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Identifying Partnership Opportunities at Air Force Installations: A Geographic Information Systems Approach

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IDENTIFYING PARTNERSHIP OPPORTUNITIES AT AIR FORCE INSTALLATIONS: A GEOGRAPHIC INFORMATION SYSTEMS APPROACH

THESIS

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Abstract

The excess capacity found in the Department of Defense (DOD) real property portfolio creates challenges for leaders to provide resilient installations. Combining this fact with current funding trends makes decisions on how to properly maintain infrastructure even more challenging. The Air Force Partnership Initiative (AFPI) provides tools for installations to leverage community capabilities and resources to achieve savings and improve quality on Air Force installations and can reduce the real property footprint. This research proposes a method for assessing the viability of a partnership between Air Force installations and their nearby communities.

This research effort created a tool capable of investigating off-base communities and discovering partnership opportunities worthy of exploration by nearby Air Force installations. The scope of this research will be limited to exploring library partnership opportunities at Air Force installations located in the Continental United States (CONUS). This research investigates the facilitators, or environmental factors, to identify where greater opportunities for creating partnerships may exist. The result of this research is a tool which produces a relative measure for each off-base community, where higher values indicate a greater potential for partnerships. This relative measure utilizes inverse distance weighting (IDW) between an installation and each service location in the surrounding community.

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Corey R. DeGroot

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IDENTIFYING PARTNERSHIP OPPORTUNITIES AT AIR FORCE INSTALLATIONS: A GEOGRAPHIC INFORMATION SYSTEMS APPROACH

I. Introduction

1.1 Background

Public agencies around the world have recognized that they may not have the resources to provide the desired infrastructure and maintain it properly once constructed. Public-Private Partnerships (PPP) between public and private sectors emerged in response to this issue. Public agencies have recognized that specialized public or private entities possess the capability to properly maintain current infrastructure and cope with changing needs. These partnerships are tools developed to meet a variety of needs depending on the needs of the public. As such, they have the capability of dealing with excess infrastructure, inadequately maintained infrastructure, and the ability to meet the changing demands of an organization.

PPPs provide highway construction and other forms of infrastructure to public agencies by private entities. One example of a PPP that is currently in use is the demolition and construction of a new city hall, library, park, and port headquarters in the city of Long Beach (Merewitz, 2016). Using private entities to provide infrastructure shifts the required investment capital to the private entity through risk allocation principles. This is the case in the city of Long Beach, where the financial risk is allocated from the public agency to the private entities for the design, construction, financing, operation, and maintenance of the facilities (Merewitz, 2016).

The United States Air Force (USAF) recognized the value of this tool with the creation of the Air Force Partnership Initiative (AFPI). AFPI leverages the capabilities and resources of military installations, local governments, or commercial entities to reduce operating costs and the costs of the services while retaining or enhancing quality. A review of the initiative shows that although partnerships exist at many Air Force installations, many are not to the scale of providing or managing existing infrastructure. As this is still a new initiative, the contract mechanism for partnerships lack guidance on their application for large-scale projects at Department of Defense (DOD) installations.

Installations compose the backbone of the United States military, allowing it to project power all over the globe. The DOD manages real property across 5,000 different locations worldwide (GAO, 2015). With many sites, and the associated infrastructure for supporting various missions, properly maintaining these assets is critical. DOD leaders often face the challenge of maintaining mission readiness with less funding than required to adequately maintain the necessary infrastructure.

Partnerships provide a tool to create more effective installations that meet the goals outlined in the Air Force Strategic Master Plan (AFSMP). The AFSMP is a 20-year plan which translates the USAF strategy into specific guidance, goals, and objectives (Department of the Air Force, 2015). As it relates to infrastructure, one objective of the AFSMP states "provide resilient installations, infrastructure, and combat support capabilities that enable the Air Force to project power rapidly, effectively, and efficiently" (Department of the Air Force, 2015). Infrastructure, by its very nature, is complex and static, thereby creating a challenge to meet this objective.

Executive Order 13327 provides further guidance pertaining to DOD infrastructure directing "the efficient and economical use of Federal real property resources in accordance with their value as national assets and in the best interest of the nation." The 2007 Defense Installations Strategic Plan (DISP) provides guidance on the implementation of Executive Order 13327. The DISP provides six goals: Right Size and Place, Right Quality, Right Risk, Right Resources, Right Management Practices, and Right Workflow (Department of Defense, 2007). The first two goals within the DISP are relevant to the discussion of resiliency: Right Size and Place and Right Quality. Right Size and Place ensure that an installation has the infrastructure needed and that installations are strategically located. The second goal, Right Quality, deals with building and maintaining infrastructure with the capability to adjust based on strategy and need.

In 2012, the DOD estimated that it had a 20 percent excess in infrastructure despite the use of Base Realignment and Closure (BRAC) (GAO, 2013). The problem is worsened by the fact that the DOD has been unable to fund the current facility sustainment, restoration, and maintenance (FSRM) requirements (Johnson, 2015). Ultimately, lack of funding can place a higher risk on the infrastructure, if not properly maintained, which can lead to accelerated failures and less resilient installations. With the DOD's limited resources, excess capacity taxes the DOD's ability to achieve proper quality and conflicts with EO 13327. These issues indicate a failure to meet the strategic requirements discussed above. Further exploring partnerships can help meet the need for resiliency and comply with Executive Order 13327.

1.2 Problem Statement

Given the current trend in FSRM funding, leaders face the difficult decision of how to properly maintain all the facilities on an installation. Responding to these challenges, Johnson (2015) developed a model for strategic basing by proposing seven different installation types: traditional, mission, hybrid, city-base, joint, total force association, and warm. Mission requirements and the capability of the local community would determine the installation type.

The model further suggests categorizing functions within an installation as core, important, and peripheral. Core and important activities provide direct mission accomplishment and support needed for the mission and personnel, while peripheral activities provided community support and Morale, Welfare, and Recreation (Johnson, 2015). Johnson (2015) suggests that depending on the size of the community surrounding a military installation, the community rather than the installation could provide some peripheral activities through partnerships.

The Johnson (2015) model gives recommendations of bases to convert to the different installation types. However, there is no analysis of the communities to support these recommendations. Both Johnson (2015) and the AFPI recognize the importance of using partnerships but fail to provide adequate guidance on the implementation of partnerships. Specifically, there is no guidance directing installations on what partnerships to investigate.

Installations are near local communities which vary in size and capabilities, limiting the amount of support provided. Li & Akintoye (2003) showed that partnerships may occur when a public agency requires a service, and a private entity can provide that service. However, if the private entities do not have the resources or capabilities needed to provide or support the service, it is inappropriate for the private entity to manage the risks of a partnership (Ng & Loosemore, 2007). Evaluating a community's profile may lead to the discovery of areas that have a greater capacity to handle the risks associated with partnerships. A review of partnership literature reveals that it does not address where to explore partnerships opportunities.

1.3 Research Statement

This research effort investigates characteristics of off-base communities surrounding CONUS Air Force installations to identify the installations that could benefit from exploring partnership opportunities. While Air Force installations provide many services, this research specifically examines library partnership opportunities at Air Force installations located in the Continental United States (CONUS).

To assess the benefit that an installation could realize for exploring partnerships, the Lambert's Partnering Process model (Lambert, Emmelhainz, & Gardner, 1996) was explored. Lambert (1996) created a model to aid corporate leaders when deciding if a partnership would be effective. The Partnering Process model describes two factors that impact the decision to partner: drivers and facilitators. Drivers are the motivations behind why companies would want to partner, whereas facilitators are the environmental factors that could affect the growth of the partnership (Lambert et al., 1996).

This research investigates the facilitators, or environmental factors, for CONUS USAF installations to identify where greater opportunities for creating partnerships may exist. The result of this research is a tool which produces a relative measure for each off-base community, where higher values indicate a greater potential for partnerships. This relative measure utilizes inverse distance weighting (IDW) between an installation and each service location in the surrounding community. The tool allows decision makers to compare the computed measures and communities for each installation, and identify where the greatest opportunity for creating a partnership may exist.

1.4 Research Questions

Looking at USAF installations, the local community could provide many peripheral services. Unfortunately, the Air Force currently does not provide guidance for identifying partnership opportunities. Therefore, this research contributes to the following research question.

> **Research Question: How can the Air Force identify installations where a greater opportunity for creating partnerships may exist?**

In this research, a specific peripheral service – base libraries, is a service that local communities provide for their citizens. Therefore, the goal of this research is to develop a model to categorize which installations have a local community possessing the current capability to provide library service for the installation's population, thus eliminating the need for the base library. To support the overarching research question, the following generalized investigative questions were developed, and will be answered by focusing on library services:

Investigative Question #1: What characteristics of off-base communities can be used to identify installations where partnerships can be utilized by the Air Force?

Investigative Question #2: Does varying the radius used to define the community significantly alter the results of the analysis?

Investigative Question #3: Does the use of straight-line distance versus driving distance substantially change the rank order list of installation?

1.5 Summary

The excess capacity found on DOD installations creates challenges for leaders to provide resilient installations. Combining this fact with current FSRM funding trends makes decisions on how to properly maintain infrastructure even more challenging. The Air Force Partnership Initiative provides tools for installations to leverage community capabilities and resources to achieve savings and improve quality on Air Force installations. This research proposes a method for assessing the viability of a partnership between USAF installations and their nearby communities. The method is verified with the base library service at CONUS Air Force installation.

This research follows the standard five-chapter format. Chapter I provides a basic overview of the research. Next, Chapter II reviews the literature pertaining to partnerships. Chapter III then discusses the methodology used to create the Inverse Distance Weighting (IDW) model used to analyze libraries. Chapter IV presents the results of the IDW model for base libraries. Finally, Chapter V provides a conclusion, and opportunities for future research.

II. Literature Review

2.1 Chapter Overview

This chapter outlines several concepts germane to public-private partnerships. The chapter begins with a review and discussion of Geographic Information Systems (GIS) and their use in solving geographic related problems. Then, the chapter provides a review of the two types of partnerships: Public-Private Partnerships (PPP) and Public-Public Partnerships (PUP). The review will focus on the different types of partnerships and the varying definitions associated with them. Finally, the chapter concludes with a discussion on outsourcing with a specific emphasis addressing the factors and drivers for successful arrangements.

