Understanding the Role of Social, Technology, and Physical Infrastructures in Smart Communities: The Case of Rural Areas in the US

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Abstract

Smartness is a concept that frames a great variety of initiatives, particularly in the urban context. Smart cities are expected to be more resilient, more sustainable, and have highly engaged citizens, among many other expected outcomes. Given the focus on urban settings, many examples of smartness take for granted that the physical and technological infrastructures exist and are available to the majority of residents. For instance, Internet access, a reliable transportation system, or electrical power are rarely questioned or considered as a problem to be solved before becoming smart. In addition, formal education and technical skills are also expected as part of the social infrastructure of a city. However, when smartness goes beyond the urban settings, the availability and combination of these different infrastructures also differ. Based on a study of a rural community in the US, this paper begins to fill a gap in what is known about smartness in rural communities by analyzing how the physical, technology and social infrastructures in rural areas are different from urban settings, but still generate unique opportunities for building smart communities. Our results indicate that the unique conditions of rural communities create atypical strengths for becoming smarter.

1. Introduction

The concept of smartness has been recognized as a key component of urban strategies addressing local challenges related to land use regulation, urban maintenance, production, and management of services, among other [34, 39, 40]. Smart city initiatives, in particular, are undertaken to help communities become more efficient, sustainable, and transparent, and, ultimately, to improve the quality of life of residents [5, 8, 9]. In these strategies and initiatives, technology and technological innovation play a pivotal roles as do social aspects and the natural and built environment [9, 12]. In this paper we adopt an infrastructure lens that includes social, technical and physical infrastructure, to try to build new understanding of how the interactions among various types of infrastructure contribute to smart communities. Much work has been done in the context of urban areas, exploring how these infrastructures work and relate to each other. However, existing studies have not clearly addressed the social, technology and physical infrastructures and how they work together in rural communities to create value for residents. More research on smartness in rural areas is needed [35].

Along with the progress of urbanization and technical development, the gap, in general, between urban and rural areas is widening in a number of key areas including the economy, education, and health care, and as a consequence affecting the stability and well-being of the society as a whole [1]. There is also increasing awareness in the importance of rural regions in that "the economy as a whole can reach its total output frontier by developing places of different sizes and densities, because it is the performance of the urban and regional system as a whole which is critical, rather than just the cities at the top of the urban hierarchy" [24]. The importance of rural areas and other communities that lay outside cities and mega-cities has been acknowledged, particularly because of the contribution they make for a region as a whole. For instance, the French government proposed 'reciprocity contracts between cities and their surrounding countryside' [25], and Germany is developing their smart rural territory through collaboration between municipalities to deliver smart services across various fields, like a digital communication platform [26].

In addition, the emerging concept of smart communities is beginning to acknowledge that cities or mega-cities are not the only ones using new

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technologies and innovations to improve services and the life of residents [3, 23, 26, 35]. For example, recent research shows that rural areas are gaining some recognition through the concept of smart villages, applied in Europe in 2017 under the European Union (EU) action for Smart Villages documented and launched by the European Parliament [2, 3].

The purpose of this paper is to build new understanding about how rural communities become smart through an exploration of the social, technology and physical infrastructures of urban and rural communities. Our research question is: How do physical, technical, and social infrastructures interact in rural communities to help them become smart? This question is considered in the context of information sharing for emergency preparedness and response from the case of a small town in upstate New York.

This paper is organized in six sections, including the foregoing introduction. Section two reviews smartness from the perspective of the three infrastructures of interest: social, technology, and physical. It draws on current literature regarding how rural communities appear to be at a disadvantage when enabling or even enhancing these infrastructures in efforts to achieve 'smartness'. Section three describes the research design and methods being used in an ongoing study focused on a specific rural community in the Northeastern U.S. The research is based on focus groups with residents from the rural community. Section four provides new insights for understanding the development of smart communities in rural areas. Section five presents the main findings and reviews some theoretical and practical implications. Finally, section six provides concluding remarks and suggests areas for future research on this topic.

