates a hierarchy of decisions for the pedestrian based on time and costs. Costs include those of running, changing velocity, and changing direction. Discrete Mode Choice simulation determines pedestrian behavior based on a traffic modeling approach that interprets "short range behavior … as a sequence of choices" (Antonini, G. 2005).

Using the behavioral predictions described above and the Cross Nested Logit Formula, as shown visually in FIGURE 5, short range pedestrian choice can be predicted.

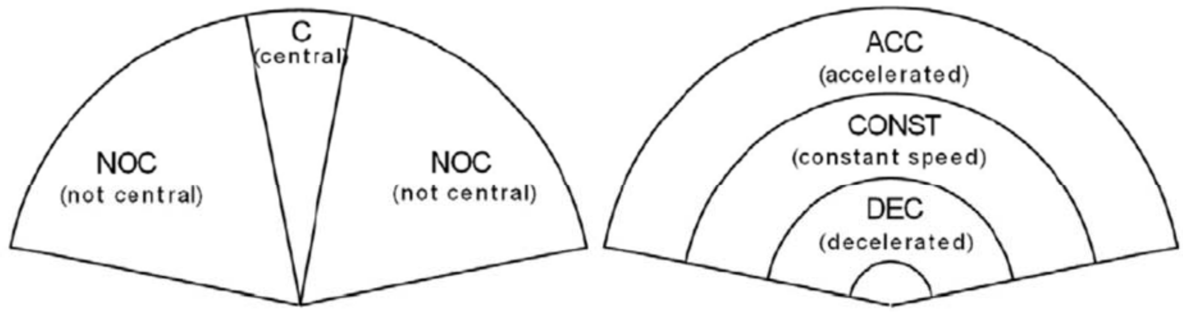

Figure 4.5: left: Nesting based on direction **right:** Nesting based on speed

Figure B.5. Pedestrian nesting behavior

Based the obstacles and attractors along the pedestrian's route and the on the probability of change in deceleration, change in acceleration, and change in direction, a scenario can be simulated. FIGURE 6 shows how this prediction is displayed in 2D and FIGURE 7 displays the pedestrian choice set in 3D. This 3D simulation can then be done for a group of pedestrians. A simulation of how multiple pedestrian's choice sets impact short range motion in model view is shown in FIGURE 8. This method could be applied to indicating the effects alley components have on behavior choice. Components would need to be added to the model as attractors and their effects could then be modeled. However, the weighted value a component has would have to be determined before it could be used as an attractor.

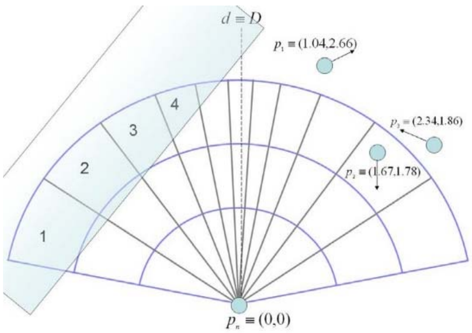

Figure B.6. Example of a simulated scenario (Antonini, G. 2005)

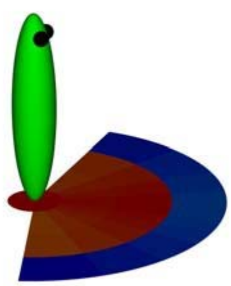

Figure B.7. Pedestrian with choice set (Antonini, G. 2005)

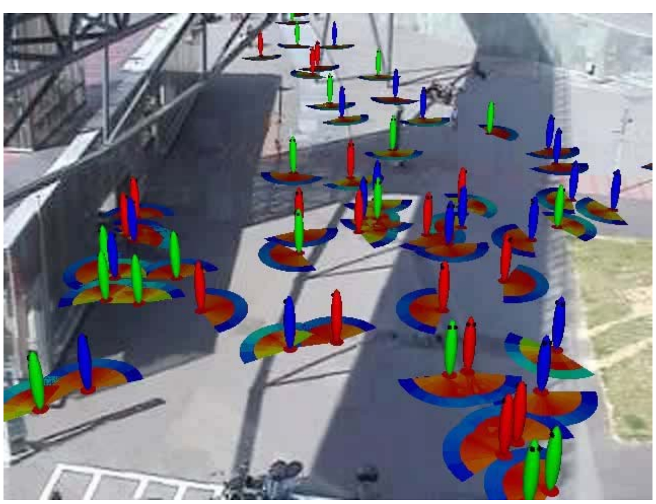

Figure B.8. Model view (Antonini, G. 2005)