2.2 Geographic Information Systems

A GIS is a system designed to capture, manipulate, and display spatially-related information on a map for visualization and analysis (ESRI, 2010). Six components make up the modern GIS: network, people, software, data, procedures, and hardware. The hardware runs the software or graphics program and provides interaction between the GIS and users. The network enables the sharing of information and data across the six components of a GIS (Longley & Goodchild, 2011).

A GIS stores information in the form of features (objects on the earth) and attributes that describe the features (ESRI, 2010). Discrete objects and continuous fields are two methods utilized by a GIS to represent geography. The discrete object method views the geography as objects with well-defined boundaries. This view works well when the geography has clear boundaries such as a city. However, other geographic objects, like mountains or lakes, do not have clear boundaries defined which is where continuous fields are more applicable (Longley & Goodchild, 2011).

The continuous field view provides a way to describe objects that do not have well-defined boundaries. Terrain is much easier to conceptualize as a continuous field, where every point requires definition. The continuous field view represents the world as a finite number of variables, where each variable is defined at every position (Longley & Goodchild, 2011). The discrete object and continuous field view are two conceptual views of how to represent the world in a GIS but do not provide the method to represent objects digitally.

The discrete object and continuous field conceptualizations described only provide ways to think about geography, but there are information storage limitations in a computer. A continuous field potentially contains an infinite amount of information by defining a value at an infinite number of points in a defined area. A discrete object can also require an infinite amount of information to achieve full description (Longley & Goodchild, 2011).

Raster and vector representations of geography provide a way to transform the discrete object and continuous filed concepts to digital representations in a computer. Raster representation divides space into an array of cells, where all geographic variation is represented by assigning attributes to each cell (Longley & Goodchild, 2011). Generally, the raster method represents continuous information that does not have distinct boundaries or well-defined shapes. In vector representation, points connected by lines define objects. Discrete objects using this method are represented as points, lines, or polygons (ESRI, 2010).

Geospatial analysis provides a unique perspective of the world with a lens to examine events, patterns, and processes that take place on the surface of the Earth (De Smith, Goodchild, & Longley, 2015). Spatial analysis recognizes the concept that everything happens somewhere and knowing where can be important. With many types of analysis, interpolation is used in spatial analysis based on the First Law of Geography (Waldo Tobler) which states that, "Everything is related to everything else, but near things are more related to distant things" (Longley & Goodchild, 2011). Geospatial analysis is the crux of any GIS – with its ability to add value to geographic data and turning that data into useful information. Furthermore, geospatial analysis helps answer location dependent questions (De Smith et al., 2015), such as the questions about partnerships posed in this research.

2.3 Review of Partnerships

The public use of partnerships has gained momentum since the late 1980s across a wide variety of organizations (Linder, 1999). The two types of partnerships, Public-Private and Public-Public, differ by the entities which are involved in the agreement. As the names imply, a PPP agreement involves at least one public and at least one private agent, whereas a PUP is an agreement between two or more public agents (Lobina & Hall, 2006).   Partnerships often develop as a way for public agencies to leverage, through cooperation, resources and expertise possessed by other public or private agencies.   Furthermore, for this research outsourcing is included in the broad definition of partnerships because they are closely related. As a result, they are included in this review.

2.3.1 Public-Private Partnerships

A PPP is an arrangement to work together between private and public entities. This broad definition captures the various definitions used by researchers to define a PPP. Some researchers view a PPP as a tool to be used by governments to replace or complement existing methods of contracting public services (Hodge & Greve, 2007). Others see it as a new expression in language, which incorporates already existing procedures for involvement of private organizations in public services (Linder, 1999). Another view of PPPs is that it extends beyond private procurement of public services and offers a new way to handle large infrastructure projects (Savas, 2000). These varying academic definitions are a result of the differing implementation strategies of PPPs around the world.

Countries across the globe have defined PPPs differently and utilized different implementation strategies. The United Kingdom Nations Development Programme (2007) stated that "PPPs should be broad such that even the informal dialogues between government officials and local community-based organizations should be included" (Tang, Shen, & Cheng, 2010). In the U.S., the National Council for Public-Private Partnerships defines a PPP as a contractual arrangement between a public agent and a for-profit private actor, where resources and risks are shared to deliver a public service or public infrastructure (Li & Akintoye, 2003).

Hong Kong provides yet another definition and further explanation. The Efficiency Unit created a new focus on Private Sector Involvement (PSI) and defined PPP as "arrangements where public and private sectors bring complementary skills to a project with varying levels of responsibility to provide public service projects." The PSI was established with the understanding that the government needed assistance in meeting its priorities and that public funds were limited (Tang et al., 2010). The PSI utilized the two related tools to accomplish its objectives: PPPs and Outsourcing (Figure 1).

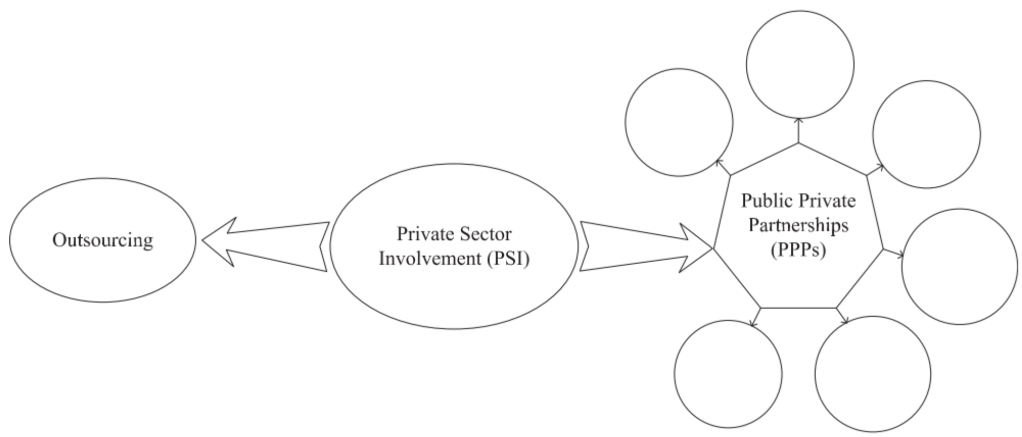

Figure 1: Hong Kong Efficiency Unit - Types of private Sector involvement (Tang et al., 2010)

As summarized by Tang et al. (2010), Hong Kong's Efficiency Unit further describes the following six forms of PPPs:

- Create Wider Markets – Utilizes current assets in terms of skills and finance from both public and private sectors.
- Private Finance Initiatives (PFIs) – The public sector purchasing of services with the private maintaining and constructing the necessary infrastructure.
- Joint Ventures – Public and private sectors pool their assets, finances, and expertise under joint management.

- Partnership Companies – Private sector ownership introduced through government legislation or regulation.
- Partnership Investments – Investments where the public-sector shares in the generated returns with the private sector.
- Franchises – The private sector pays a fee during the concession period for the revenue that the service will generate in the future.

Infrastructure provided through a PPP potentially generates an arrangement that is more complicated when compared to standard infrastructure contracts. The cause for this increased complexity can be attributed to long-term agreements and the increased number of public and private sector entities that are involved (Grimsey & Lewis, 2002). Arrangements utilizing PPPs for infrastructure will take on some or all of the following elements (Grimsey & Lewis, 2002; Peirson & Mcbride, 1996):

- The public-sector entity transfers a facility controlled by it to the private sector entity (with or without payment in return) usually for the term of the arrangement
- The private sector entity builds, extends, or renovates a facility
- The public-sector entity specifies the operating features of the facility
- Services provided by the private sector entity using the facility for a defined period (usually with restrictions on operations and pricing)
- The Private sector entity agrees to transfer the facility to the public sector (with or without payment) at the end of the arrangement

Examining the different implementations of PPPs around the world illustrates that, although the definitions differ, a common theme is present in all of them. The varying views of partnerships communicate that the establishment of PPPs generate benefits for both the private and public sectors involved. The partnership brings together strong qualities from each sector, where they can be combined to increase results (Hodge & Greve, 2007). The main advantage found in PPP is that it can save resources by bringing together these strengths and allowing public agencies to focus on their core competencies (Tang et al., 2010). Although PPPs have the advantage of utilizing the private sector strengths, disadvantages do exist.

PPPs leverage the private sector to provide public infrastructure and services at a lower cost; however, not all PPPs achieve an increase in savings or efficiency. There are many cases where a PPP has run into issues and has failed to achieve cost savings or improved service. Oftentimes, these projects ran into problems due to cost overruns, unrealistic finance projections, and legal disputes, which can be attributed to the complexity and poor understanding of PPP arrangements (Kumaraswamy & Zhang, 2001). Furthermore, it has been indicated that political obstacles can make the use of PPP difficult (Ayed Muhammad Algarni, Arditi, & Polat, 2007). This is not surprising considering many PPP projects require the passing of special legislation. Government agencies, who are responsible for making new legislation, may be resistant to change, including new project delivery mechanisms that are not always easy to understand, such as PPP (Tang et al., 2010).

The definitions used to define PPPs and their implementation differs greatly around the globe. Despite this variance, they offer public agencies another avenue to pursue the procurement of public services or infrastructure by combining the strengths of both the private and public sectors. PPPs do not come without their drawbacks; they create a higher level of complexity in projects that may not have existed otherwise.

2.3.2 Public-Public Partnerships

Public-Private Partnerships first became popular to create water service reform in developing countries in the 1990s. It was expected that private sector involvement would deliver quicker results that what would have been possible from the public sector alone. The reality of the use of PPPs in water service reform has fallen short of its expectations, with many operating contracts that are struggling or failing (Lobina & Hall, 2006). High transaction costs, contract failure, dynamic interest seeking, and resistance to PPPs have led to the failure of some PPPs to achieve the expected benefits. These failures have caused organizations to acknowledge the shortfalls of PPPs and look to PUPs to create water service reform.

Public-Public Partnerships are a new type of partnership that resulted from the use of PPPs. The simple definition of a PUP is any collaboration between two or more public authorities in the same country. This definition includes collaboration between different types or levels of government and any part of the general public (Lobina & Hall, 2006). The use of these types of partnerships is relatively new, with limited usage. One sector where PUPs have gained traction is water service reform in developing countries. The reason for the emergence of PUPs in this sector is due to the failure of Public-Private Partnerships.