2. Smart Cities, Infrastructure and Rural Communities

This section presents the results of a review of current literature related to the importance of different infrastructures to smart cities and smart communities. It includes an explanation of the socio-technical nature of smartness, particularly in urban settings. It also highlights some of the differences that characterize the much less studied rural context.

2.1. Smartness and the importance of technical, physical, and social infrastructures

Often smart city and community conceptualizations emphasize the use of Information and Communication Technologies (ICT) as these technologies tend to play a significant role in enabling smart city initiatives [4]. However, the idea of smartness goes beyond ICT's. This paper takes a more comprehensive view of smartness and looks at it as a socio-technical phenomenon, in which components of human capital, creativity and other social dimensions are just as important [9]. Therefore this section discusses various components that contribute to community smartness, including technology infrastructure, but also the physical and social dimensions of infrastructure.

2.1.1. Technology infrastructure. One of the most major components that enables smart cities is the technology infrastructure that enables connectivity and the utilization of broadband and cellular networks. Technology infrastructure can be understood as the structures and facilities that are needed for operations beyond the networks themselves. These can include fixed and mobile assets, and virtual structures [5]. This type of infrastructure can also involve a network of sensors and actuators embedded in the terrain, interacting with wireless mobile devices [6].

Smart cities include the use of tools and technologies for city-wide, geo-data collection and management, public participation, and domain-specific applications [7, 8].

2.1.2. Physical infrastructure. Physical infrastructure includes the natural and built environment of a community including the buildings, roads, bridges, tunnels, pipelines, and electrical and communication networks [9, 10]. Physical infrastructure also includes high-tech fiber technologies on which telecommunication depends [11]. For instance, in terms of a utility, the infrastructure contains the underground and aboveground cables and pipes networks supported by related assets [12].

The natural environment and ecological sustainability are at the core of the physical environment in the context of creating a smart city [9]. A recent trend developing around the physical infrastructure of smart cities and smart communities is combining environmental sustainability where it concentrates on the interconnection and the synchronization of the individual technologies with products and services that already exist in a smart city. With the advance of urbanization, cities have become more crowded both in terms of people and built infrastructure and as a consequence energy demands have increased. This has created a new smart city trend for going green and creating eco-cities where information and technology is capitalized for smart sustainable development [1, 13]. Examples of this includes sensors that can be used on bridges, buildings, lamp posts and other physical infrastructure to detect

air pollution, water pollution, traffic congestion, structural health of bridges and roads [9, 10].

2.1.3. Social infrastructure. Despite the relatively new urbanization movement since 1960, the UN reports that about 55% of the population of the world lives in urban areas as of 2018 [14]. The large accumulated population in urban areas is recognized as cultivating a dynamic environment that enables an organic mix of creative ideas and cultural exchange. The corollary to this is an innovative and diverse aesthetic that is an essential element to attract smarter people to a city and to further create a better city [9]. This movement and increase in populations in urban areas, in particular, has helped shape the definition of a smart city to one that is humane, where creativity, the knowledge economy, collaboration between government and residents, and education are key drivers [9]. The social infrastructure highlights the importance of human capital and co-production contributions made by people and supported by institutions such as education systems and the knowledge economy [9].

Education, learning and knowledge are at the core of the social infrastructure component of smart cities because these areas tend to be a "magnet for education and training, culture and arts, and creative economy and industry [9]. A large portion of young populations are, and have been, migrating to cities due to access to higher education, and the existence of the knowledge workforce that supports sustainability within a city. At the same time, smart cities are growing partially because migrants often stay in these cities after they've completed their education, becoming an essential factor in sustainable growth [15, 16]. Areas that enable social infrastructure, like higher education institutions and the knowledge workforce, are key elements for smarter cities because they create creative and diverse cultures [9].

Many cities that are deemed 'smart' offer spaces for higher education, using digital tools for educating and creating scientific workforces. As mentioned in this section, these areas also create new job positions for university graduate students and provide competition in the workforce. The collaboration within the city across universities, technology centers, industry and government further increase the development of science technology and innovation that can be used not only in that city, but in other, often urban, areas [17].

