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Angsana A. Techatassanasoontorn
Pennsylvania State University, University Park, angsanat@ist.psu.edu

Shuguang Suo
Pennsylvania State University, suoshuguang@gmail.com

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EXPLORING RISKS IN SMART CITY INFRASTRUCTURE PROJECTS: MUNICIPAL BROADBAND INITIATIVES

Angsana A. Techatassanasoontorn, College of Information Sciences and Technology, Pennsylvania State University, University Park, PA, USA, angsanat@ist.psu.edu

Shuguang Suo, College of Information Sciences and Technology, Pennsylvania State University, University Park, PA, USA, szs214@ist.psu.edu

Abstract

In recent years, cities are under increasing pressure to transform education, health care, transportation, civic engagement, public safety as well as other government services to maintain their competitiveness and improve citizen's quality of life. This transformation is known as "smart city" initiatives. Broadband network infrastructure is an important underlying infrastructure for smart city projects. This study investigates risks in municipal broadband projects led by local government. Our goal is to develop a middle range theory to explain risks and their interrelationships. We first used grounded theory to identify a set of risks from archival and interview data. Next, we used revealed causal mapping analysis to develop a model of risks and their linkages. Our results suggest five risk categories: socio-political risks, approval risks, financial risks, technical risks, and partnership and resource management risks. We also found that several risk categories are intertwined. In particular, socio-political risks have impacts on other risks. Therefore, risk management and risk mitigation strategies need to take a holistic view towards all risks and their interconnections instead of focusing on each type of risks in isolation.

Keywords: Risk, Smart City, IT Infrastructure, Broadband.

1 INTRODUCTION

"Just as the Internet has transformed our businesses and personal lives, it will now transform our cities and communities. Everything will be connected, from healthcare to education, government, buildings, physical security and much more — truly everything."

Wim Elfrink, Executive Vice President, Cisco Services & Chief Globalization Officer

Cities in the digital age are important actors in global economic and social development. Recently, cities are under increasing pressure to transform education, health care, transportation, civic engagement, public safety as well as other government services to maintain their competitiveness and improve citizen's quality of life. Such transformation is known as "smart city" initiatives. Around the world, leading cities are investing in smart city projects such as Sangdo's wired city initiative in Korea, King Abdullah Economic City in Saudi Arabia, or Ariel's smart city program in Israel.

Information and communication infrastructure particularly a broadband network is important underlying infrastructure for smart city's projects. A growing number of cities have taken a leading role in their broadband development (Gillett et al. 2004; Jain et al. 2007). These projects are often referred in the literature and in the popular press as "municipal broadband" or "municipal wireless" projects. The significance of municipal broadband projects in smart city initiatives warrants a fresh investigation of risks and challenges that are critical to the success of these projects. Unlike traditional information system (IS) projects in organizations, municipal broadband projects are complex from technological, political, and economic standpoints. For example, studies cited a project's scale and scope, the rapid evolution of technology, a diverse set of stakeholders, and sustainable business models among some of the key challenges in these projects (Hudson 2010; Mandviwalla et al. 2008; Techatassanasoontorn and Tapia 2007).

This study analyzes risks with the goal to develop a middle range theory to explain risks in the municipal broadband context. First, we used grounded theory and examined interview and archival data to classify risks. Second, we used revealed causal mapping analysis to develop a model of risks and their interrelationships. We then discuss important findings, contributions, and limitations.

2 LITERATURE

Three relevant literatures that support the development of our analysis are *risks in IS projects*, *risks in IT sourcing*, and *studies on municipal broadband initiatives*. The IS project risk literature offers a broader understanding of various risks in IS projects. Since municipal broadband projects require extensive public-private partnerships, the IT sourcing literature provides a perspective on risks involved in outsourcing relationships. Finally, the municipal broadband literature provides a contextual understanding of the process, key activities, and stakeholders in these projects.