Space Syntax

Space Syntax is a pedestrian volume modeling tool. It was originally developed at the University College of London in the 1980s (Raford, N and Ragland, D. 2004). It is used primarily to show how safety influences pedestrian movement. It has also been applied to show the impacts land uses, emissions, traffic, and spatial networks have on pedestrian behavior. Space Syntax shows “movement, awareness and interaction; density, land use and land value; urban growth and societal differentiation; safety and crime distribution.” (‘Spacesyntax.net,’ 2015). Pedestrian exposure and risk has been a huge concern. Rising concern with pedestrian related collision and risk of incidents has been gaining public interest. Space Syntax has been developed in order to predict pedestrian volumes in order to model and simulate these very risks.

The City of Oakland used Space Syntax in their first pedestrian plan in order to identify high risk areas. Their method was to create a pedestrian route network map of the entire city area. They then processed this map using Space Syntax software. They used Census data to overlay population levels and density within census blocks. By adding pedestrian count volumes and employment data, also obtained from the census, they were able to create a volume coefficient and estimate pedestrian volumes throughout the city. They then compared that with the statewide integrated traffic reporting system (SWITRS) and geocoded the data as an overlay in order to estimate pedestrian risk and exposure.

The city’s “final relative pedestrian risk index” used the following equation to assess risk as a whole or at any given location:

$$\text{relative risk} = \frac{\text{annual pedestrian}-\text{vehicle collisions}}{\text{average annual pedestrian volume}}$$

(Raford, N., & Ragland, D. (2004)

This was then modeled into a map that shows higher level of relative pedestrian risk across the city. This can be seen in Figure B.9.

