ARTICLES

External Factors in Using GIS Tools for City Management - Case Study: Riyadh, Saudi Arabia

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Abstract:

GIS helps in visualizing and analyzing information that can help a user to monitor projects, make decisions, and develop solutions. Government agencies also use GIS to perform and manage many functions. In addition, GIS data can be shared between government agencies and departments. The scope of this study focused on government organizations inside Riyadh. The main objective was to study the effect of using GIS in city projects. Two different methods were used. First, GIS users and managers were interviewed, and information was collected regarding the usage of the GIS in their departments, then factors that affect city project management's use of GIS are identified. Second, the collected data was subsequently used to build an employee survey that included department heads, IT employees, and engineers. The results showed no statistically significant relationships between the success percentage of recently completed projects and sharing data or hiring GIS consulting expertise. However, a statistically significant relationship was found between the success percentage of recently completed projects and GIS training. The study recommends that the municipality and government sectors should provide appropriate GIS training for people working in city projects to upgrade the level of their work.

1. Introduction

Geographic information system (GIS) is increasingly used in government, business, and personal work. This technology is used in many types of work, such as urban planning, market analysis, environmental analysis, health care, and so forth (Overman, 2010).

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GIS helps in visualizing and analyzing information that can help the user monitor projects, make decisions, and develop solutions. For example, in 2003, the Oregon Department of Transportation used GIS in many projects to plan and manage its work. One of those projects was creating plans for repairing 400 bridges. Members of the Oregon Department of Transportation collected environmental data around bridge sites. Using GIS technology, they drew a box around each of the bridge sites and identified all the necessary resources of the project inside the box. By using information gathered around the sites, the engineers designed the work for this large project (DeMeritt, 2012).

Global interest is growing in regard to GIS in government and business sectors (Overman, 2010). In 2003, the King County Geographic Information Systems Center in the state of Washington contacted the analysis team of Richard Zerbe and Associates to perform a study about the development and use of GIS within county agencies. The results of the Zerbe's study showed that GIS technology remained a beneficial investment for King County agencies where "the use of GIS has produced approximately $775 million in net benefits over the 18-year period from 1992 to 2010" (Babinski, et al., 2012, p. 1).

The objective of this research is to study the relationship between usage of GIS tools and some external factors. The scope of this study focused on government organizations inside Riyadh. It is a case study of two organizations which use GIS to manage a city project: Riyadh Municipality and the Riyadh Development Authority.

2. Literature Reviews

GIS can be used in management, including asset and real-estate management. For instance, the computerized maintenance management system can provide useful information to "design an approach for managing public assets that leverages the investment local governments continue to make in GIS and provides a common framework for sharing useful data from disparate systems" (ESRI, 2011 para. x). It can be seen that GIS provides flexible tools to perform and manage many functions for government agencies. Moreover, GIS

data can also be shared between government agencies and departments (Abdulaal, 2009).

GIS can also create flow information from one stage to the next stage in many city projects, such as transportation asset management, with many different applications. In 2002, the Program and Organizational Performance Division of John A. Volpe National Transportation Systems Research, which is part of the U.S. Department of Transportation's Innovative Technology Administration, stated that some agencies used GIS for geospatial analysis. Some of these applications include:

- Location-based data queries;
- Statistical analysis of two or more data sets for a geographic area;
- Comparing project alternatives based on defined spatial criteria or temporal data;
- Asset optimization and cross-asset optimization; and
- Asset data collection, inspection, and maintenance (U.S. Department of Transportation, 2012, pp. 5-6).

After using these applications, Volpe came up with some beneficial results, including easy sharing of data, more accessible data, data entry, proactive asset management, support projects, monitoring, and information decision-making.

City projects can utilize GIS in many stages of construction such as planning, scheduling, monitoring, and execution (Bansal, 2016). The construction planning can be expressed as a bridge between idea and execution, (Laufer et al., 1993). Using GIS as tools in the project construction planning stage was suggested by Bansal (2016). Based on his review and examination of the last 25 years' articles related to GIS in construction planning stage, potential application areas of GIS in construction planning stage and uses of BIM as platforms, BIM\CAD functions, and third-party software, Bansal revealed that using "tools and techniques in preconstruction planning stage has a significant effect on the project duration, cost, and quality" (Bansal, 2016, p. 6).