2.1 Risks in IS Projects

According to various studies, organizational fit, skill mix, management structure and strategy, software system design, user involvement and training, technology plan, project management, and social commitment are critical risks in IS projects (Sumner 2003). Organizational fit refers to risks associated with organizational environment, including task complexity, the extent of changes, resource insufficiency and the magnitude of potential loss (Barki et al. 1993). Skill mix relates to a lack of expertise, such as application-specific knowledge, user experience, or development skills (Ewusi-Mensah 1997). Management structure and strategy risks include a lack of goal congruence and a lack of senior management commitment (Barki et al. 1993). User involvement and training could become significant risks when there is a lack of user commitment or ineffective communications (Block 1983).Risks in software system design may arise from a misunderstanding of or changes in requirements (Block 1983; Keil et al 1998). Risks associated with technology planning may include project scope, application complexity, and technology expertise (Ewusi-Mensah 1997). Time and budget overruns due to a lack of appropriate assessment and planning are some of the

common project management risks(Block 1983; Ewusi-Mensah 1997).Social commitment risks occur when there is a tendency to continuously invest resources into a failing project (Keil and Montealegre 2000).

2.2   Risks in IT Sourcing

Studies on IT sourcing risks have focused on risk categories, risk impacts, and risk mitigation strategies across different stages and different types of IT sourcing contexts. Currie and Willcocks (1998) investigated the rationales behind four types of IT sourcing decisions—total sourcing, joint venture/strategic alliance sourcing, multiple-supplier sourcing, and in-sourcing. They argued that each IT sourcing model is closely aligned with organizational risk sharing practices. Beulen et al. (2005) examined thirteen types of risks in offshore outsourcing and found different risk profiles of application development and infrastructure management projects in terms of their strength and impact. Aubert et al. (1998) used agency theory and transaction costs theory to explore undesirable consequences of IT sourcing and identified risk factors in the literature. We postulate that, among the risk factors they outlined, impact commitment, a lack of experience and expertise, contract management, asset specification, and technology discontinuity are factors that may also exist in municipal broadband projects. From a risk mitigation perspective, Willcocks and Lacity (1999) suggested that risks in IT sourcing can largely be mitigated by "careful delineation of outsourcing type and scope, strong vendor selection criteria and processes, detailed relevant contract terms, retained capabilities and management processes, and close vendor-client partnering" (p.178). We believe that some of their risk mitigation strategies may be applicable to municipal broadband projects as well when there are partnerships involved.

2.3   Studies on Municipal Broadband Initiatives

Municipal broadband research has examined a number of issues including governments' involvement rationales (Gillett et al. 2004; Lai and Brewer 2006), policy and legislation issues (Bar and Park 2006; Tapia et al. 2006), business models (Gillett et al. 2004; Mandviwalla et al. 2008), to name a few. Although most studies did not explicitly study risks, they identified risks as critical to an understanding of outcomes of municipal broadband projects. Balhoff and Rowe (2005) argued that technology choices, investment costs, and competitive bundling increase broadband projects' risks in both the private sector and government-owned operations. Drawing on their observations of risks, Balhoff and Rowe (2005) contended that cities should pay attention to financial factors associated with broadband initiatives. These factors include capital expenditures, operating costs, customer demand, and technology upgrading costs. Lehr et al. (2006) stressed the importance of a flexible strategy that can adapt to changing technology and market needs. Tapia et al. (2006) pointed out that a requirement that a city needs to seek an approval from a state agency will prolong the process and thus increase the political risk for a municipal broadband project. Techatassanasoontorn and Tapia (2007) emphasized the role of learning processes in municipal broadband projects. In particular, they concluded that the dynamics of technology development, partnership commitment, political dynamics, and the limitation of external knowledge and the role of learning-by-doing shape learning processes and project outcomes. In their comprehensive study of Philadelphia broadband project, Jain et al. (2007)identified six drivers and five inhibitors of municipal broadband projects. These drivers are technology availability, market opportunity, historical precedent and policy imperative, reuse of available assets, legislative approval and social economic potential. The inhibitors are technology risks, role of government, potential government incompetence, legislative environment and response from incumbent players.

Despite some findings on risks in municipal broadband projects, it should be noted that most studies focus on a narrow set of risks that are pertinent to their studies. Also, very little is known about the interrelationships among these risks throughout broadband development process. In this study, we first extended the municipal broadband framework outlined in Mandviwalla et al. (2008). We introduced the fourth stage – network maintenance and management in addition to the first three stages in their article –goal identification, infrastructure and funding design, and network

implementation. Building on this extended framework, we offer a model to understand risks across the lifespan of a municipal broadband project.