An empirical study on the migration among young skilled and creative people in Romania showed that two of the most important factors influencing movement among young people are regional identity and education and investment in lifelong learning. Moreover, since big cities generally offer better job opportunities and financial stability, after graduation, a great number of young well-educated members of the workforce choose to stay in the city.

2.2. Rural Communities, Smartness, and the Role of Infrastructures

If enhancing 'smartness' is important for urban environments, it is arguably even more necessary in the case of more sparsely populated areas, such as those found in rural communities. In 2017, European Cohesion Policy on smart villages mentioned the concept of 'smart specialization strategies' which emphasize the usage of the region's most promising areas in addressing the rural area economic challenges. Like urban areas, each rural community is unique, and smart development in rural areas has to be carried out within the unique context of each community. As illustrated by Zavratnik, the growth of infrastructure is hardly strictly divided into urban and rural areas due to their mutual interconnections when significant changes in one will cause changes in the other [3]. To understand the importance of smart transformation in rural areas, this section will review the challenges rural areas often face in the development of technical, physical and social infrastructures, particularly when those approaches derive from smart city concepts.

2.2.1. Technology infrastructure. In contrast to urban areas, rural areas have, in generally lagged behind in the development of technical infrastructure due to a number of factors including a geographically dispersed user base, resistance to adopting new technologies, and affordability [18]. These factors result in a lack of technology infrastructure investment and can create economic and social disparities in remote areas. The challenge this poses for rural areas is significant, because the use of ICTs are often major pillars within smart cities designed to support smart initiatives. The failure to utilize information technology for rural development can also occur because the lack of a strategy, unfocused planning, and inefficient execution of activities [19].

Technology infrastructure, in the form of communications networks, also play a crucial role in disseminating information and knowledge. Unfortunately, telecommunications companies are less likely to provide such communities with needed infrastructure due to the low population densities and low investment return often found in rural communities. Sandberg and Wahlberg [20] discuss how this lack of investment and planning can impact small businesses in rural areas. They assert that in an information economy, ICTs are a driver of economic

growth and therefore “rural businesses are caught in a vicious cycle — lack of communications infrastructure reduces the demand for communications services, which further constrains future investment in that infrastructure [20].

In this digital age, rural areas are simply not as well connected by technology infrastructure as their urban counterparts. Much focus, as noted above, relates to broadband and digital connectivity and much of what many government officials are looking to address with ICTs are related to urban problems [29]. For example, ICTs in smart cities are often designed to address issues of population density, pollution, traffic congestion and managing large resources that provide services. Such issues are not experienced in rural areas, at all, or at best, in the same way and although rural and urban areas, do have some common issues such as pollution, addressing such problems requires approaches that incorporate the physical and social contexts of rural areas.

There are attempts to address challenges brought about by the lack of available technology infrastructure in rural areas. Researchers, practitioners and businesses alike have tried to increase the connectivity and instant accessibility to information networks in the lives of rural residents. Broadband initiatives across the U.S., such as federal funding for rural utilities services, are still focused on closing the availability gaps. However, much of that funding, around 58%, focuses on distance learning and telemedicine grants, whereas 1% focuses on telecommunications infrastructure [30]. Take for example the Community Connect and Broadband Access programs provided by the U.S. Department of Agriculture. These programs have made an effort to improve rural broadband access by providing both wireless and wireline technologies, however, rural areas still lag behind urban areas partly due to the continued practice among providers of focusing investments in urban areas where there are higher income consumers and higher density residential communities [42].

Some efforts are related to connectivity while others attempt to provide useful information to residents. For instance, Corsar and colleagues [21] built a Real-time Passenger Information System (RTPI) which is called the GetThereBus app to enable rural bus passengers to share real-time public transport data and access information. Corsar and colleagues admit the difficulties of recruiting and motiving enough users to provide data needed to expand the area of coverage, however, it offers valuable insights in showing the design and development of data-driven systems in a rural area.