The transition from PPPs to PUPs for water service reform in developing countries highlights that the two types of partnerships are fundamentally different. The main difference in these partnerships is that a PUP can be described as “a peer relationship forged around common values and objectives, which exclude profit-seeking”

(Hall et al., 2009). An advantage of using a PUP over a PPP is that neither party expects to achieve a commercial profit. In 2009, Hall (2009) summarized the advantages of a PUP as follows:

- Mutual understanding of public sector objectives
- Non-commercial relationship resulting in low risk
- Transparency and accountability
- Many potential partners available
- Lower risk and complexity result in lower transaction costs
- Possibility of 100% reinvestment of financial resources
- Long-term gain in capacity-building
- Local control over objectives and methods
- Involvement of local civil agencies is possible
- Partners benefiting from a PUP can become supporting partners to others

Public-Public Partnerships offer yet another tool which can achieve cost savings, improve efficiency, and increase customer satisfaction. The use of PUPs achieved success in water service reform where PPPs failed (Lobina & Hall, 2006). A PUP is fundamentally different from a PPP, because the private agencies' goal to achieve profit is no longer present. The USAF looks at both the PUP and PPP as tools to complete the varying required missions.

2.3.3 Risk Allocation in Partnerships

In a successful public-private partnership (PPP), the private entity provides a product or service to the public at a greater value. To achieve this, proper risk allocation must occur, where all parties involved are incurring risk in pursuit of a successful project.

If both parties share a risk outcome, then it is considered a shared risk (Bing, Akintoye, Edwards, & Hardcastle, 2005). Delivery of services is shared between both the public and private sectors, thereby bringing complementary skills to the project and resulting in an increased efficiency (Shen, Platten, & Deng, 2006). Risk allocation is important for a successful partnership because it binds all parties to work together for mutual benefit. If the risks are simply transferred to the private sector, rather than shared between both sectors, decreased savings can result. Therefore, the public entity must be aware of the amount of risk that it is shifting and how it affects whether they are achieving value for the money (Grimsey & Lewis, 2005).

Allocating risk comes with a cost; therefore, there must be a balance for a partnership to exist. The goal of any such partnership should be to improve value for money or improve service for the same cost (Grimsey & Lewis, 2005). Most research on partnerships relates to the procurement of infrastructure, and as such are usually more complicated than a simple construction project. Some have argued that this complexity actually increases the risk to the public sector, rather than reduce it, by increasing service costs for the public and creating an entry barrier for private entities (Moore & Muller, 1991; Ng & Loosemore, 2007).

Another aspect of risk associated with private procurement relates not to the complexity, but the required length of time that exists in these arrangements. With many arrangements lasting for long periods, this creates risk due to the amount of uncertainty. The uncertainty, and the inherent difficulty to predict the extent of risk, leads private sector to demand premiums for the increased risk (Ng & Loosemore, 2007). If the public entity is unwilling to accept some of this risk, via allocation, then the project may not achieve a desired value-for-money partnership for the public.

With any partnership, the public and private entities agree to the allocation of all foreseeable risks. Grimsey and Lewis (2002) identified the following nine risks that exist in any infrastructure project:

- Technical risk – risk due to engineering and design failures
- Construction risk – risk due to faulty construction techniques
- Operating risk – risk due to higher operating and maintenance costs
- Revenue risk – risk due to traffic shortfall or failure to extract resources, leading to revenue deficiency
- Financial risk – risk due arising from inadequate hedging of revenue streams
- Force majeure risk – risk due to war and other calamities and acts of God
- Regulatory/political risks – risk due to legal changes and unsupportive government policies
- Environmental risk – risk due to adverse environmental impacts and hazards
- Project default – risk due to failure of the project from a combination of any of the above

These nine risks provide a means to allocate specific risks in a partnership. However, it is difficult to define rules for allocating risk because every partnership is different. As a result, Ng and Loosemore (2007) classified risks into two groups: general risks and project risks. General risks, not specifically associated with the project, influence the outcome of the agreement. Project risks are those that deal specifically with project management. Risk allocation by groupings eliminates some of the complexity and allows for the creation of guidelines rather than hard rules.

When allocating risk in a partnership, there are some well-established general rules that should be followed (Ng & Loosemore, 2007). They are, that risk should only be allocated to a party who:

- Has been made fully aware of the risks they are taking
- Has the greatest capacity to manage the risk effectively
- Has the capability and resources to cope with the risk
- Has the necessary risk appetite to want to take the risk
- Has been given the chance to charge an appropriate premium for taking it

Since every partnership is different, varying in complexity and the entities that are involved, a general risk allocation strategy exists. It is important to remember that this risk allocation is very important for maximizing the public's value-for-money. Like any contractual arrangement, it is paramount that the appropriate party assume the proper risks. These general rules outline the general risk allocation strategy in a partnership.

2.4 Partnering Strategies

This section provides a review of partnerships and outsourcing as used by the private sector. Specifically, this section provides the factors or considerations used when determining whether to pursue partnering or outsourcing. The section then discusses the factors for partnerships and outsourcing within the context of PPPs and PUPs.

Partnerships between businesses are not a new concept and share concepts in outsourcing. Partnerships vary greatly in complexity, range of services provided, and their establishment. However, a partnership can be defined as a business relationship where all parties involved cooperate with mutual trust, shared risk, and outcomes that result in competitive advantage (Lambert et al., 1996). When using this definition, outsourcing is a similar type of arrangement to PPPs and PUPs, but differs in that the government no longer has a role in the ongoing operations (Minow, 2003).

2.4.1 The Partnering Process Model

Using this definition of a partnership allows for the study of partnerships between corporations, and not just public-private partnerships, to understand the factors that determine the success of a partnership. In 1996, Lambert (1996) developed the Partnering Process model, shown in Figure 2, to help corporate leaders decide if they should pursue partnerships. Although partnerships provide opportunities for savings and improved service, they will not work in all circumstances. Therefore, the Partnering Process describes the drivers and factors that are critical in partnership development.

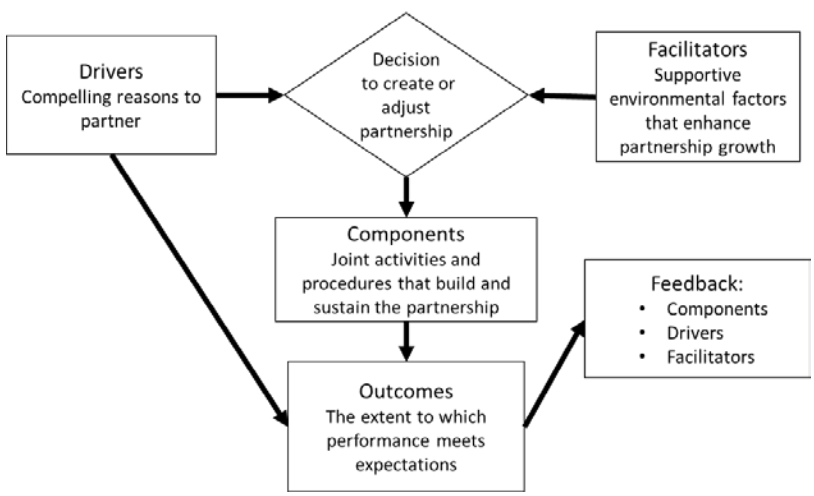

Figure 2: The Partnering Process model (Lambert & Emmelhainz, 1996)

As seen in the model, two elements lead to the decision to create partnerships: drivers and facilitators. Drivers are the motivations or reasons that drive corporations to partner. All parties involved in a partnership must believe that they will receive benefits in one of the four drivers presented in Table 1, which would not be possible without the formation of a partnership. The presence of drivers is important for the formation and success of a partnership, but drivers alone do not guarantee its success (Lambert et al., 1996).

Table 1: The Partnering Process model - partnership drivers (Lambert & Emmelhainz, 1996)

Driver	**Description**
Asset/Cost Efficiency	Integration of activities can lead to lower costs in transportation, handling, packaging, information, and increased managerial efficiency.
Customer Service	Integration of activities can also lead to service improvements for customers in the form of reduced inventory, shorter cycle times, and more timely and accurate information.
Marketing Advantage	Strong integration between two organizations can enhance their marketing mix, ease entry to new markets and provide access to better technology.
Profit Stability/Growth	Partnering often leads to long-term volume commitments, reduced variability, shared assets and other improvements.

The drivers presented in the model must provide a significant benefit for each organization to motivate pursuing a partnership. These drivers were established with a mindset of private organizations partnering with one another, but that does not exclude them from being useful when considering a PPP or PUP. The model does not require that each potential partner has the same drivers or that a significant benefit be present for all four drivers. However, it is important that both partners recognize the drivers or motivation of the other partner involved. The drivers motivate partnerships, but the environments that exist will also play a large role in predicting success.

Facilitators are the environmental factors that exist in each of the corporations, which will affect the growth of a partnership. The Partnering Process model suggests that each partner must exist in an environment that is supportive of developing a close relationship with the other. There are four essential facilitators to developing a partnership: corporate compatibility; similar managerial philosophy; and techniques, mutuality, and symmetry. These four facilitators are universal and should exist in any partnership, as their presence increases the probability of success. Additionally, Lambert et al. (1996) provides five situation-specific factors, whose presence are likely to increase the probability of success. Table 2 provides a brief description of each of the universal and situation-specific factors presented in the Partnering Process model.

Drivers and facilitators can be likened to marriage where a couple can have a strong desire to marry (driver) but may become affected by in-laws, personal finances, individual morals, and other factors (facilitators).

Table 2: The Partnering Process model - partnership facilitators (Lambert & Emmelhainz, 1996)

Type	Facilitator	Description
Universal	Corporate Compatibility	Partners must have compatible values. The culture and objectives of each partner should be similar and cannot clash. The closer the culture and objectives align, the more likely a partnership is to succeed.
Universal	Managerial Philosophy and Techniques	Organizational structure, attitude toward employee empowerment, and the importance of teamwork are examples of managerial philosophy. Partners will have a difficult time working together if these philosophies and techniques are not similar.
Universal	Mutuality	The ability of managers to place themselves in their partner's shoes is critical. This is expressed as being willing to develop joint goals and share sensitive information. A partnership must benefit both parties.
Universal	Symmetry	Success is more probable when the partners are demographically similar. Symmetry refers to partners being equally important to the other's success, relative in size, and possesses similar market shares, financial strength, productivity, brand image and reputation.
Situation Specific	Exclusivity	When managers of both firms are willing to entertain exclusivity, there is an increase in advantages of the partnership.
Situation Specific	Shared Competitors	Partners facing a common competitor produce a strong foundation and willingness to work with one another.
Situation Specific	Geographic Proximity	Key players located near each other are likely to produce a stronger partnership. Proximity to each other allows for relationships to be built over time.
Situation Specific	Prior History	Firms with a prior history of positive interaction will have an advantage when building partnerships.
Situation Specific	Shared End User	In the case where both parties share the same end user, and the end user is of particularly high value, the partnership is likely strengthened.