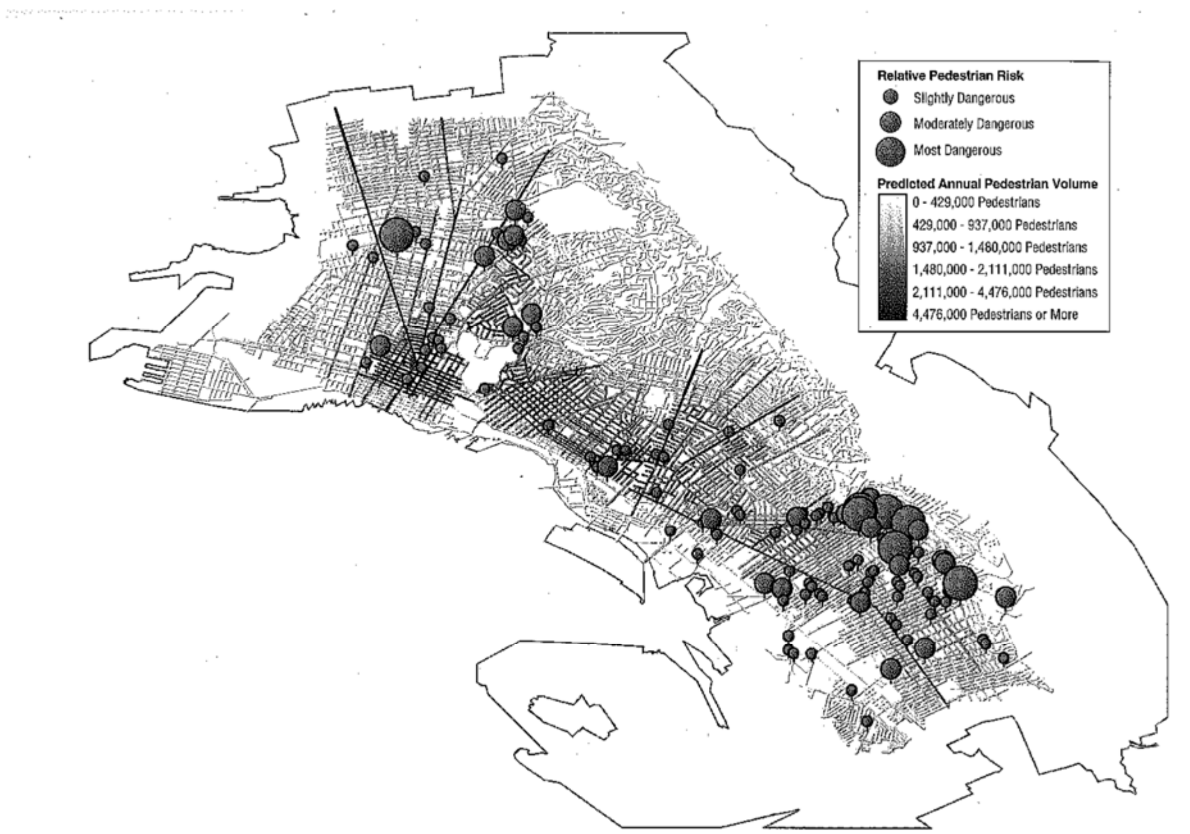

FIGURE 5 Final relative pedestrian risk index map. Balloons represent intersections with high relative pedestrian risk, expressed as a function of annual collisions per pedestrian.

FIGURE 6 Detail of pedestrian risk in downtown areas. Downtown intersections experience slightly more pedestrian–vehicle collisions per year than the intersections in East Oakland but carry approximately three times as many pedestrians annually, indicating lower annual accident rate per pedestrian than that in East Oakland.

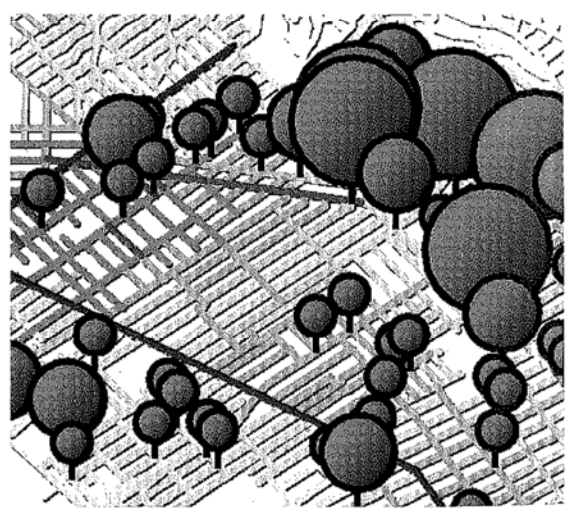

FIGURE 7 Detail of pedestrian risk in East Oakland area. Intersections in East Oakland experience lower collisions but also lower pedestrian volumes. In regard to relative risk, intersections in east Oakland are approximately 3.5 times more dangerous than those in downtown area.

Figure B.9. Relative pedestrian risk index map for the City of Oakland. (Raford, N. & Ragland, D. 2004)

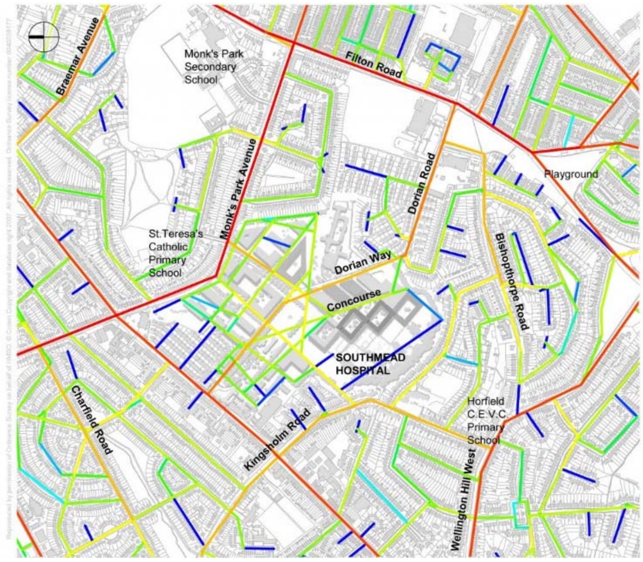

Figure B.10. Color space syntax segment safety analysis using space syntax software ('Spacesyntax.com,' 2015)

"Space Syntax research has made five key discoveries that demonstrate how spatial layout directly affects:

- **movement**, such that Space Syntax models can be used as strategic traffic modelling tools for vehicle, pedestrian and cycling movement

- **land use**, showing how land use performance is deeply influenced by spatial location

- **safety**, allowing risk to be identified and safer places to be created

- **land value**, demonstrating the influence of spatial networks on property economics

- **carbon emissions**, highlighting the contribution of spatial planning and design to environmental impact." ('Spacesyntax.com,' 2015)

This method can be used to create evidence based models of observations of pedestrian flow, route choice, and short range decisions. It will be useful in the application of the effect activated alley components have due to its capability to study wayfinding and the effects of design. It can also be used to assess visibility in public space, and other spatial accessibility and connectivity analyses.