2.2.2. Physical infrastructure. Physical infrastructure, as mentioned in one of the previous sections, is all about the natural and built environment. The geographic location determines the terrain and challenges associated with it. Unlike in urban areas, typically rural areas include vast terrain, whether it is densely forested areas, open farmlands or plains. These types of natural environments can have an impact on the built environment in rural areas. For example, hilly and densely forested areas may have more fading and signal power loss than other flat regions. Moreover, location determines the cost of the infrastructure development and transportation of telecommunication equipment and maintenance of the network [41]. The differences in terrain directly impacts the way in which the built environment is organized and developed.

Beyond the natural landscape, the built environment within rural areas differs greatly from that of urban areas and as a consequence physical structures in a rural area can be widely dispersed. While both urban and rural areas have similar infrastructure components that deliver services such as sewer, water and electric, as well as transportation infrastructure (roads, bridges, airports, etc.), the level at which those infrastructures are funded, maintained and organized differ. While built infrastructure across the nation is in general deteriorating, this is especially true for rural areas. Issues of water quality, degrading bridges and roads are prevalent and changing weather patterns are impacting both urban and remote areas but the ability for rural communities to address emergencies around destroyed infrastructure (e.g. floods washing away roads, and power outages in mountainous areas) are more complex. Unlike urban areas, funding and other resources for addressing physical infrastructure needs is not as accessible, particularly when there is a lack of investment from private companies and local governments are strapped for financial resources [31].

Initiatives geared towards rural areas to improve physical infrastructure have occurred across the globe. Take for example the case of the IEEE smart village initiative. Since 2010, IEEE smart villages have co-operated with local entrepreneurs and nongovernmental organizations to empower off-grid villages, based on the success of the first Himalayan project, IEEE smart villages scale its operation in all off-grid mountainous communities which face energy-access problems all over the world [22]. Due to the reliance on electricity, the use of micro-grid solar-power plants, especially when the plants are under poor weather conditions from cold or rain, or overload conditions from growth in power consumption. However, they also face a financial burden where the replacement usage of the generator is costly. To solve

this challenge, smart villages collaborated to create an affordable backup generator by creatively uses automobile parts available in most villages. In this example, the new technology tools allow the interoperability and configuration between various solar home systems. The application of this innovation also increased technology adoption in the smart village network [22].

Grevelt and colleagues [23] suggest that in order to achieve initiatives like smart villages, which represent a portion of rural areas, there needs to be higher levels of collaboration among the government and private sectors as well as coordination across initiatives to create better synergy in achieving goals. This is true not only for rural spaces, like villages, but for all rural areas, especially when access to public and private sector resources are not as freely available and accessible like they are in urban spaces.

2.2.3. Social infrastructure. The social infrastructure of a community can play a vital role to enabling 'smartness'. This includes contributions from the public and private sectors and participation on the part of residents and the human capital they create [9]. In collaboration, government, the private sector and residents play a key role in producing, co-producing and enabling policies and programs to create a better community.

A challenge in the rural context is that many rural communities don't typically have easy access to universities and colleges, one resource that not only helps create the knowledge economy and develop human capital, but a resource that provides opportunities for exploring and engaging in policies or initiatives often associated with smart cities. In terms of workforce, rural areas face the challenge of having limited job opportunities which forces many rural residents to commute to neighboring cities.

From the perspective of the workforce, chronically distressed areas across the country, like Appalachia, have high percentages of the population living in poverty as traditional economic sectors like mining and manufacturing are changing [32]. This has caused many rural areas to lose jobs, and of the jobs that do exist, many are transitioning from low-skill to specialized skill, creating a mismatch in employer's needs and the skills of the existing rural workforce [32, 33].

3. Research Design and Methods

This section introduces the case of a town in upstate, New York, providing a brief description of the data collection and analysis approach. The study is based on focus groups conducted with residents of the Town of Thurman, which stems from an existing NSF funded project designed to build a novel framework to improve emergency preparedness and response (EPR) in rural contexts.