Zîvkovic' and Dordevic (2016) built a GIS (called INSPIRE) to include data management and standards of spatial information. They used two proposed models: one to take care of the metadata and types

of urban plans and one to respond to classification of data and type. These models helped them to understand different types of data from different sources in the city. This approach is expected to help decision-makers to create requirements for future sustainable land development in the city of Èaèak, Serbia. In addition, GIS can be used to evaluate urban land, as in Alemie et al. (2015) who used a sociospatial methodology by applying GIS tools and functions to evaluate government urban lands.

However, the requirements in managing and administrating a local government or municipality have changed over the last few years. Traditional tools cannot help the increases and changes of those complex needs, especially those from the last two previous decades. Jornea et al. (2017) used GIS as tools and solutions for efficient administration of Hundoara County. The authors presented a GIS model to be used in management of the Hundoara County Council. This model supports decision-making through accessing information and providing updated data to the local Hundoara County administration.

In Saudi Arabia, Abdulaal (2009) studied the framework for GIS enterprise in Saudi municipalities. He found that IT applications including GIS are limited in use in municipality departments and cannot help a municipality in decision-making. Abdulaal believed that building a framework that is suitable for the Saudi municipalities should consider GIS as a major IT requirement. He used interview methods with heads of the Jeddah municipality in 2004 to gather data required for the application of the proposed GIS framework. Three factors were considered: business functions, tasks, and data requirements. The results indicated that these three factors were critical in building a GIS framework for the municipality. Also, the results showed that other issues regarding GIS data sources, sharing data, and managing data authority should be considered.

For any project that needs to work with GIS tools, we may utilize a GIS specialist to manage the project, who has the ability to lead a project to success. Sugarbaker (1999) stated that, in a small organiza-

tion, "the GIS manager may serve as project manager and assign tasks to staff as needed to complete work" (pp. 116).

As can be seen from previous studies, GIS can be applied to project management to perform many tasks such as sharing information, monitoring sites, planning projects in a city, and so forth. In this study, the researcher aims to: (1) find the effect of using GIS in city projects and (2) find the gap between government organizations regarding GIS usage.

3.1. Statement of the Problem

The relationship between the utilization of GIS tools and city project management has not been explored. Certain factors may affect the use of GIS tools to provide a city project's management based on employees' perspective.

3.2. Identify Factors

Based on the relevant literature and from the interviews, three factors that may affect the use of GIS to manage a city's project were identified, viz. sharing data, hiring GIS consultants, and training employees to use GIS. We called these factors "external factors", which were used in the survey that was sent to the study population.

3.3. Research Questions

The following questions helped inform the research and resolve the problem identified above.

RQ 1: What relationships, if any, exist between the degree of utilization of GIS tools by government organizations and each of the three identified external factors (sharing data, hiring experts GIS consultant, training current employees to GIS)?

RQ 2: What differences, if any, exist between Riyadh Municipality and the Riyadh Development Authority in the frequency of usage of external GIS factors to manage city projects?

3.4. Research Hypotheses

H1 (null hypothesis): There is no significant relationship between the use of GIS tools to successfully manage city projects and sharing GIS data.

H2: There is no significant relationship between the use of GIS tools to successfully manage city projects and hiring GIS experts.

H3: There is no significant relationship between the use of GIS tools to successfully manage city projects and train current employees.

H4: There are no significant differences between respondents from Riyadh Municipality and the Riyadh Development Authority regarding the frequency of usage of each of the external GIS factors.

3.5. Limitation and Delimitation

This study focused on the organization that manages government projects (namely Riyadh Municipality and the Riyadh Development Authority) inside Riyadh, which may employ GIS tools.

3.6. Assumptions

It was assumed that the three external factors identified from the literature review and interviews would have an effect on managing GIS for city projects. Also, it was assumed that the respondents in the survey would provide accurate data.

4. Methodology

4.1. Study method

Interviews and a survey can be used as a methodology to assess the effect GIS has on agencies' output (Zerbe, 2012). In this research, descriptive methodology was used to collect data from employees. First was interviewing GIS users and managers in the two main agencies in Riyadh to identify and collect information on departments that use GIS. The results helped us to identify the number of departments that use GIS and the most important external factors that may affect delivering best management using GIS. Then, the results were used to build an employee survey, which includes heads of departments, IT employees, and engineers.