3   METHODS

3.1   Data Collection

Interviews. Since our research goal is to develop a middle range theory for a previously unexplained domain of risks in municipal broadband projects, it is important to use a diverse set of experts to fully capture various risks. Following this guideline, we conducted interviews from October 2009 to February 2010 with three groups of experts: public policy experts, telecom consultants, and government officers. Contact information of potential informants was obtained from three sources: *Muniwireless and Muni WiMAX group on Linkedin, government websites,* and *referrals from the respondents*. Only those whose jobs were or are closely related to municipal broadband projects are selected. To date, six experts were interviewed: one policy expert, one government officer and four telecom consultants. The policy expert serves on a committee of a state wireless association. The government officer is a city's CIO who has been directly involved in a municipal wireless project for four years. All four telecom consultants have experiences of advising at least one municipal wireless project. We used open interview techniques with probes. Interview questions address the current situation of municipal broadband industry, various types of risks, antecedents and consequences of risks, risk rating, and interconnections among risks. Each interview lasted from 35 to 65 minutes. The interviews were transcribed to a 29-page document.

Archival Data. We searched the ABI/INFORM database using the keywords "municipal wireless risk" or "municipal broadband risk" to identify relevant articles. The search result reported 123 articles published during 2005-2009. After eliminating industry news and articles with no available full text, we retained 49 articles for coding.

3.2   Data Analysis

This study uses two qualitative methods to develop a model of risks in municipal broadband projects. We used grounded theory (Glaser and Strauss 1967) to identify a set of risks from archival and interview data. We then used revealed causal mapping analysis (Nelson et al. 2000) to develop a model of risks and their linkages.

Grounded Theory.   Archival and interview data were coded using multiple content analysis procedures. Coding was performed in *NVivo*, a widely used qualitative data analysis software. First, we used constant comparative analysis (Glaser and Strauss 1967) to identify concepts that arise from data, to document their properties, and to catalogue recurrent themes by observing the similarities and differences. Second, we completed axial coding to identify the context where a theme is embedded and the conditions that give rise to it (Strauss and Corbin 1990).

Causal Mapping. We used revealed causal mapping analysis to identify causal relationships among the risks in the interview data. A revealed causal map is "the network of causal relations embedded in an individual's explicit statements" (Nelson et al. 2000, p. 481). We followed the rigorous causal mapping analysis procedure outlined in Nelson et al. (2000). First, we identified causal statements in the interview transcripts. Second, we constructed raw causal maps for six respondents using causes and effects from the causal statements identified in the previous step. Third, we use the risk classification from our content analysis to develop concept level and construct level revealed causal maps. Concepts are roughly equivalent to second-order constructs in path analysis models. Fourth, we developed an aggregated causal map by combining revealed causal maps of all respondents. Adjacency and reachability matrices were calculated to capture direct and indirect causal linkages. Fifth, we used the results from reachability matrix to identify the strength of causal relationships in the aggregated construct level map. We refer the reader to Fahey and Narayanan (1989), Nelson et al. (2000), and Riemenschneider et al. (2006) for detailed procedures and examples of studies that used causal mapping methods.

3.3 Trustworthiness of the Study

Trustworthiness in qualitative research is established by attending to four criteria: credibility, transferability, dependability, and confirmability (Lincoln and Guba 1985). We took several steps to satisfy these criteria in our study. First, two sources of data were used to ensure internal consistency or credibility. Note that we intentionally recruited respondents who have different employment backgrounds in order to increase the credibility of our findings. Second, to establish transferability, we developed rich details of first-order analysis so that others can evaluate the plausibility and generalizability of our findings to other settings. Third, to satisfy the dependability criterion, data coding, content analysis, and causal mapping analysis were independently performed by two authors. Any disagreements of coding were resolved through discussion. The concept of interrater reliability, which has been widely used in quantitative research, is not appropriate because qualitative research assumes that each researcher has a unique interpretation of findings (Lincoln and Guba 1985). Fourth, to guarantee that confirmability is met, we invited two independent auditors to conduct an inquiry audit. These auditors examined the inquiry process, data and findings to make sure that our interpretation is reasonable and is supported by the data.

4 RESULTS

We first discuss the results of the classification of risks from content analysis. Next, we discuss the model of risks and their linkages from causal mapping analysis.

4.1 Classifications of Risks in Municipal Broadband Initiatives

We found five types of risks in municipal broadband projects. These risks are socio-political risks, approval risks, financial risks, technical risks, and partnership and resource management risks (See Table 1). Due to space limitation, a table with first-order themes, second-order concepts, and textual evidence from interview and archival data is available from the authors by request.