3.1. Brief Description of the Case

There are a great number of small and isolated rural communities in the United States. In fact, according to the Census Bureau, in the U.S., 97% of the territory is categorized as rural is home to 19.3% of the overall population. Of that 19%, about 30% still lack mobile broadband access. With an average population density of 73 people per square mile, Warren County is a typical example of rural U.S. Several towns in the county, including Thurman, lack commercial mobile and broadband access.

As of the census of 2010, there were 1,219 people, 497 households, and 337 family households residing in Thurman. Thurman is therefore a typical example of a mountainous and remote town in rural US, for the town lies entirely inside the largest state-owned park in the U.S.

In addition, given the physical characteristics of the area, natural disasters are not out of the ordinary, making emergency responders within the community a key resource not only for addressing emergencies, but for providing information on emergencies and preparedness needs In particular, the area in which Thurman NY is located has high risks of flooding. According to residents and first responders, connectivity in Thurman NY and the surrounding rural areas is still a challenge, yet access to government information, including emergency preparedness and response, frequently relies on continuous and high quality Internet access.

To address the lack of commercial mobile and broadband access, Thurman recently secured a grant through the New York State (NYS) Broadband initiative which supported the deployment of a TV White Space (TVWS) wireless network. The network is town-owned and operated, and currently connects thirty households in Thurman. A hundred additional households fall in the current coverage area of the network. Beyond TVWS, satellite-based Internet could also be a good option, but in some rural areas the costs are high and it is not always reliable, particularly in mountainous regions and extreme weather.

This case of a rural community talks about addressing smart city components outlined in the technical, physical and social infrastructure through the lens of emergency management and preparedness. The Warren County Office of Emergency Services is usually the organization in charge of coordinating response efforts. The Warren County Emergency

Medical Services, the Town of Thurman Fire Company, and the Warren County Sheriff also play important roles during such events. Other national organizations are present during these events, in particular, the American Red Cross, and FEMA. Effective and efficient response requires that all these organization exchange information and that they keep citizens informed of the situation and of what actions they should be taking. In addition to limited connectivity, some of these actors are geographically dispersed, making the required information sharing difficult.

3.2. Data Collection and Analysis

We selected a case study approach, which is particularly useful to respond to questions related to why or how [36]. In addition, case studies show how particular practices are developed in specific organizations and, therefore, help refine theory [37]. Qualitative case studies also allow us to study the research questions in depth while leaving room for unexpected, interesting findings that can form the basis for specific hypotheses to be tested in future research [36, 38] This is particularly useful when there is little existing research on a topic [36] as is the case here.

To better understand the Town of Thurman's physical, political, and demographic characteristics the research team collected and analyzed documents from local government websites. With a general understanding of the situation, we then contacted a few key actors of the Town of Thurman's government. With their help, we started to recruit participants (first responders and residents). We then conducted two focus groups with first responders and two with residents. The first responder focus group included firefighters, emergency medical service, and the County Office of Emergency Management. All participants voluntarily joined the focus groups. The focus groups took between one and two hours and were conducted at the first responders' premises and the town hall of Thurman. They were recorded and transcribed.

The main themes covered in the focus groups included, but were not limited to, the use of information technology during emergency events, the sharing of information to prepare and respond to such events, as well as the information needs of both residents and other potential users. Participants talked about how they currently deal with the lack of reliable connectivity and the challenges they faced in terms of physical infrastructure in Thurman. The focus groups helped the research team gain a deeper understanding of the perspectives of residents toward innovation and technology adoption. They also provided critical information about how the technology, physical, and social infrastructures in the town could foster or hinder information sharing about emergencies.

4. Analysis and Results

In this section, we discuss the case of the Town of Thurman in terms of the three types of infrastructure and how each infrastructure is interrelated in enabling 'smartness'. Overall, it was apparent from the case of Thurman that the strength and cohesion of the existing social networks could potentially compensate for the lack or inadequacy of technological and physical infrastructures.