This survey questionnaire provided information on using GIS in the current work. The usage of GIS in city projects was used as a dependent variable, and the external factors (data sharing with other

agency, experts GIS, trained current employee) as independent variables.

4.2. Study Population

This study focused on government sectors that may have to manage projects in Riyadh. Two main agencies that were found after the interview (Riyadh Municipality and the Riyadh Development Authority) lead project management in the city. Also, from the interviews, we identified the population size, which is equal to the number of departments that use GIS in projects inside Riyadh. The interview results show that 17 departments use GIS in the Riyadh Development Authority, with 81 employees, and five departments in Riyadh Municipality, with 53 employees.

The results also reveal that only 22 departments use GIS. Because the number is small, the researcher decided to interview all employees to represent the population. Thus, 134 surveys were sent to the target population.

4.3. Data Collection

Data was collected through surveys, and then entered via Qualtrics. A questionnaire was distributed to the entire target population. Out of the 134 surveys, we received 84 surveys, two of which were incomplete. A total of 82 returned surveys were used, which means the return rate was 61%. All of the completed surveys were analyzed using the Statistical Package for the Social Sciences (SPSS), Version 24 for Windows.

5.Data Analysis and Results

Any survey in which the question of using GIS had been answered was considered a completed survey. For the Likert-scale questions, the researcher used Cronbach's alpha coefficients to measure internal consistency. The Cronbach's alpha 0.7 is the lowest value to be accepted for internal consistency (Tavakol, 2011). In this research, the results indicated an acceptable level of internal consistency (as shown in Table 1). The standard deviations were computed to find the data type, which showed as non-normal distribution in this research.

Table (1)
Reliability Analysis

Number of Cases	Excluded	Valid	Number of Items	Cronbach's Alpha
83	6	77	13	0.734

4.1. Organization Characteristics of the Sample

A total of 37.3 responses came from the Riyadh Development Authority and 62.7% from Riyadh Municipality. With regard to education level, 73.5% have an undergraduate degree; 24.1% have a graduate degree (master's and PhD), and only 2.4% have a high school degree (Table 2). Moreover, as shown in Table 3, the respondents' job position level featured general manager 3.6%; department manager 8.4%; project manager 27.7%; engineer and GIS analysis 30.1%; consultant 9.6%; and other 4.8%, including secretarial, accounting, and financial jobs. As shown below, these results represent middle management positions (project management and engineer/GIS analysis).

Table (2)
Demographic Characteristics of the Sample for Level of Education

		Responses	
		Frequency	**Valid Percent**
Valid	High School	2	2.4
	Undergraduate	61	73.5
	Master's	16	19.3
	PhD	4	4.8
	Total	**83**	**100.0**

Table (3)
Demographic Characteristics of the Sample for Level of Position

		Responses	
		Frequency	Valid Percent
Valid	General Manager	3	3.6
	Department Manager	7	8.4
	Project Manager	23	27.7
	Engineer»/GIS Analysis	25	30.1
	Consultant	8	9.6
	Others	17	20.5
	Total	**83**	**100.0**

Table 4 shows the percentage of the total number of employees (one response is missing); thus, a total of 82 were completed for this questionnaire. The survey results showed that 11% of the total respondents came from small departments with five employees or less. Also, 37.8% of the total respondents came from departments with five to 10 employees, 23.2% medium-size departments with 11 to 20 employees, and 28% with 20 or more employees.

Table (4)
Demographic Characteristics of the Sample for Number of Employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5	9	10.8	11.0	11.0
	Between (5-10)	31	37.3	37.8	48.8
	Between (11-20)	19	22.9	23.2	72.0
	More than 20	23	27.7	28.0	100.0
	Total	**82**	**98.8**	**100.0**	
Missing	System	1	1.2		
	Total	**83**	**100.0**		

Regarding experience in using GIS, Table 5 shows that 15.7% of the total respondents had experience between two to three years, 15.7% had experience between three to five years, and 43.3% had more than five years' experience. In addition, the survey results in Table 6 show that more than 84.7% had average, good, and excellent knowledge of using GIS to manage city projects. The high-rank score of these two questions indicates that these samples can represent the purpose of this research (see Tables 5 and 6 for more details).