If these facilitators are strong and supportive, then the marriage is more likely to succeed; however, if they are weak and unsupportive, the strong driver of marriage has the potential to be overcome. Likewise, strong environments are unlikely to overcome the lack of drivers in a partnership.

Therefore, as highlighted by the Partnering Process model, a partnership is only likely to succeed if both strong drivers and facilitators exist. Each partner must individually identify its drivers or motivation and determine if significant benefit exists through partnering. If both partners can identify strong drivers for partnering, then the potential partners evaluate the facilitators together, as it is the joint environment between both partners that will exist in a partnership.

2.4.2 Strategic Outsourcing

The theory of strategic outsourcing can be contributed to the convergence of Transaction Cost Theory (TCT) and Resource Based View (RBV) (Holcomb & Hitt, 2007). Both TCT and RBV are theories used to explain why a firm should outsource an activity. TCT argues that if outsourcing results in a lower cost than internal production, then the activity should be contracted out or outsourced (Williamson, 1979). The RBV looks beyond just the cost of an activity and places emphasis on the importance of resources to achieve competitive advantage (Barney, 1991; Holcomb & Hitt, 2007). The convergence of these two theories, that capability or resources affect the boundary conditions created by TCT, drive the model of strategic outsourcing.

Holcomb (2012) defined strategic outsourcing as an arrangement wherein firms rely on the market to provide a specialized service that supplements the firm's existing capabilities. Firms must make difficult decisions about whether to internalize or outsource an activity or service – defining their firm scope. Internalization of an activity requires commitment of resources and limits strategic flexibility because it can be difficult to reverse (Leiblein, Reuer, & Dalsace, 2002). However, this internalization may be required to effectively carry out production. Understanding firm scope or boundaries attempts to explain which activities should or should not be outsourced.

Firm scope is the definition of activities that should or should not be provided internally (Holcomb & Hitt, 2007). One framework to dictate outsourcing decisions is to define activities as either core or non-core. This is not to say that every non-core activity should be outsourced, but rather that it can be, and that core activities should not be outsourced. However, using this method to define firm scope can lead to firms that outsource too many activities or too large of a list of core activities. Another issue with this decision process is that not every business-unit will consider the same activities as core or non-core, which leads to confusion in management (Heikkilä & Cordon, 2002). Core and non-core activity definition attempts to determine which activities to outsource; however, these definitions may change from unit to unit and may not fully clarify the outsourcing decision.

Recognizing the deficiency in defining firm scope, Heikkila (2002) developed an outsourcing decision-making framework. The framework consists of six drivers for outsourcing and four potential drawbacks. The drivers highlighted by the framework are:

- **Scarcity of capital**. This driver highlights the fact that companies may not have the sufficient capital to fund all the activities which they may wish to pursue. Outsourcing would reduce the required capital needed.
- **Lack of know-how**. Other companies considered experts in a specialized area and know how to perform the activities more efficiently.
- **Flexibility and the need for quick response or small production**. Certain companies have the capability of adjusting to market fluctuations.
- **Speed or time to market**. Outsourcing can enable products brought to the market at a much quicker rate or enter a new geographical area than what could be accomplished internally.
- **Asset utilization or spare capacity**. Certain activities may require a minimum level of asset utilization or infrastructure to justify investment. The ability for companies to meet these minimums in production must exist.
- **Economies of scale**. Specialized companies can produce products sold to many companies, which reduces cost of assembly and manufacturing.

The framework also highlights potential drawbacks of outsourcing:

- Transfer of know-how that encourages new competitors.
- Changes in the balance of power in the industry.
- Dependency, confidentiality, and security issues.
- Fear of opportunism.

The driving factors and potential drawbacks for outsourcing provide firms with reasons why they may want to outsource an activity. These same factors can be applied to a public agency in deciding when a partnership may be beneficial. With this context, the factors still have meaning. A public agency, such as the DOD, does not have the same requirements as a private agency to achieve profit, but must be fiscally responsible. The USAF is constrained by budgets, may lack know how and requires flexibility (resiliency). It is important to consider the drivers and potential drawbacks when deciding to partner, because they may not always dictate or deter partnering when applied to a public sector.

2.5 Summary

This chapter reviewed relevant literature pertaining to this research and the questions that were posed in Chapter I. Geographic information systems were reviewed because they offer insight in how questions can be answered when location is important. The review on Public-Private Partnerships and Public-Public Partnerships reveals how partnerships have been used, and provides insight on to developing a successful partnership. Furthermore, reviewing literature on partnerships revealed that it fails to address how to identify partnership opportunities. Finally, literature on outsourcing was reviewed because this research believes that the concept of partnering and outsourcing are closely related.

III. Methodology

3.1 Chapter Overview

This chapter details the methodology used to obtain, process, and analyze data on over 9,000 public libraries and library systems used in this research. It is important to note that no central data repository exists for information on public libraries. For this research, data were pulled from various public and government websites. Therefore, web scraping techniques were utilized to create the final data set used in this research. The functions used to gather and format the data were consolidated into a software package for the R programming language called 'publicLibs', which will be submitted for publication to the Comprehensive R Archive Network (CRAN). The data was then used to produce an overall quality measure for each library. For this research, library quality is represented by estimating the size of each library. Finally, Inverse Distance Weighting (IDW) was used to create an index for each installation that can be used to identify partnership opportunities. The results of the research are presented in Chapter IV.

3.2 Data Collection

The IDW methodology imposes two requirements for data: distance and quality. Therefore, data used for this analysis, at a minimum, must contain the location and information pertaining to the quality of each library. The geographic location of for each library allows for the distance from each library to each CONUS Air Force installation to be determined. Initially, four sources of library data were identified: www.publiclibraries.org, www.publiclibraries.com, Library Research Services, and the

Institute of Museums and Library Services (IMLS). The two website sources of data were identified containing public library locations, as well as individual metrics for all libraries, rather than only central libraries as the latter two sources. As a result, the two websites were chosen as the data sources, but neither source provided a means to export the large amount of data that it contained. This section describes the data from each source, how the data were retrieved, and how the data were combined to form the final library data set.

The first data source identified (www.publiclibraries.com) provided library information for libraries within the United States by state (Public Libraries, n.d.-a). The data are arranged such that there is a webpage for each state with a table of libraries located in that state. The website and tables were constructed using HTML and contained the name of the library, its address, city, zip code, and phone number. An example table from the website is shown in Figure 3.

The data obtained from every library in a state were used to identify and join additional data using the library name as an identifier. Furthermore, the addresses allowed for each library to be accurately geocoded. The R software environment was utilized to automate the process of extracting the HTML tables and constructing matrices that could be manipulated (R Core Team, 2016). Figure 4 shows an example of the HTML code.

City	Library	Address	Zip	Phone
Abbeville	Abbeville Memorial Library	301 Kirkland Street	36310	(334) 585-2818
Adamsville	Adamsville Public Library	4825 Main Street	35005	(205) 674-3399
Akron	Akron Public Library	207 First Avenue South	35441	(205) 372-3148
Alabaster	Alabaster - Albert L. Scott Library	100 9th Street N.W.	35007	(205) 664-6822
Albertville	Albertville Public Library	200 Jackson Street	35950	(256) 891-8290
Albertville	Marshall County Cooperative Library	600 College Street	35950	(256) 878-8523
Alexander City	Alexander City - Adelia Mcconnell Russell Library	318 Church Street	35010	(256) 329-6796
Alexander City	Mamies Place Childrens Library	284 Church Street	35010	(256) 234-4644
Aliceville	Aliceville Public Library	416 Third Avenue Ne	35442	(205) 373-6691
Andalusia	Andalusia Public Library	212 South Three Notch Street	36420	(334) 222-6612
Anniston	Public Library Of Anniston-Calhoun County	108 East 10th Street	36201	(256) 237-8501
Anniston	Public Library Of Anniston-Calhoun County - Carver	722 West 14th Street	36201	(256) 237-7201
Arab	Arab Public Library	325 2nd Street Nw	35016	(256) 586-3366
Ariton	Ariton - Dot Laney Memorial Library	30 W. Main Street	36311	(334) 762-2463
Arley	Arley Public Library	6788 County Road 41	35541	(205) 387-0129
Ashford	Houston-Love Memorial Library - Ashford	305 6th Avenue	36312	(334) 899-3121

Figure 3: Screenshot of www.publiclibraries.com - public libraries located in Alabama