4.1. Technology Infrastructure

As noted above, Thurman lacks ubiquitous broadband connectivity. However, what was observed from the focus groups was that the lack of technology infrastructure is not always perceived as a negative. For instance, some participants described that they like being able to "escape" from being "constantly connected". As was expected, some participants do not work in the Town of Thurman, commuting to nearby cities for work. They saw their home in Thurman as an escape from being constantly connected, as they are when at work. Some participants saw the lack of technology infrastructure as a negative, particularly when it comes to having information on emergencies occurring in their community.

With sparse connectivity, some participants felt they didn't always know what was going on. Many participants expressed that even in cases where they do understand what is happening, such as flooding emergencies, they emphasized that their community includes visitor or tourist populations that often don't have deep knowledge of the risks of such events in Thurman and lack adequate information. When tourists visit the area, they run into "dead zones" and as a consequence, are unable to get information about what is happening in the community. Because they are transient, often in Thurman for the first time, they have not established alternative strategies for getting information under such conditions, nor are they often even aware they need them.

Beyond the lack of available broadband, the focus groups confirmed the research team's understanding about the demographics of rural areas. Many of the focus group participants discussed that the population in Thurman is an aging population where much of the younger generation is either in school or has moved away to attend other colleges/universities, often with no plan to move back to the area. In terms of mobile technology, we found a number of individuals who

actually use mobile applications, even when network connectivity is not always available. Some participants noted that not everyone in the community owns a smart phone or knows how to use one to its full potential. Even if the available infrastructure for connecting technology was available, the focus groups revealed that digital literacy was lacking for many residents.

4.2. Physical Infrastructure

The geographic landscape of Thurman, located in mountainous terrain, presents various challenges that are not necessarily present in urban areas. Like many rural areas, Thurman is not densely populated, and therefore much of the built environment is dispersed across the natural landscape. Moving around in the town is challenging in that while there are paved streets and proximity to an interstate, many residents of Thurman are connected by dirt roads. Focus group participants discussed the various challenges with Thurman's built environment, noting that much of the physical infrastructure is old and need repairs. This infrastructure includes dams, bridges and roadways. Participants discussed the impact of the weather on the built environment. For instance, ice jams during the winter can occur across the many rivers and streams within the Town and neighboring Towns across Warren County. Ice jams can cause issues with bridges, causing bridges to be out of service and to be damaged. During the spring, ice melt from the mountains can create flooding of rivers and streams that can take out bridges, roads and houses.

Experience has enabled year-round residents to deal with the challenges to the physical infrastructure. Residents in Thurman, for instance, have used their experience with flooding, power outages and wintery conditions to prepare. They know the landscape (various travel routes and road access), have backup generators and general knowledge of resources needed for different types of emergencies. For instance, one resident said "We all have wood because we heat with wood. We all have a generator, because we- who here doesn't have a generator, anybody? No, I have two generators so …we're pretty catered to already".

While many of the residents have experienced multiple flooding and ice jam emergencies, and typically know how to respond, weather has been changing rapidly over the past few years, creating greater amounts of rainfall and snowfall. These types of natural environment changes have made common emergencies more frequent, drastic and unpredictable.

4.3. Social Infrastructure

In Thurman, like many other rural areas, the average age of the population tends to be higher. In Thurman, the median age is 46 years and 20% of the population is 62 years of age and older [27]. Although the population is not as diverse or as large as seen in many urban areas, the social networks created within the Town are robust and important for day-to-day life. Though the population is dispersed across a wide geographic area, many of the people who live in Thurman year round know one another and rely on those social networks to get information. Many people interact with 10 or more other residents on a regular basis as part of their work, social events (such as a town hall meetings), shopping at local stores or school events.

While some residents in Thurman use social media as a means to get information, reliance on the social infrastructure among residents have proved important, particularly for emergency preparedness and response purposes. Focus group participants noted that they often rely on their neighbors and other locals they engage with on a regular basis to get updates on what is going on in the community, and to help in the event of an emergency. This is especially true when first responders are not always able to access residents due to unforeseen circumstances caused by natural disasters (e.g. destruction of roads or fallen trees) or, in the event of major disasters, first responder resources are spread thin and therefore, residents often provide aid to their neighbors. For instance, one first responder stated that "I will say that in this town we can take care of each other quite well, I think everybody checks on their neighbors. For the most part, we have a, I would say a pretty high elderly community. We do not have a lot of young people in this town and there runs a little problem too right? So maybe if you're elderly, you're not using social media...you are not connected."