Table (5)
Demographic Characteristics of the Sample for Personal GIS Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	21	25.3	25.3	25.3
	2-3 years	13	15.7	15.7	41.0
	2-5 years	13	15.7	15.7	56.6
	More than 5 years	36	43.4	43.4	100.0
	Total	**83**	**100.0**	**100.0**	

Table (6)
Demographic Characteristics of the Sample for GIS knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	5	6.0	6.0	6.0
	Poor	8	9.6	9.6	15.7
	Good	29	34.9	34.9	50.6
	Very Good	16	19.3	19.3	69.9
	Excellent	25	30.1	30.1	100.0
	Total	**83**	**100.0**	**100.0**	

4.2. Project Success

Regarding this question, a total of 82 surveys were completed and

used (one response is missing). Three (3.7%) respondents reported that recently completed projects were unsuccessful with 50% and less; 32 (38.6%) respondents reported a medium success rate between (51% to 89%), and 47 (56.6%) respondents reported total success of such projects (Table 7).

Table (7)
Success Percentage of Recent Completed Project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 50%	3	3.6	3.7	3.7
	Between 51%-89%	32	38.6	39.0	42.7
	Between 90%-100%	47	56.6	57.3	100.0
	Total	82	98.8	100.0	
Missing	System	1	1.2		
	Total	83	100.0		

With regard to using GIS, as shown in Table 8, out of the 83 respondents, 63 (75.9%) stated that they had used GIS in at least one stage of the recently completed project, and 20 (24.1%) said they had not used GIS in any stage of the recently completed project.

Table (8)
Using GIS in any Stage of Recently Completed Project

		Frequency	Percent	Cumulative Percent
Valid	Yes	63	75.9	75.9
	No	20	24.1	85.5
	Total	**83**	**100.0**	

Eighty-three of the respondents reported that the external factors (Tables 9, 10, and 11) may affect project success. Concerning sharing data to complete any stage in the recently completed project, 47 (56.6%) shared data, while 36 (43.4%) did not. Regarding training

courses, 55 (66.3) had training courses, while 28 (33.7%) did not. As for hiring consultants, 58 (69.9%) reported that they had hired a GIS consultant, while only 25 (30.1%) had not.

Table (9)
Sharing GIS Data in any Stage of Recently Completed Project

		Frequency	Percent	Cumulative Percent
Valid	Yes	47	56.6	56.6
	No	36	43.4	100.0
	Total	**83**	**100.0**	

Table (10)
Training Course During or Before Recently Completed Project

		Frequency	Percent	Cumulative Percent
Valid	Yes	55	66.3	66.3
	No	28	33.7	100.0
	Total	**83**	**100.0**	

Table (11)
Hiring Consultant for Recently Completed Project

		Frequency	Percent	Cumulative Percent
Valid	Yes	58	69.9	69.9
	No	25	30.1	100.0
	Total	**83**	**100.0**	

4.3. Hypotheses Testing

Before testing the hypotheses, we need to check if the study sample, which comes from two organizations, is from two different populations (Riyadh Municipality and the Riyadh Development Authority) regarding project success. By using a chi-square test, the results show no significant

difference between the two populations with respect to percentage of success in recently completed projects, as shown in Tables 12 and 13, where (χ^2 (2) = 5.149, p =. 076).

Table (12)
Cross Tabulation

		Success Percentage of Recently Completed Projects			Total
		Less than 50%	Between 51%-89%	Between 90%-100%	
What is your current organization?	Riyadh Municipality	0	16	14	30
	High Commission for Riyadh Development	3	16	33	52
Total	**3**	**32**	**47**	**82**	

Table (13)
Chi-Square Test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.149	2	.076
N of Valid Cases	82		

Based on this finding, we can consider that the respondents came from one population regarding success level.

The following section is a review of the null hypotheses. Regarding the first three hypotheses, a chi-square test was used because the data considered two variables: one categorical and one dichotomous (Leedy & Ormrod, 2010, p. 282). A chi-square test of independence helps researchers to determine whether two or more variables are independent or related to others (Cunningham & Aldrich, 2012, p. 202).

H1 (Null Hypothesis): There is no significant relationship between the use of GIS tools in successfully managing city projects and sharing GIS data.