Risk	Definition
Socio-political risks	Possibilities of hazards in the form of regulations, policy, social power, and other social and political forces
Approval risks	Possibilities of hazards that prevent a city to receive a formal permission or sanction to start or make progress in a municipal broadband project
Financial risks	Possibilities of fund-related hazards in building and operating a municipal broadband network
Technical risks	Possibilities of hazards associated with technology selection and implementation
Partnership and Resource Management Risks	Possibilities of hazards regarding multiple stakeholders, partnerships, asset ownerships, human resources, marketing, and network performance

Table 1.   Definitions of the Risks

Socio-political Risks

Municipal broadband projects are subject to a number of social and political risks. These risks are in the form of regulations, policy, and other social and political forces. Six archival documents have addressed the fact that state legislatures are often pressured by telephone and cable companies to pass bills to prohibit taxpayer-funded municipal networks. Philadelphia and Austin, for example, are among those cities that have to engage on a long battle with legislatures to build their municipal broadband networks. In addition, municipal broadband projects are subject to prescribed terms or conditions when cities apply for $4.7 billion stimulus money from the federal government. In the first round of the broadband stimulus program, the government restricted the funding to mostly rural and under-served areas. Also, these projects are required to have several broader social and political objectives such as addressing the digital divide, enhancing public safety, increasing broadband access at local libraries or schools for educational purposes.

The oppositions of a municipal broadband network not only come from external forces such as incumbent operators, but also sometimes from inside the government itself. For example, a city often cited the use of video surveillance to increase public safety as a strong reason for creating a municipal broadband network. Ironically, vocal opponents of video surveillance are police officers. The reason behind their objections is detailed in one respondent's comments:

"Because the policemen don't like to change their routine. They are creatures of habits. They like to follow the same old routine that they have been following for decades. No. 2, they are afraid that the network will replace them. They are afraid that it is the overall strategy of the whole police department to cut down their hours, to decrease the number of police officers. But in fact, the opposite is true, when you have better and better surveillance, you have better and better evidence that the police officers need to follow up. Instead of not needing officers, you need better trained officers when you start installing wireless video surveillance."

4.1.1   Approval Risks

Approval risks are those risks that prevent a city to receive a formal permission or sanction to start or make progress in a municipal broadband project. Approval risks are manifested through, for example, a lack of a good business plan, a lack of good feasibility analyses, and a failure to meet deployment requirements.

A good business plan is important to the success of municipal broadband projects. One respondent commented:

" … if you don't have a good plan on how they are going to make revenue, the network will still fail". On the flip side, "*if you do have a good business plan, you have created your expectation and you know what you need to raise, the capital you need to raise and your chances of success are much greater than you don't have a good business plan*".

A lack of appropriate feasibility analyses may also put the project at risk. A feasibility analysis, if done well, should provide answers to the questions: who the users are going to be, what is the demand level, what the potential options are, what the economic climate looks like, what is a realistic perception of the coverage based on available technologies and budget, and is the technology vendor qualified to build a network. A number of failed municipal broadband projects are in part because technology vendors do not have the ability to implement a network. One respondent commented:

"If those communities had better analysis of the vendors, they wouldn't have taken those vendors because it was very clear to the people that the vendor doesn't have the ability to deliver what it was they needed."

A failure to meet deployment requirements may prevent a project to gain approval in the first place. Some of these deployment requirements may include specific objectives, deadlines to complete network deployment, and other technical requirements.

4.1.2   Financial Risks

Financial risks relate to funding problems that may jeopardize project existence and success. One of the financial risks is a lack of initial funding to build a network. One respondent commented:

"You don't get your project off the ground, if you cannot raise the money".

The second financial risk is associated with failure to generate enough revenue to support network operation. The problem is that a city only secures enough money to build a network without setting aside additional money to support the network in the operational phase. One respondent commented:

"Whether the government runs it, or private sector, or a combination of these two, you have to generate enough money to make it work, and this is one of my big criticism about the broadband stimulus program because the stimulus program is designed to take out some of the risks which is the cost of building the network."

The third financial risk is associated with a lack of money to replace or upgrade equipments. Cities that fail to prepare their budget to upgrade the system will soon find that their municipal networks are unable to provide satisfactory services and to compete with other alternatives offered by private sectors. With the outdated technology, the city will lose customers and fail to generate enough revenue. This in turn exacerbates the financial risk. Eventually the project may fail.