The XML package contains functions to retrieve HTML tables from a URL and read those tables into a variable (Lang & the CRAN Team, 2016). The resulting list in R was restructured into a data frame. A data frame is made up of a collection of coupled variables sharing many of the same properties as matrices and lists (R Core Team, 2016). The data frame contained the same information as the HTML tables, but it enabled easier manipulation of the data.

```
<div style="width:100%;margin:20px;">

    <div style="float:left;width:93%;margin-left:0px;font-size:12px;">
        <table id="libraries"><tr><th>City</th><th>Library</th><th>Address</th><th>Zip</th><th>
<tr><td>Abbeville</td><td>Abbeville Memorial Library</td><td>301 Kirkland Street</td><td>36310</
<tr><td>Adamsville</td><td>Adamsville Public Library</td><td>4825 Main Street</td><td>35005</td>
<tr><td>Akron</td><td>Akron Public Library</td><td>207 First Avenue South</td><td>35441</td><td>
<tr><td>Alabaster</td><td>Alabaster - Albert L. Scott Library</td><td>100 9th Street N.W.</td><t
<tr><td>Albertville</td><td>Albertville Public Library</td><td>200 Jackson Street</td><td>35950<
<tr><td>Albertville</td><td>Marshall County Cooperative Library</td><td>600 College Street</td><
<tr><td>Alexander City</td><td>Alexander City - Adelia Mcconnell Russell Library</td><td>318 Chu
<tr><td>Alexander City</td><td>Mamies Place Childrens Library</td><td>284 Church Street</td><td>
<tr><td>Aliceville</td><td>Aliceville Public Library</td><td>416 Third Avenue Ne</td><td>35442</
<tr><td>Andalusia</td><td>Andalusia Public Library</td><td>212 South Three Notch Street</td><td>
<tr><td>Anniston</td><td>Public Library Of Anniston-Calhoun County</td><td>108 East 10th Street<
<tr><td>Anniston</td><td>Public Library Of Anniston-Calhoun County - Carver</td><td>722 West 14t
<tr><td>Arab</td><td>Arab Public Library</td><td>325 2nd Street Nw</td><td>35016</td><td>(256) 5
<tr><td>Ariton</td><td>Ariton - Dot Laney Memorial Library</td><td>30 W. Main Street</td><td>363
<tr><td>Arley</td><td>Arley Public Library</td><td>6788 County Road 41</td><td>35541</td><td>(20
<tr><td>Ashford</td><td>Houston-Love Memorial Library - Ashford</td><td>305 6th Avenue</td><td>3
<tr><td>Ashland</td><td>Ashland City Public Library</td><td>11 Second Avenue North</td><td>36251
<tr><td>Ashville</td><td>Ashville Public Library</td><td>196 Sixth Avenue</td><td>35953</td><td>
<tr><td>Ashville</td><td>St. Clair County Library</td><td>139 5th Avenue</td><td>35953</td><td>(
<tr><td>Athens</td><td>Athens-Limestone Public Library</td><td>405 East South Street</td><td>356
<tr><td>Atmore</td><td>Atmore Public</td><td>700 E. Church Street</td><td>36502</td><td>(251) 36
<tr><td>Atmore</td><td>Escambia County Cooperative Library System</td><td>700 East Church Street
<tr><td>Attalla</td><td>Etowah County Public Library</td><td>604 North 4th Street</td><td>35954<
<tr><td>Auburn</td><td>Auburn Public Library</td><td>749 East Thach Avenue</td><td>36830</td><td
```

Figure 4: HTML code example from www.publiclibraries.com

As previously discussed, the data source provided the address for each library. The location of each library was required to determine the distance from the library to the military installation. Thus, each library was required to be geocoded, which is the process of assigning latitudinal and longitudinal coordinates. The R package ggmap (version 2.6) was utilized to geocode each library through Google Maps (Kahle & Wickham, 2013). The Google geocode Application-Programming Interface (API) limits unregistered users to 2,500 searches per day.

The Google geocode API allows users to query more than 2,500 times per day by creating an account for an API key. Google offers free and paid APIs depending on the service and map loads required. For this research, a free web service account was created allowing for up to 25,000 map requests per day. Unfortunately, the ggmap package version 2.6 does not allow a user to pass the API key from are R ggmap package to the Google API. Fortunately, R is open source, which allows for users to alter the code of published packages. The ggmap package was modified allowing for an API key to be passed through the package to the Google geocode API. An update was sent to the author of the ggmap package, notifying them of the shortfall and the associated fix. Obtaining the API key and altering the ggmap package allowed for the entire library data set to be geocoded.

The data from the first source provided the names and addresses of 15,834 libraries. Using R, the data were transformed into a data frame, and the geographic coordinates of each library were obtained via the Google geocode API. The list of library locations allowed for distance calculations using the Haversine formula shown as Equation 1 (Douglas Nychka, Reinhard Furrer, John Paige, & Stephan Sain, 2015; Sinnott, 1984). This formula calculates the great-circle distance (d) between two points on a sphere from their longitudes (λ) and latitudes (φ), where r is the radius of the sphere.

$$d = 2r * \arcsin(\sqrt{(\sin\frac{\varphi_2 - \varphi_1}{2})^2 + \cos\varphi_1 * \cos\varphi_2 * (\sin\frac{\lambda_2 - \lambda_1}{2})^2}) \qquad (1)$$

3.3 Library Size Estimation

For this research, the size of the library is a proxy variable for quality. The reason for this proxy variable choice is the assumption that a larger library serves a larger population with a wider range of services. The second source of data (www.public-libraries.org) provided the metrics needed for this proxy variable. Similar to the first source, the second source of data listed the libraries by state and then by city (Public Libraries, n.d.-b). However, the information provided for each library is not in easy tabular form, nor did every library contain the same type of information.

Extracting the data from the second source required many of the same R functions previously discussed. Every library in the data set contained either a basic set of data (i.e. location address and library information) or more comprehensive information (i.e. location address, basic library information, media information, staff information, children's library services, financial information, and library technology information) (Public Libraries, n.d.-b). Reviewing the basic and comprehensive sets of data revealed that the size of the library was given in the basic set but not in the comprehensive set.

Although the comprehensive data set did not contain the size of the library, it possessed other factors utilized to estimate the size of the library. The *Public Library Space Needs: A Planning Outline 2009* recommended planning factors for the construction of a new library. Based on these planning factors, an estimation of the library size was created from the comprehensive data set. The planning guide allocated space into six categories: collection space, reader seating space, staff workspace, meeting room space, special use space, and non-assignable space. The planning outline broke down each of these categories and provided factors on how to estimate the space needed for each category (Dahlgren, 2009).   The guide provided minimal, moderate, and optimal level factors for designer flexibility. The moderate factors were used in this research in all but one category.

Libraries contain books and periodicals, audio, and visual materials (non-print), and computer workstations. The total space required to house these materials is the collection space defined in Equation 2. Depending on the type of media, different planning factors were used to estimate the amount of square footage needed. The data set provided the total number of books (N_b) and serial volumes (N_v), number of audio and visual materials (N_{av}), and the number of internet terminals (N_{it}) available to the public. The moderate planning factors used for each of these variables was 13 square feet per volume, 13 square feet per volume, and 45 square feet per terminal, respectively (Dahlgren, 2009).

$$Collection\ Space = 13 * (N_b + N_v + N_{av}) + (45 * N_{it}) \qquad (2)$$

The next spaces considered were staff work space and reader sitting space. The data provided the number of terminals for staff only; therefore, the number of terminals was estimated to be the number of staff workstations in the library (N_{sw}). The moderate planning factor of 150 square feet per workstation was used to determine the staff workspace needed. For the reading space, the planning guide (2009) recommended 30 square feet per seat, with the number of seats (N_s) determined by the service population (Table 3) (Dahlgren, 2009). Equation 3 estimates the workspace using the number of staff workstations (N_{sw}) and the number of seats (N_s) determined from Table 3. The total size of the library can then be estimated with Equation 4.

$$Work\ Space = 150 * N_{sw} + \left(30 * N_s * \frac{Service\ Population}{1000}\right) \quad (3)$$

Table 3: Reader Seating Schedule (Adapted from Dahlgren, 2009)

Population	**Seats per 1,000 population (N_s)**
1,000	22.50
2,500	14.25
5,000	10.00
10,000	7.00
25,000	4.50
50,000	3.00
100,000	2.25

$$Library\ Size = (Collection\ Space + Work\ Space) \quad (4)$$

3.4 Inverse Distance Weighting

The metric created to identify partnership opportunities relies on the use of Inverse-Distance Weighting (IDW). IDW is used in GIS analysis and recognizes Tobler's First Law of Geography which states: "All things are related, but nearby things are more related than distant things" (De Smith et al., 2015). IDW estimates a value as a weighted average at an unknown location based on the known measurements at nearby points (Figure 5) (Longley & Goodchild, 2011).

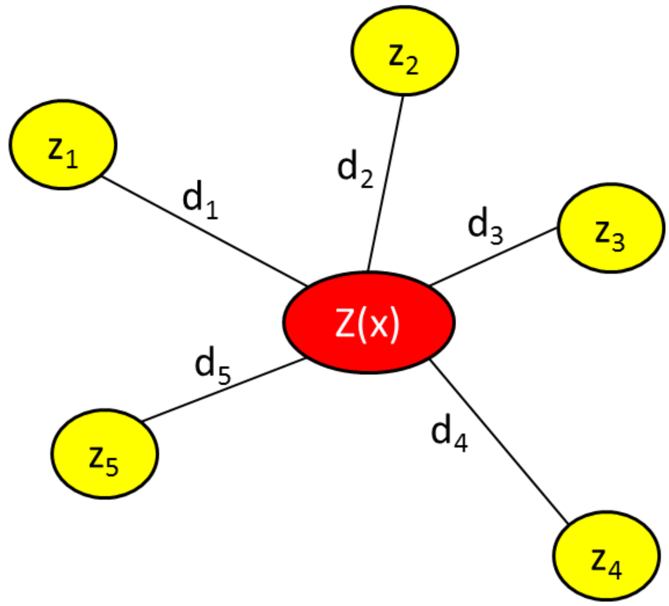

Figure 5: Inverse Distance Weighting Example

IDW uses Equation 5 to account for the distance between a library and an installation. Many applications use IDW where z_i is the quality or value of an object and d_i is the distance from the existing value to the unknown value. In this research, size approximates the quality of a library. IDW then provides a comparable metric for each installation. A higher index indicates that the surrounding community has a greater capacity for providing the library service and, therefore, greater potential to offer library services to the base population.

$$Z = \frac{\sum_i z_i * d_i^{-2}}{\sum_i d_i^{-2}} \tag{5}$$

3.5 Summary

This chapter outlined the methodology that was used to complete the analysis for this research. Inverse distance weighting (IDW) was identified as a GIS technique that will be used to answer the research question posed in Chapter I. IDW requires that the data used in the analysis contain distance and quality measures. As such, four sources of data were identified, and web-scraping techniques for collecting the data set were discussed. The data set will be analyzed using inverse distance weighting to create an index for each CONUS USAF installation with the results of this analysis presented in Chapter IV.

IV. Analysis and Results

4.1 Chapter Overview

This chapter reviews how the data that was obtained and processed using the methods outlined in Chapter III were analyzed. It presents the results of the two models that were created and discusses the application that was created, thus allowing users to change inputs and quickly review the results. Finally, the chapter presents the limitations associated with this research. Conclusions from the results will be discussed in Chapter V.