Route Choice Model

Pedestrian route choice can be modeled using microsumulation in order to determine pedestrian behavior within a network. This method was originally developed for a shopping center in order to predict where a pedestrian will walk given the number of goods, or objectives, they aim to accomplish in the center. (Borgers, A. and Timmermans, H. 1985). This can be applied to measuring route choice within network connectivity by predicting the likelihood a pedestrian will pass through certain segments along their trip. This simulates pedestrian route choice based on the number of entry points, links, and objectives within the network. This probability distribution throughout the network can then be calculated. This method determines how likely a pedestrian will pass through a link. The process predicts length of route, maximum number of links a route can have within the network, the likelihood of sequential stops, and the total number of routes that exist given the generated rules within the pedestrian choice set. This method makes an attempt to identify the elements that influence pedestrian route choice dependent on shopping needs. It will be challenging to find an application for this method for determining route choice based on the effects of components within an alley context.

Normative Pedestrian Theory

This theory of pedestrian behavioral modeling is based on the assumption that "pedestrians are expected cost minimizers: they schedule their activities, choose the activity areas and the routes connecting these activity areas simultaneously to maximize the expected utility of their efforts." (Hoogendoorn, S. & Bovy, P. 2002). By integrating the utility of a segment and node this model can predict a pedestrian's route choice. Obstacle, preferred walking areas, and other pedestrian infrastructure components, the locations of various activity possibilities within and area, and demand patterns are all considered when modeling pedestrian behavior. This process allows for a simulation to generate the movement of pedestrians within a given timeframe. This simulation can then utilize software such as NOMAD, which was developed in order to run normative pedestrian theory simulation, to predict optimal routes for pedestrians, as well as predict the trajectory, time, and speed of pedestrians. It can even predict the gap between pedestrians and plot pedestrian density contours. (Delft University of Technology, 2015). FIGURE 11 is an example of how pedestrian space can be simulated with barriers and entry points. FIGURE 12 shows the density contours that exist within this space. This method is most commonly used in station and terminal design however it has direct application in in the route choice for pedestrians through networks with activated alleys as it has the capability of incorporating the barriers in streets and the utility of the activated alley. A survey will first need to be developed in order to generate component utility within activated alley walk space.

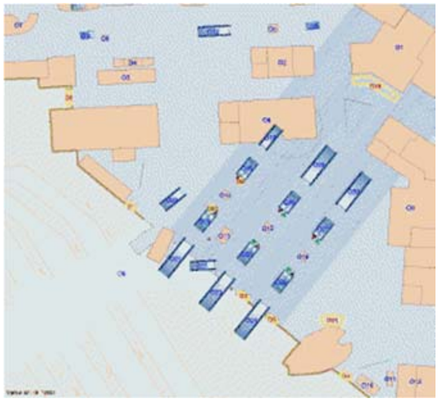

Figure B.11. Display of walkable space (Delft University of Technology, 2015)

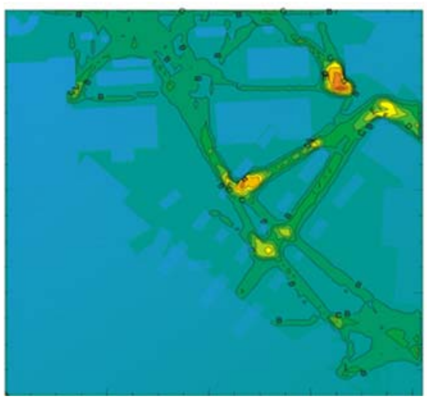

Figure B.12. Pedestrian density contour (Delft University of Technology, 2015)