Another financial risk deals with unpredictable implementation costs. Our archival data suggest that *"independent analyses and prevailing market prices for network and construction costs make clear that the real costs could range anywhere from $30 million to $100 million for a feasible network."* These costs would be much greater for big cities that require greater network coverage. Unpredictable implementation costs can increase the risk of budget overrun.

4.1.3   Technical Risks

Technical risks are risks associated with technology selection and implementation. We identified three types of technical risks: geographical obstacles of network coverage, discontinued technology, and a questionable technology choice. Geographical obstacles can become a major problem when cities want to provide indoor coverage in a flat area with heavy trees, or when cities want to use wireless broadband technology to provide Internet services in a rural area with sparse population or in a hilly area.

Discontinued technology often occurs when a network equipment vendor is out of business, leaving a city with discontinued and eventually outdated equipment. A wrong technology choice can manifest in several ways such as the inability for a chosen technology to support users' needs or a lack of scalability or technology upgrade to support increased bandwidth demand, wider area coverage or future services. One respondent commented:

"There is really going to have a problem in terms of not building the right technology. If the government is the builder of the network, the government runs the risk of building the wrong technology because they don't know or don't understand the needs. The private sector runs the risk of building the wrong network because they only can build what they have to sell."

4.1.4   Partnership and Resource Management Risks

Partnership and resource management risks are those risks that deal with multiple stakeholders, partnerships, asset ownerships, human resources, marketing, and network performance. Municipal broadband projects often involve multiple stakeholders who may have conflicting goals and interests. Mandviwalla et al. (2008) reported that at least 13 diverse stakeholders involved in the Wireless Philadelphia project ranging from state and city government, community residents, businesses, telecoms and ISPs, to public schools and higher educational institutions. Our archival data suggests that cities have to carefully *"rationalize the competing versions and maintain public interest while simultaneously staying current with technological developments"*.

We also found that maintaining a working partnership is critical to successful network deployment and operation. One respondent used an example to illustrate how a partnership may be at risk when partners have conflicting goals:

"The city doesn't care about making profit, but they want to make enough to pay the network operation. But the private sector does care about the subscription fee because they've got to make a profit, pay the shareholders, so on and so forth. If they can't reconcile these kinds of business issues, then the network is in danger."

Cities often do not have appropriate human resources and expertise to implement and maintain a large scaled municipal broadband network. As a result, their projects are vulnerable to a number of problems and pitfalls that can otherwise be foreseen and resolved with adequate human resources and expertise. Infrastructure ownership and operational rights affect whether or to what extent a city can deliver network services. In some cases, a city owns the facilities such as backhaul, antenna, electric poles or street lights. In other cases, a city may own the necessary facilities but it cannot use them

because the city has a long-term contract that gives the exclusive usage rights to a cable company. This point is supported by the following comments:

"If you try to do a municipal WiFi deployment, the city does not own the power lines or street poles and you get the final stage of doing implementation and you want to install radios, now what, you get a serious problem."

A low number of subscribers and low service quality are two additional risk factors identified from the data. A low number of subscribers may lead a private company to terminate its partnership with a city and a suspension of network services.

4.2   A Model of Risks and their Linkages in Municipal Broadband Initiatives

4.2.1   A Revealed Causal Map

Following the reveal causal mapping analysis procedure described earlier, we developed an aggregated revealed causal map by combining the individual revealed causal maps of six respondents. To understand causal linkages among risks, we first developed the adjacency matrix to capture direct causal linkages (See Table 2). The values in the matrix reflect a percentage of total linkage between two constructs (Ford and Hegarty 1984). To capture both direct and indirect causal linkages, we next developed the reachability matrix (See Table 3). This matrix considers the cumulative direct and indirect effects of a construct on all other constructs. As suggested in Riemenschneider et al. (2006), we retained only those reachability values of 0.04 or above in our causal model. A higher reachability value indicates that there are more direct and indirect paths between two constructs, suggesting a stronger cause-effect relationship. Figure 1 presents an aggregated revealed causal map of municipal broadband risks.