Many participants described how they often commute within the Town and outside of it, socializing at local coffee spots, but also during Town Hall meetings and school events. These centers of social activities act as hubs of information where people who may live, often as much as a mile away from their neighbors, can get together with other residents or visitors to get information on what is happening in the community. Through the focus groups, we found the existence of tight social networks and a feeling that everyone knows everyone. Participants, for instance, described how many people play multiple roles in the community such as being a volunteer firefighter but also working for county agencies providing other types of services. Many of the people who live in this community are able to interact with others on a regular

basis because of the jobs they have and the volunteer positions they take on, such as being on the town board or school committees.

5. Discussion and Implications

From the case of Thurman, it is clear that there are links among physical, social and technology infrastructures. However, what was also evident is that weaknesses in one type of infrastructure can be, at least partially, compensated by strengths in another. For example, Thurman's strong social infrastructure appears to compensate for the lack of technology infrastructure and the challenges raised by physical infrastructure.

In urban areas, physical and technology infrastructures tend to be more complex and resilient than in rural communities, particularly in urban areas that are actively working with a smart city agenda. However, often urban areas have highly dense residential spaces, which can degrade social ties and encourage social exclusion [28]. Alternatively, the social infrastructure in rural communities, as was found in Thurman, tends to be more cohesive [28]. Rural social networks tend to be dense and family focused, and because of the sparse and dispersed nature of the populations, social contact is considered desirable, creating better conditions for interpersonal information exchange [28]. For rural areas, this means that the strength of the interpersonal relationships created across the population provide a better avenue for using a network model that focuses on community connectivity and mobility.

Rural communities, like Thurman, may have some limitations and face additional challenges when it comes to the physical and technology infrastructure when compared to urban areas. However, what they lack in those infrastructures, they make up through their social infrastructure. As was seen in Thurman, it appears to be the case that rural areas have advantages and strengths, like their resilient social network and local knowledge that can help foster new approaches to creating smartness.

Using the social infrastructure strengths that exist within rural communities may be a key to adapting broadband, cellular networks and other technologies to enable a better exchange of information and improve the quality of life. Such an approach can leverage the unique context and strengths a community has to offer to address limitations in other areas, like Thurman. Given this, there could be many different combinations of capabilities that could lead to new kinds and levels of smartness in different types of communities.

6. Conclusions

When looking at approaches to creating smart communities, much of the focus remains on urban communities. Innovations in technology, physical and social infrastructures, as well as research studies themselves, are often focused on the needs and challenges faced by cities. However, rural areas represent an important part of the U.S. economic, political and social systems. As was clear in the case of Thurman NY, even though the technical infrastructure is lacking, particularly around adequate internet access, rural communities and their social infrastructures could be useful to public managers and policy-makers dealing with smart community initiatives, particularly as they try to replicate them across communities for emergency preparedness.

It is important for researchers to understand how social, technical and physical infrastructures are used to enable smartness within the rural context. Although the majority of the existing literature on smartness focuses on the limitations and challenges that rural communities face, the case of Thurman NY shows how some communities have the potential to overcome some of those challenges posed by technical infrastructures, using their unique resources and capabilities within the existing social infrastructures.

In terms of future research in the area of emergency preparedness and response in rural communities, further case studies in rural areas focused on the physical, technology and social infrastructures that exist are needed. It is also important to understand how these infrastructures could be affected by privacy and security concerns in rural communities, and how those concerns are similar or different from their urban counterparts. Like cities, no two rural areas are the same. In order to understand how rural communities can take advantage of new and emerging technologies to become smarter, it is necessary to have a fuller understanding of the different challenges rural areas face, ways those communities are addressing those challenges, and how the strengths of their social networks can contribute to identifying new approaches to instituting information technologies and enabling smarter and connected communities.

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