After using the cross tabulation to find the subject's chi-square test, the researcher found no statistically significant relationship between the success percentage of the recently completed project and sharing data in any phase of the recent project. This result (see Tables 14 and 15) failed to reject the null hypothesis because it (χ^2 (2) = 4.182, p = .124) did not meet the p-value of less than or equal to 0.05.

Table (14)
Cross Tabulation Null Hypothesis 1

Count		What Is the Percentage of Success for the Recent Completed Project?			Total
		Less Than 50%	Between 51%-89%	Between 90%-100%	
Did you share GIS data to complete any phase of the last completed project	Yes	0	19	28	47
	No	3	13	19	35
Total	**3**	**32**	**47**	**82**	

Table (15)
Chi-Square Test for Null Hypothesis 1

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.182	2	.124
N of Valid Cases	82		

H2: There is no significant relationship between the use of GIS tools in successfully managing city projects and hiring GIS consultants.

No statistically significant relationship was found between the success percentage of the recently complete project and hiring GIS

consultants. By using cross tabulation to find a subject's chi-square test, the result (Tables 16 and 17) failed to reject the null hypothesis because it (χ^2 (2) = 1.948; p = . 378) did not meet a p-value of less than or equal to 0.05.

Table (16)
Cross Tabulation Null Hypothesis 2

Count		Which Factors Specify the Percentage of the Last Completed Project?			Total
		Less Than 50%	Between 51%-89%	Between 90%-100%	
Have you hired a GIS consultant in any phase in the last completed project?	Yes	1	23	33	57
	No	2	9	14	25
Total		3	32	47	82

Table (17)
Chi-Square Test for Null Hypothesis 2

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.948	2	.378
N of Valid Cases	82		

H3: There is no significant relationship between the use of GIS tools in successfully managing city projects and training current employees.

A statistically significant relationship was found between the success percentage of the recently completed project and GIS training. This result (see Tables 18 and 19) rejects the null hypothesis because it (χ^2 (2) = 5.655; p = .050) meets the p-value equal to 0.05.

Table (18)
Cross Tabulation Null Hypothesis 3

Count		Which Factors Specify the Percentage of the Last Completed Project?			Total
		Less Than 50%	Between 51%-89%	Between 90%-100%	
Did you have GIS training course?	Yes	1	26	28	55
	No	2	6	19	27
Total		3	32	47	82

Table (19)
Chi-Square Test for Null Hypothesis 3

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.655	2	.050
N of Valid Cases	82		

H4: There are no significant differences between respondents from (Riyadh Municipality and the Riyadh Development Authority) regarding the frequency of usage of each of the external GIS factors.

In this null hypothesis, a total of 80 participants completed the question. However, this kind of question has a ranking level that deals with the level of usage of each of the external GIS factors between Riyadh Municipality and the Riyadh Development Authority. The Mann-Whitney U-test can provide statistical evidence that two different sample populations are significantly different (Cunningham & Aldrich, 2012). For this null hypothesis, the frequency of using external GIS factors is the dependent variable, and the two organizations, which, as mentioned above, are the independent variables.

Results of the Mann-Whitney U-test reveal no statistically significant difference between the two organizations regarding the frequency usage of each of the three external GIS factors. The analysis

failed to reject the null hypotheses for the three external GIS factors (Table 23).

It can be said that the scores of sharing data in the Riyadh Development Authority (mean rank = 40) are close to the scores of sharing data in Riyadh Municipality (mean rank = 41.33), U = 725.5; z = -0.261; p = .794) (Table 20). Also, the scores of hiring a consultant in the Riyadh Development Authority (mean rank = 42.49) are close to the scores of sharing data in Riyadh Municipality (mean rank = 37.18), U = 650.500; z = -1.031; p = .303) (Table 21). Similarly, the scores of GIS training in the Riyadh Development Authority (mean rank = 39.98) are close to the scores of sharing data in Riyadh Municipality (mean rank = 41.37), U = 724; z = -.270; p = .788), as shown in Table 22.