	A	B	C	D	E
A. Approval risks	-	-	-	-	-
B. Socio-political risks	0.188	-	0.104	0.083	0.063
C. Financial risks	0.042	-	-	0.021	-
D. Technical risks	-	-	0.146	-	0.083
E. Partnership and resource management risks	0.083	0.104	0.083	-	-

Table 2.   Aggregated Adjacency Matrix

	A	B	C	D	E
A. Approval risks	-	-	-	-	-
B. Socio-political risks	**.200**	.008	**.123**	**.084**	**.073**
C. Financial risks	**.044**	.002	.002	.021	-
D. Technical risks	.015	.009	**.154**	-	**.087**
E. Partnership and resource management risks	**.108**	**.105**	**.096**	.009	.009

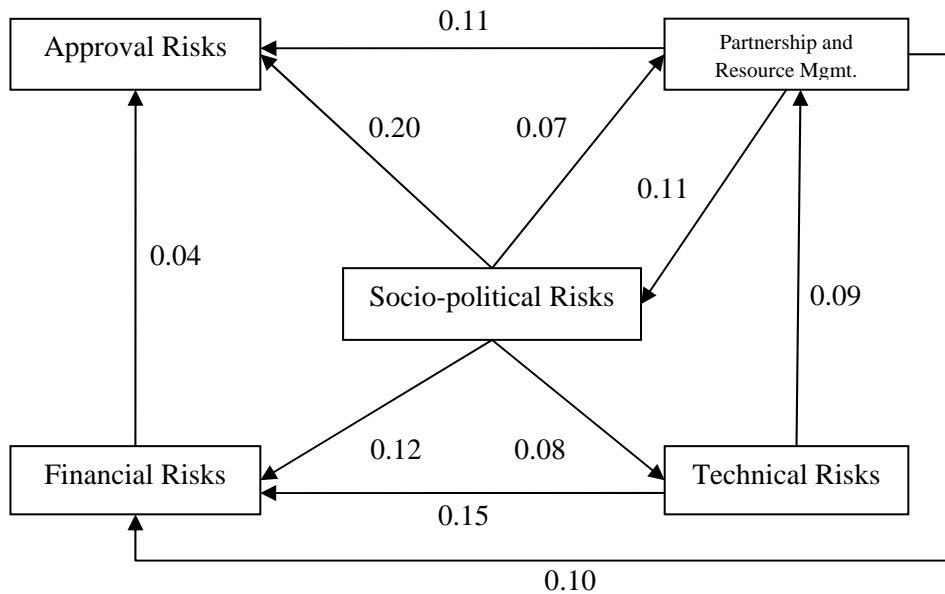*Table 3.   Aggregated Reachability Matrix*

Figure 1.   Aggregated Constructed Level Revealed Causal Map

4.2.2   *Analysis of Key Causal Linkages*

Next, we discuss the causal relationships among five risk categories. Note that approval risks do not have an impact on other risks. Instead, they are affected by other risks.

Socio-political Risks. Our results clearly suggest that socio-political risks have significant impacts on other risk categories. For instance, socio-political risks have the highest impact on approval risks. One respondent supported this relationship: "*If the city is going to run the network, they may have the great risk of the project no getting started. You have to get the political support, get voted city councils or counties. You have to get these approval supports.*"

Socio-political risks can trigger financial risks in several ways. For example, customer expectations at the beginning of a project determine the cost to maintain a network. In addition, the process to obtain funding for municipal broadband projects is highly political. Socio-political factors also have an impact on partnership and resource management risks through changes in a politician's plan. One respondent stated: "*Any time a mayor backs muni Wi-Fi, the guy who is going to run against him is not going to back it. If he wins, he has got to shut it down.*"

Socio-political risks also play a role in technical risks in terms of technology selection and a scale of network. One respondent commented: "*If they didn't put sufficient system in the first place, because they chose the most politically expedite role they are going to award, chances are the system will fail commercially and there will not be a chance they can overlay or upgrade effectively, meaning that it will be abandoned.*"

Financial Risks. Financial risks have an impact on approval risks: "*Even though the community says this is the fiber what they need, the city may not be willing to spend that money. That brings back to that your project will never get off the ground.*" In some cases, financial risks have an impact on technical risks when funding to upgrade the system is not available: "*When you planned a city Wi-Fi network, you also need a plan for future budget. You have to replace your equipment. There is a risk associated with that, like where will the money come from?*"