DATA COLLECTING METHODS

The biggest challenge to measuring and modeling pedestrian connectivity and behavior is the lack of data. Unlike autos, transit, and bicycles automated detection methods like loop detectors are not available. The most effective ways to collect data is through observation and surveying. Observation can be done on site or through video surveillance. Video surveillance is more effective as the video can be slowed down in order to ensure proper counts and observe all behaviors. This is especially necessary on high volume segments. Video surveillance is how data is generally

collected for discrete mode choice models. The biggest issue with observance data is there is no known origin or destination, which makes it less effective at understanding how the built environment effects route choice and behavioral decisions. With observational data the origin and destination must be assumed. Surveys are more effective for collecting this type of data, however they are extremely time consuming. This method of data collection provides an opportunity to collect demographic information, origin and destination information, and for discovering what the value elements of the built environment have and their effect on behavioral and route choices. By performing an intercept survey along a designated segment, it is possible to question individuals on the factors that made them choose that route. The hope is that researchers will uncover unconscious decisions in route choice. It will also allow researchers to understand if environmental factors or route directness holds more weight in the pedestrian's route choice. It will also allow the researcher to identify if these factors have different values given the trip type, i.e. work commute trip or other social trip. This will be of great importance in future research on the effects alley components have on route choice and other micro-level behavioral decisions. From this data collection it will then be possible to model the attractors and barriers that effect a pedestrian's short range route choice. This will provide researchers a better understanding of the impact that an alley activation or its various individual components have on the connectivity of the network as a whole.

MODELING SOFTWARE OPTIONS

After data is collected it will be possible to model the attraction of components and the barriers within the local network. There are a few software options in the modeling of this

data. Most were designed for simulating evacuations. Some are more adaptable and provide options for modeling the effects components have on pedestrian behavior as an attractor.

- NOMAD – Micro-level simulation based on pedestrian travel characteristics
- EXODUS – Software for simulation of evacuating large numbers of people
- Simulex – Evacuation simulation, used for evacuation from buildings
- EVAS – Visibility Graph Analysis simulator
- EVACSIM – Java developed evacuation simulator
- Space Syntax – software for simulating risk and exposure. Most commonly used for safety but has other applications.

APPENDIX B REFERENCES

Antonini, Bierlaire, Weber (2005). “Discrete choice models of pedestrian walking behavior” Science Direct: Transportation Research Part B, 667-687.

Borgers, A., & Timmermans, H. (1986). City centre entry points, store location patterns and pedestrian route choice behaviour: A microlevel simulation model. *Socio-Economic Planning Sciences*, *20*(1), 25-31. doi:10.1016/0038-0121(86)90023-6

Delft University of Technology,. (2015). *NOMAD*. Retrieved 11 March 2015, from http://www.citg.tudelft.nl/en/about-faculty/departments/transport-and-planning/traffic-management-and-traffic-flow-theory/dynamisch-verkeers-management/special-projects/pedestrians/simulation-models/nomad/

Dill, J (2004). “Measuring Network Connectivity for Bicycling and Walking” Portland State University

Hoogendoorn (2003). “Microscopic Simulation of Pedestrian Flows” Transportation Research Board

Hoogendoorn (2014). “The Nomad model: theory, developments and applications” Science Direct: Transportation Research Procedia 2 462 – 467

Hoogendoorn, SP, & Bovy, PHL (2002). Normative pedestrian behaviour theory and modelling In Michael A.P. Taylor (Ed.), Transportation and traffic theory in the 21st century (pp. 219-245). Oxford: Pergamon, Elsevier science.

Movement, R. (2015). *Review of Simulation Techniques for Microscopic Mobility of Pedestrian Movement*. *Academia.edu*. Retrieved 11 March 2015, from http://www.academia.edu/8832098/Review_of_Simulation_Techniques_for_Microscopic_Mobility_of_Pedestrian_Movement

Raford, N., & Ragland, D. (2004). Space Syntax: Innovative Pedestrian Volume Modeling Tool for Pedestrian Safety. *Transportation Research Record*, *1878*(1), 66-74. doi:10.3141/1878-09

Southworth, M. (2005). ”Designing the Walkable City.” J. Urban Plann. Dev. 131, SPECIAL ISSUE TITLE: Innovating Regulations in Urban Planning and Development, 246–257.

Spacesyntax.com,. (2015). *Space Syntax | science-based : human-focused*. Retrieved 11 March 2015, from http://www.spacesyntax.com/

Spacesyntax.net,. (2015). *Space Syntax Network*. Retrieved 11 March 2015, from http://www.spacesyntax.net/