4.2 Preparing Data

This research planned to create the data set using web scraping techniques on two different websites, www.publiclibraries.com and www.public-libraries.org. However, data scraping from the latter website caused it to crash and become no longer available. Since this site provided much of the information for the analysis, a new data source was required. The final analysis carried out by this research utilized data from the Institute of Museum and Library Services (IMLS).

The IMLS conducted the public library survey in 2014, which reported operational information for libraries in the United States. This survey was updated in 2016 with new information and imputed values for some that had not been reported. This data set only provides information on library systems. In cases where a library system consists of more than one library, a singular data point represents the entire system. For a standalone library, the figures are for that individual library. The size of a library is a proxy variable for quality, and was estimated using the methods in Chapter III.

The survey by the IMLS provides the name, address, and coordinates for each library. Furthermore, the following variables estimate the size of the library: service area population, total staff, print materials, audio materials, video materials, print serials, computers. Reviewing the data set revealed that there were instances where libraries did not complete parts of the survey. In these cases, points were removed systematically by checking if the variables listed above were less than zero.

As discussed in Chapter III, the coordinates of each location enabled the distance from the library to installation calculation. All the data points provided the address of the library, and most also gave the latitude and longitude coordinates. For those that did not, the ggmap package and the address were used to obtain their coordinates (Kahle & Wickham, 2013). The next step in preparing the data was to determine the distance from a library to an Air Force installation. The final analysis produced two results, one for a straight-line distance from an installation to a library and a second for driving distance.

The straight line distance was calculated using the fields package in R (Douglas Nychka et al., 2015). The package calculates the geographic distance between two points using the Haversine method to account for the curvature of the earth. This research assumed libraries further than 100 miles from an installation are not a part of the installation's community and were excluded from the data set. A subset of the library data set was created for each Air Force CONUS installation which included all the libraries that were within 100 miles of the installation.

Calculating the driving distance between libraries and installations was more challenging because it required the use of Google Maps and gmapsdistance package

(Zarruk, 2016). The Driving Distance API from Google calculates the distance, but it only allowed for 2,500 searches per day. Due to this limitation, only the libraries with a straight-line distance of 100 miles or less of an installation had driving distances calculated. In a few cases, the driving distance was undeterminable, and therefore, removed from the data set. The final data subsets for each installation contained libraries within 100 miles, all the library information provided, as well as the straight-line and driving distance to the installation.

The subsets of data created a single measure for the library service around an installation. A requirement for this measure is a single radius around each installation. The radius defines what the user considers the size of the community around an installation and determines the libraries analyzed, further sub setting the data. The measure calculated is only useful when compared against other CONUS installations.

4.3 Analysis

4.3.1 Model Results

Inverse distance weighting (IDW) is used to calculate the relative measure for each installation. Comparing each of these measures is only possible if the size of the area around each is installation is the same. In preparing the data, it was reduced to only include libraries within 100 miles of an installation, thus making the data set smaller and more manageable. A single radius of 50 miles defines the community around an installation and determines libraries included in the analysis.

The analysis in this research produced two models; one for straight line distances and one for driving distances. The results are shown in Table 4 and Table 5, respectively.

The analysis produces an IDW measure for each installation at the specified radius. The measure can be compared to other installations, where the greater measure indicates greater partnership opportunity. The measures were normalized using equation 6 within their respective categories (straight line and driving distance). This provides reference points (0 and 1) for the IDW measure. The final step in the analysis was to provide an overall ranking for each installation based on the IDW measure. Installations with higher rankings are estimated to have greater library service in the local community, and thus, are best to consider for eliminating the base library.

$$Z_i = \frac{x_i - \min(x)}{\max(x) - \min(x)} \tag{6}$$

The analysis for both straight-line distance and driving distance produces similar results since many installations maintain similar overall rankings. However, there were some installations that moved a significant amount up or down in their overall rank. The analysis that utilizes driving distance is more detailed and accurate and, therefore, believed to be the better model. However, the Google API limits the number of driving distance searches making it more difficult to acquire the required data. Therefore, the difference between the two models requires further investigation.

Table 4: Inverse distance weighting results - straight line distance (1-33 of 65)

Base Name	IDW – 50 Miles	Normalized IDW – 50 Miles	Overall Rank
MacDill AFB	21038621.023	1	1
Bolling AFB	16751190.063	0.792	2
Patrick AFB	16162391.494	0.764	3
Andrews AFB	14016297.15	0.66	4
Charleston AFB	10661285.635	0.497	5
McChord AFB	10533067.521	0.491	6
Davis-Monthan AFB	8547426.11	0.395	7
Creech AFB	8366599.333	0.386	8
Tinker AFB	7904141.266	0.364	9
Travis AFB	6465288.951	0.294	10
Hill AFB	5821880.682	0.263	11
Peterson AFB	5619174.894	0.253	12
Barksdale AFB	5482525.67	0.247	13
Little Rock AFB	5226916.112	0.234	14
Air Force Academy	5210669.704	0.234	15
Nellis AFB	5068495.45	0.227	16
Lackland AFB	4924517.071	0.22	17
Pope AFB	4878228.122	0.217	18
Los Angeles AFB	4756136.932	0.212	19
Maxwell AFB	4675877.796	0.208	20
FE Warren AFB	4624190.202	0.205	21
Schriever AFB	4328720.291	0.191	22
Buckley AFB	4266649.562	0.188	23
Gunter AFB	4181384.007	0.184	24
Wright-Patterson AFB	4122190.897	0.181	25
Brooks City-Base	4017614.62	0.176	26
Robins AFB	3733941.509	0.162	27
Kirtland AFB	3479113.052	0.15	28
Goodfellow AFB	3400517.886	0.146	29
Moody AFB	3196970.35	0.136	30
Tyndall AFB	2870337.266	0.12	31
Keesler AFB	2842795.352	0.119	32
Seymour Johnson AFB	2853284.292	0.119	33

Table 4: Inverse distance weighting results - straight line distance (34-65 of 65)

Base Name	IDW – 50 Miles	Normalized IDW – 50 Miles	Overall Rank
Shaw AFB	2826745.566	0.118	34
Beale AFB	2731675.329	0.114	35
Dyess AFB	2552367.77	0.105	36
Fairchild AFB	2454591.249	0.1	37
Luke AFB	2433166.284	0.099	38
Langley AFB	2332003.192	0.094	39
Hanscom AFB	2110976.622	0.083	40
McConnell AFB	1941850.04	0.075	41
McGuire AFB	1854246.644	0.071	42
Vandenberg AFB	1736589.257	0.065	43
Malmstrom AFB	1578815.604	0.058	44
Offutt AFB	1585193.764	0.058	45
Otis AFB	1497939.658	0.054	46
Sheppard AFB	1475760.195	0.053	47
Cannon AFB	1464019.596	0.052	48
Whiteman AFB	1349258.819	0.047	49
Dover AFB	1316710.17	0.045	50
Edwards AFB	1046211.329	0.032	51
Minot AFB	995508.322	0.029	52
Scott AFB	980231.553	0.029	53
Columbus AFB	941248.165	0.027	54
Ellsworth AFB	951781.871	0.027	55
Altus AFB	905869.626	0.025	56
Holloman AFB	906794.178	0.025	57
Hurlburt Field	913310.126	0.025	58
Grand Forks AFB	823820.049	0.021	59
Vance AFB	757102.385	0.018	60
Laughlin AFB	706374.596	0.015	61
Arnold AFB	672087.51	0.014	62
Randolph AFB	598275.313	0.01	63
Mountain Home AFB	492984.411	0.005	64
Eglin AFB	387595.007	0	65

Table 5: Inverse distance weighting results - driving distance (1-33 of 65)

Base Name	IDW – 50 Miles	Normalized IDW – 50 Miles	Overall Rank
MacDill AFB	22819541.611	1	1
Patrick AFB	17499508.823	0.764	2
Bolling AFB	17137085.719	0.748	3
Andrews AFB	13645267.511	0.592	4
McChord AFB	10481073.562	0.452	5
Charleston AFB	10295271.547	0.444	6
Air Force Academy	8380488.604	0.359	7
Peterson AFB	7882720.585	0.336	8
Tinker AFB	7878969.339	0.336	9
Davis-Monthan AFB	7287296.209	0.31	10
Travis AFB	6590709.294	0.279	11
Hill AFB	6340372.375	0.268	12
Barksdale AFB	6011373.586	0.253	13
Pope AFB	5704680.13	0.24	14
Wright-Patterson AFB	5392141.833	0.226	15
Maxwell AFB	5252925.11	0.22	16
Little Rock AFB	5196280.106	0.217	17
Schriever AFB	4764077.052	0.198	18
FE Warren AFB	4639398.129	0.192	19
Nellis AFB	4446867.101	0.184	20
Los Angeles AFB	4371546.336	0.18	21
Gunter AFB	4211683.275	0.173	22
Buckley AFB	3786656.68	0.154	23
Lackland AFB	3682735.095	0.15	24
Robins AFB	3646816.904	0.148	25
Kirtland AFB	3576686.296	0.145	26
Brooks City-Base	3526126.117	0.143	27
Goodfellow AFB	3290303.195	0.132	28
Moody AFB	3238618.137	0.13	29
Shaw AFB	2920069.219	0.116	30
Seymour Johnson AFB	2796558	0.111	31
Beale AFB	2788181.453	0.11	32
Luke AFB	2708560.119	0.107	33

Table 5: Inverse distance weighting results - driving distance (34-65 of 65)

Base Name	IDW – 50 Miles	Normalized IDW – 50 Miles	Overall Rank
Tyndall AFB	2707917.319	0.107	34
Creech AFB	2651030.433	0.104	35
Keesler AFB	2609884.975	0.102	36
Dyess AFB	2475817.635	0.096	37
Fairchild AFB	2447163.173	0.095	38
Langley AFB	2151358.922	0.082	39
Hanscom AFB	2032187.856	0.077	40
McGuire AFB	1983257.814	0.074	41
McConnell AFB	1751036.175	0.064	42
Offutt AFB	1709367.098	0.062	43
Malmstrom AFB	1548131.931	0.055	44
Otis AFB	1547515.017	0.055	45
Sheppard AFB	1546916.802	0.055	46
Vandenberg AFB	1531590.682	0.054	47
Cannon AFB	1483476.744	0.052	48
Whiteman AFB	1473887.285	0.052	49
Dover AFB	1289851.801	0.044	50
Minot AFB	1116275.392	0.036	51
Scott AFB	1128646.383	0.036	52
Edwards AFB	1049067.347	0.033	53
Holloman AFB	1023861.725	0.032	54
Hurlburt Field	1025853.276	0.032	55
Ellsworth AFB	1005587.215	0.031	56
Altus AFB	925335.663	0.027	57
Columbus AFB	902282.84	0.026	58
Grand Forks AFB	886041.479	0.026	59
Vance AFB	754227.62	0.02	60
Laughlin AFB	709213.211	0.018	61
Arnold AFB	686448.204	0.017	62
Randolph AFB	563356.643	0.011	63
Mountain Home AFB	346818.168	0.002	64
Eglin AFB	308818.58	0	65

A Spearman's correlation test was used to determine the relationship between the two models. The calculation for Spearman's correlation only requires that the data is ordinal, interval or ratio, and that the two variables are monotonically related. The test shows that there is a positive correlation between straight-line IDW and driving distance IDW ($r_s = .97, n = 65, p < .001$). The scatterplot in Figure 6 summarizes the results. Overall, the IDW measure for the straight-line distance and driving distance models are positively correlated.