Technical Risks. Technical risks have an impact on financial risks. Three scenarios in which technical risks can trigger financial risks have been identified. The first is related to revenue generation: "*You cannot generate enough revenue if you don't build the right network.*" The second

is about unrealistic technical objectives of network deployment: *"We have a large county, 400 square miles, we are looking for a proposal to provide one mega bit connectivity across 90% of that county. It is predominantly rural, fairly hilly, heavily tree environment. They didn't have a clue what they are looking for. They tried to meet the requirement. They told them, look, we can do that, but it is going to be so expensive."* The third relates to uncertainty in technology development. One archival document argued: *"There will be waste of the taxpayers' money on projects that fail or in using public money that might be more productively used in other civic needs. This risk is exacerbated by the nascent state of wireless broadband technologies, which are changing much faster than the technologies underpinning traditional municipal services, e.g. water, electricity and waste management."*

Technical risks have an impact on partnership and resource management risks in terms of user subscription, network performance, and a city's ability to bring in new customers. The following three comments support these impacts: (1) *"If we would not increase our bandwidth, we would see an aggregation of customers and they would move on to some other service provider."*, (2)*"In a fully mesh network, they kick off the path back to the haul. If it wasn't built to that robustness, you may have three, four, five radios that are now down because they don't have alternative back path to the haul. So the design will impact your management."*, and (3)*"In a market environment, you have to have available capacity to bring on new customers. Or else you are running into a situation, you are going to be turning your customers away."*

Partnership and Resource Management Risks. Partnership and resource management risks have an impact on approval risks, socio-political risks, and financial risks. Approval risks are increased if cities do not have appropriate human resources or a strong working partnership: *"Chicago couldn't reach an agreement with service providers after offering free use of street lamps for radio transmitters in exchange for a network built, owned and operated by providers at no cost to the city."*

Partnership and resource management risks can have an impact on socio-political risks when network performance is not acceptable to customers: *"If the network performance is not good, the customers go to somebody else. In our case, they may talk to a council member. In this town the citizen is kin so they start to complain with the council member and we hear about it right away. So there is a political risk involved."*

Partnership and resource management risks can also trigger financial risks through a low number of subscribers. If a city does not appropriately market the network, or they do not provide good customer services, or they do not set up the right price, the network will not make money, and it will subsequently fail.

4.2.3   *Non-causal interconnections*

Our analysis also reveals additional complexity of municipal broadband risks that were not revealed through our causal mapping analysis. For example, managing network growth and network capacity can be a significant challenge. On the one hand, a city wants to grow its subscriber base in order to generate enough revenue to support network operation. On the other hand, if the network does not have the slack capacity to bring in more customers, this will lead to unacceptable network performance. Unhappy customers may decide to switch to a different service: *"What happened if the network is wildly successful, but then it doesn't have enough capacity to be able to provide reasonable level of service. You have either limited number of subscribers or else you have to sacrifice the quality of service."*

5   DISCUSSION AND CONCLUSION

This study represents a first step to classify risks and identify their complex relationships in municipal broadband projects. It contributes to the literature in several ways. First, this research extends the risk literature in traditional IS/IT projects by studying project risks in a new research context. Our research settings are large-scaled broadband infrastructure projects that include a number of stakeholders who may have conflicting interests and goals. Our finding is consistent with previous literature (Hirschheim et al 1991; Newman and Robey 1992) that socio-political risks play an important role in

IT projects. However, we found that socio-political risks in municipal broadband projects are much more complex than political risks in user-analyst relationships in other IT projects. Second, our study provides a useful analysis approach and schema to classify risks across the lifespan of municipal broadband projects. Third, this research develops a revealed causal map to discover causal relationships among risk categories. The findings suggest that municipal broadband projects are heavily politically oriented and most risks are intertwined. In particular, our findings suggest that risk management and risk mitigation strategies need to take a holistic view towards all risks instead of focusing on each type of risks in isolation.

A few limitations should be acknowledged. First, we have a relatively small number of interview respondents. We address this limitation by collecting archival data to ensure that we did not miss any important risks and contextual details. Second, since the respondents have diverse backgrounds, some may give more weights to certain risks than others. Third, the goal of this study is to develop a middle range theory of risks in a municipal broadband context. The high-level of risk categories may not offer contextual details and specific insights. We believe that future studies may want to consider using other qualitative approaches such as an in-depth case study to offer more refined analysis and findings.

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