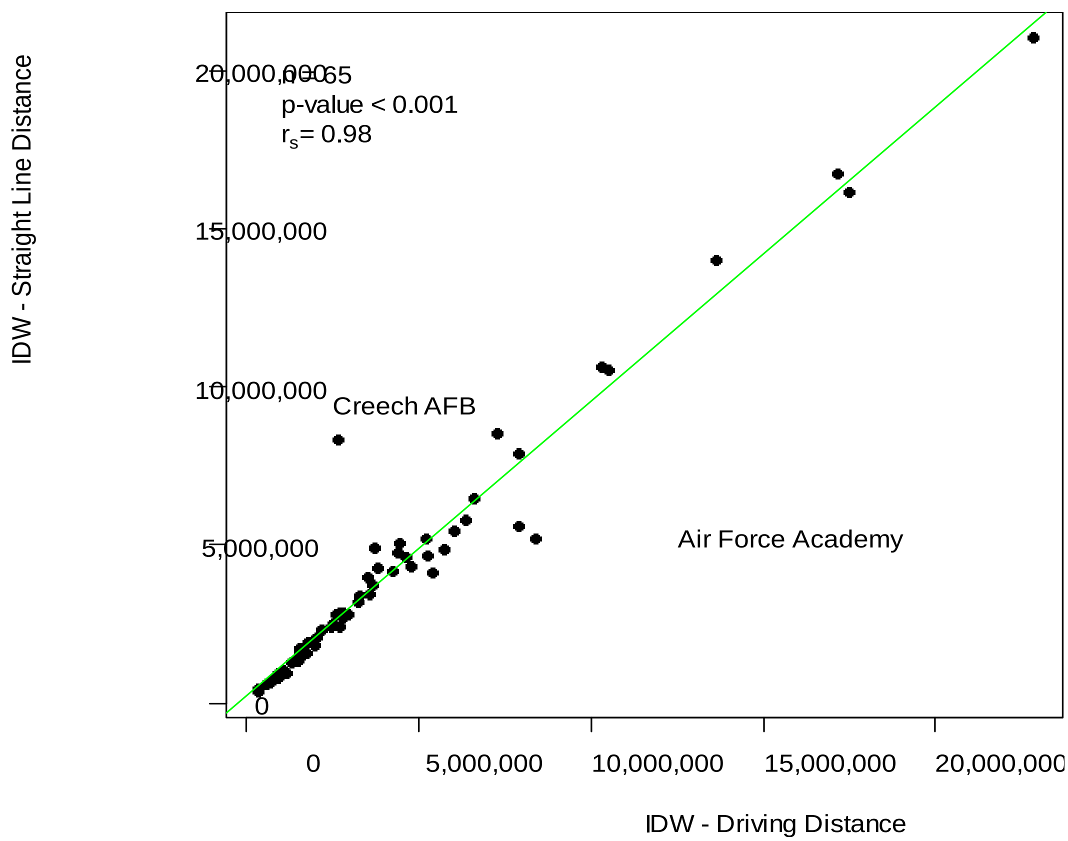

Figure 6: Driving distance versus straight line distance correlation scatter plot (50-mile radius)

4.3.2 Tool discussion

Recognizing that the 50-mile radius is somewhat of an arbitrary value, chosen by the researcher, a tool was developed which allows for users to change the radius considered. The tool allows users to change the radius of the community size, select driving distance or straight-line distance, and displays the results. The tool was created in R as shiny application using various packages (Allaire, 2016; Chang, Cheng, Allaire, Xie, & McPherson, 2016; Cheng & Xie, 2016)

The shiny application allows users to view the results and further investigate the results of the analysis; an example is shown as Figure 7. The input pane contains directions for how to use the application and has three user inputs available: radius around the base, installation, and distance mode. The radius around the base slider is the input for the user to select the radius around the installation and thus the libraries included in the analysis. The radius slider allows for radius changes in 5-mile increments from 5 to 100 miles and will change the output. The installation drop-down list allows users to select the installation of interest. The final user input is the Distance Mode drop down list. This allows users to select straight-line distance or driving distance for the analysis.

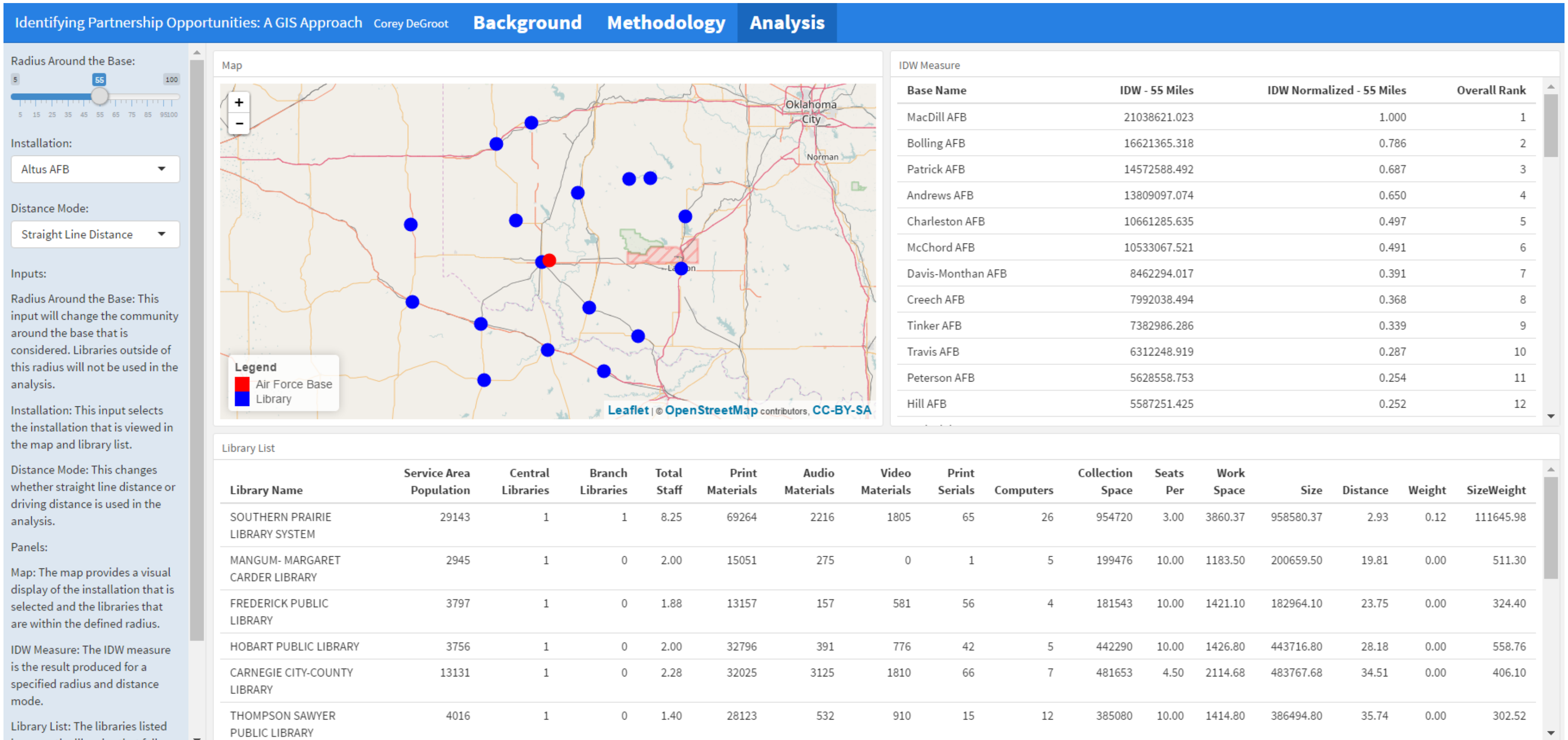

Figure 7: Screenshot of Shiny Application

The output pane consists of three panels: Map, IDW measure, and Library List. The map panel displays a map showing the installation selected by the installation input and the libraries that are within the radius selected. The Library List displays the libraries in the specified radius around an installation of interest, sorted by distance from the installation. For each library, the data used to estimate the library size is displayed.

The application is as a standalone tool. The background and methodology tabs provide a brief description of the research and the methodology used. The application allows decision-makers to review and interpret the results. Furthermore, decision-makers have the capability to change the inputs used in the analysis. From a research standpoint, the application greatly assisted in reviewing the results, highlighting limitations, and enables conclusions to be drawn from the analysis. The application simplified the process of reviewing the results by allowing the researcher to view specific installations and the subset of data used.

4.4 Limitations

The results from the analysis provided a rank order listing of all CONUS Air Force installations based on the level of library service provided by the community. However, several limitations exist in the study. Limitations must be identified and considered when interpreting the results and drawing conclusions about the research. The major limitations in this study are quality of data and the quality factor used in the analysis.

The data used in this research were gathered by the IMLS and provides the all the central libraries in the United States. However, the first limitation identified in the data set is the collection method. The IMLS does not actually gather the data itself, but rather combines state-specific annual public library surveys. This issue can be seen in how states organize and report their libraries. In some cases, states such as Massachusetts, consider most libraries to be central libraries. On the other hand, states such as Florida, organize libraries such that there are few central libraries but with many branch libraries.

The difference in organization and reporting is a limitation to this research. In the case of many central libraries, each library is singularly represented. This is drastically different than the case where there are very few central libraries and many branch libraries. In this case, only the central libraries are analyzed but the quality factor (i.e. size) encompasses the resources for all branch libraries associated with it. The quality factor or size of a central library with many branch libraries associated with it is much larger than a standalone central library. Thus, central libraries with many branch libraries provide a much greater weight in the IDW, which can affect the results if they are located near an Air Force installation. This limitation does not mean that the analysis is incorrect, but it requires that the user be aware of it when drawing conclusions. Central libraries with many branch libraries associated with them may have greater access to more resources than a standalone library and therefore warrant a greater quality factor.

Another limitation of this study is the quality factor used for the IDW analysis. The quality factor used, estimated the size of a library based on the size of its collection and resources. However, the estimated size of a library fails to include other factors that could affect the quality of a specific library. The collection size and available resources may not be fully adequate to define the quality of libraries.

The analysis performed by this research provides a rank order listing of Air Force installations based on the level of library service provided by the community. However, it is difficult to know if the list created with this analysis is correct or useful. As such, the methodology and results were presented to an independent subject matter expert. The subject matter expert was a group of professionals from Booz Allen Hamilton, a strategy and technology consulting firm. The firm is contracted by the Air Force Partnership Initiative (AFPI) to assist installations in creating partnerships with their local community.

The consulting firm reviewed the methodology, analysis, tool, and results of this research independently from the work that it does for the USAF. They were asked to give their opinions of the research effort and the results, as well as the methodology and how it could be improved. The consultants found no faults with the results or the methodology but provided suggestions for how the quality factor could be improved. The consultants also suggested other services that could be analyzed using this same approach. The suggestions provided will be discussed in Chapter V.

4.5 Summary

This chapter reviewed how the library data from IMLS was obtained and processed for the analysis. It discussed the results of the two models that were created and the application that was created, allowing users to change inputs and quickly review the results. The chapter concluded with a discussion on the limitations of this research. The following chapter provides an interpretation of the results and a research conclusion.

V. Conclusions and Recommendations

5.1 Chapter Overview

This chapter provides an interpretation and discussion of the results presented in the previous chapter. The chapter also reviews the research question and investigative questions from Chapter I. The chapter continues by presenting potential ideas for future research. Finally, the chapter provides a conclusion for this research effort.

5.2 Review of Research Questions

The investigative questions posed in this research contribute to the overarching research question of identifying partnership opportunities for Air Force CONUS installations. The results and answers to these questions can potentially aid Air Force planners in identifying installations where the local community has greater potential to offer services through the Air Force Partnership Initiative (AFPI).

Research Question: How can the Air Force identify installations where a greater opportunity for creating partnerships may exist?

This research reviewed literature on public-private partnerships and public-public partnerships to gain a better understanding on what is necessary for their success. Through this review, the Partnering Process model (Lambert et al., 1996) identifies a way to decide when to pursue a partnership. The model describes two factors for that impact the decision to form a partnership: drivers and facilitators. Drivers are the motivations behind why companies would want to partner, whereas facilitators are the environmental factors that could affect the growth of the partnership (Lambert et al., 1996).

This research identified inverse distance weighting (IDW) as a methodology that could be used to describe or measure the facilitators that exist between an installation and the local community for a specific service. IDW estimates the unknow quality of a service at a location using the quality and location of known services nearby. This measure can then be compared to other installations to determine which installations possess a greater opportunity for forming a successful partnership for that service. The following investigative questions focus on CONUS installations and the base library service but contribute to this research question.

Investigative Question #1: What characteristics of off-base communities can be used to identify installations where partnerships can be utilized by the Air Force?

The researcher identified distance to an installation and library size as two characteristics used to identify Air Force installations where library partnerships may be more effective. The analysis performed in this research produced a rank order list of CONUS installations which have the greatest library service in a 50-mile radius. The analysis estimated the size of a library based on the collection size and resources as a proxy variable for quality. Installations with a higher IDW measure identify installations that have off-base communities capable of providing base library services through the AFPI. Due to the limitations discussed in Chapter IV, the researcher believes that the results should not be viewed as a list where the top installation is the absolute best choice. Rather, the list provides a starting point to identify installations that have greater library services available in the local community.

Investigative Question #2: Does varying the radius used to define the community significantly alter the results of the analysis?

Defining the local community around an installation is needed so that the libraries included in the analysis could be identified. Although, IDW does not require this, every library could be considered for every installation, it is useful to identify only those that are near each installation. However, defining a single radius that encompasses the local community for all CONUS installations is challenging. Thus, this research selected a 50-mile radius to report, but created a tool that allows users to select the radius and present the associated results.

The tool created for this research allows for results to be investigated, allowing users to interact with the model and see the resulting changes. Installations can be viewed with the subsequent data used in the model and allow for greater insight to be gained. Ultimately, the significance of the tool is that it provides a greater mechanism for displaying the results and allowing users to change the inputs of the model. Furthermore, the tool was created as a standalone product of this research, allowing for the results to be dispersed more efficiently.

Investigative Question #3: Does the use of straight-line distance versus driving distance substantially change the rank order list of installation?

IDW requires the distance from each service to the installation. This research produced two models for library services, one using straight-line distance and the other using driving distance to provide rank order lists of installations. The models created were unique and had differences in their rankings. However, a correlation test reveals that the models were highly correlated and therefore very similar in the results that they produced. This high correlation implies that using either model should produce similar results. Therefore, future research could use either straight-line distance or driving distance for the analysis. This decision can be made based on the needs of the research and the data available.

5.3 Recommendations for Future Research

Several opportunities exist for future research in this area. As discussed in Chapter IV, an interview conducted with professionals from Booz Allen Hamilton, a strategy and technology consulting firm, to assist in verifying the results produced in this research. The interview helped identify two main areas for future research in this area: improving the quality factor and other services for analysis.

The first area for future work is associated with improving the quality factor used in the IDW analysis. The research used the size of the library as a proxy variable for quality. Although the size of each library was estimated using variables associated with collection size and resources, it is recognized that there are other factors that can impact the quality of library service. The factors that could be used to improve the quality metric can be broken into two categories: internal and external. Internal factors can include many things that are specific to what the library has or can provide. Including the number of reading programs or access to external resources are examples of internal factors that could be used to improve the quality metric.

The internal factors considered are measures of what currently exists. However, if a base library were to close, surrounding libraries in the local community would see an increase in usage. Realizing this, future work could also include discounting the quality based on the measurement of usage versus expected increase in usage. Discounting the quality could be accomplished by comparing the base population to the service area population of each library. Libraries with large service area populations are not likely to be as affected by the increase in usage from a smaller base population.

The quality factor used in the IDW analysis could also be improved by including external factors for each library. External factors are not directly associated with the library but could affect the quality as viewed by a user. These factors would include data about the area in which the library is located. Crime rates is an example that could be included as an external factor. Including factors about the area a library is in might impact the way users view the quality of a library and affect their decision to use it.

The second area for future work is associated with expanding the analysis to other services. The IDW analysis used in this research is very flexible because it only relies on distance and quality. Chapter IV shows that either straight-line distance or driving distance can be used for the analysis; however, it is believed that driving distance provides greater detail. In either case, calculating the distance for other services can easily be achieved. On the other hand, the method to define the quality of each library would not apply to other services.

Many CONUS Air Force installations provide services to the base population that are duplicated by local communities. In Chapter I, a model was presented that categorized functions within an installation as core, important, and peripheral. Core and important activities provide direct mission accomplishment and support needed for the mission and personnel, while peripheral activities provide community support and Morale, Welfare, and Recreation (Johnson, 2015). This research focused on a peripheral service, because they are services that can be easily duplicated by the surrounding community.

Reviewing services offered at many installations provides opportunities for future work. The base commissary, child development centers, and fitness centers are services that could be analyzed in future research. For each of these services, the quality factor could be refined based on the data available. Future work could also combine each individual service analysis to provide a clearer picture of the services provided around each installation. In doing so, a market analysis could be completed to help decision-makers decide where city-bases would be more effective.

5.4 Conclusion

Air Force leaders face the challenge of maintaining mission readiness with less funding than required to maintain the necessary infrastructure. Public-Private Partnerships and Public-Public Partnerships are recognized as a tool that can be utilized to help alleviate these challenges. Thus, the Air Force Partnership Initiative helps guide the formation of partnerships to leverage the capabilities and resources of military installations, local governments, or commercial entities to reduce operating costs and the costs of the services while retaining or enhancing quality. It has been suggested that at some installations, the local community could play a major role in providing base services, thus changing the current installation model. However, before making these decisions, the Air Force needs to identify which installations should benefit from exploring partnership opportunities.

The scope of this research was limited to exploring library partnership opportunities at Air Force installations located in the Continental United States (CONUS). For library services, two characteristics were used to identify installations that could benefit from using a partnership to provide library services: distance and quality. The results of the analysis provide a rank-order list of CONUS installations, thus identifying installations that have the greatest opportunity for creating a partnership for library services. Going forward, the Air Force can use the results from this research to selectively implement library partnerships. Furthermore, insights gained from this research can be used for other services and allow planners to implement partnerships more effectively.

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The excess capacity found in the Department of Defense real property portfolio creates challenges for leaders to provide resilient installations. Combining this fact with current funding trends makes decisions on how to properly maintain infrastructure even more challenging. The Air Force Partnership Initiative provides tools for installations to leverage community capabilities and resources to achieve savings and improve quality on Air Force installations and can reduce the real property footprint. This research proposes a method for assessing the viability of a partnership between Air Force installations and their nearby communities.

This research effort created a tool capable of investigating off-base communities and discovering partnership opportunities worthy of exploration by nearby Air Force installations. The scope of this research will be limited to exploring library partnership opportunities at Air Force installations located in the Continental United States. This research investigates the facilitators, or environmental factors, to identify where greater opportunities for creating partnerships may exist. The result of this research is a tool which produces a relative measure for each off-base community, where higher values indicate a greater potential for partnerships. This relative measure utilizes inverse distance weighting between an installation and each service location in the surrounding community.

15. SUBJECT TERMS

Public-Private Partnerships, Public-Public Partnerships, Geographic Information Systems, Inverse Distance Weighting

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