Table (20)
Mann-Whitney U-test for Sharing Data in the Arriyadh Municipality versus the Riyadh Development Authority

	Arriyadh Municipality	**the Riyadh Development Authority**
N	30	50
Mean Rank	41.33	40
Sum of Ranks	1240	2000
Mann-Whitney U-test	725.000	
Wilcoxon W	2000.000	
Z	-.261	
Asymp. Sig. (2-tailed)	.794	

Table (21)
Mann-Whitney U-test for Hired Consultants in Arriyadh Municipality versus the Riyadh Development Authority

	Arriyadh Municipality	the Riyadh Development Authority
N	30	50
Mean Rank	37.18	42.49
Sum of Ranks	115.50	2124.50
Mann-Whitney U-test	650.500	
Wilcoxon W	1115.500	
Z	-1.031	
Asymp. Sig. (2-tailed)	.303	

Table (22)
Mann-Whitney U-test for GIS Training in Arriyadh Municipality versus the Riyadh Development Authority

	Arriyadh Municipality	the Riyadh Development Authority
N	30	50
Mean Rank	41.37	39.98
Sum of Ranks	1241	1999
Mann-Whitney U	724.000	
Wilcoxon W	1999.000	
Z	-.270	
Asymp. Sig. (2-tailed)	.788	

Table (23)
Mann-Whitney U-Test of Null Hypotheses 4_{1-3}

Null Hypothesis	Statistical Significance	Decision
Distribution of sharing data in any phase of projects is the same between Arriyadh Municipality and the Riyadh Development Authority	.794	Retain the null hypothesis
Distribution of sharing data in any phase of projects is the same between Arriyadh Municipality and the Riyadh Development Authority	.303	Retain the null hypothesis
Distribution of sharing data in any phase of projects is the same between Arriyadh Municipality and the Riyadh Development Authority	.788	Retain the null hypothesis

6. SUMMARY, DISCUSSION, AND RECOMMENDATIONS

This study focused on three external factors that could affect delivering GIS projects to manage cities in government sectors. Descriptive methodology was used to collect data from employees by interviewing GIS users and managers in the two main agencies before a survey questionnaire was distributed to gather information regarding the effect of the assumed external factors on the GIS project. Instrument reliability was 0.73, which is significantly above the recommended minimum acceptable reliability value of 0.7. Based on the survey results, the researcher can answer and discuss the following questions.

6.1. Answer to Research Question 1

RQ 1: What relationships, if any, exist between the degree of utilization of GIS tools by government organizations and each of the three identified external factors (sharing data, hiring GIS consultants, GIS training for current employees)?

The first three null hypotheses address this question. As mentioned in the results section, based on the perceptions of the respondents, there was no significant relationship between the use of GIS tools in successful management of city projects and sharing GIS

data (Null Hypothesis 1). Also, there was no significant relationship between the success percentage of the recently completed project and hiring GIS consultants (Null Hypothesis 2).

The findings for Hypotheses 1 and 2 were not consistent with results from other research studies. Others mention that sharing data is important to save time and deliver projects for less cost (U.S. Department of Transportation, 2012; Abdulaal, 2009). Exchanging data and experiences with other organizations and departments resulted in a high cooperation level, which helped to reduce some of the project's expenditure and increase productivity levels (Abdulaal, 2009; Zerbe, 2012). Moreover, sharing GIS information and data reduced redundant data sets for municipal GIS (Alterkawi, 2005). Another study ensures that removing or breaking the barriers that keep out departments or organizations from sharing GIS data is important in order to have a new maturity and effective GIS model (Tomaselli, 2004). Other studies covered the importance of hiring GIS consultants. For example, some studies indicate that using consultants and hiring qualified GIS are important in having a GIS maturity model (Tomaselli, 2004). Consultants are important for any projects, especially in the start phase. Al-waraqi and Zahary argue "Consultants are very important starting from an early phase, especially for beginner manager and big projects" (Al-waraqi & Zahary, 2012, pp. 60). Other researchers focus on the human aspects of GIS expertise in building GIS models (O'Flaherty, et al., 2005). But GIS skills may not be enough to deliver successful projects to government organizations. Another study mentions that project management skills are important in avoiding serious errors, communicating with team members, passing barriers, etc. (Richman, 2002). Thus, we can say that having project management skills with GIS skills help to deliver successful projects. The results of previous research (U.S. Department of Transportation, 2012; Abdulaal, 2009; Alterkawi, 2005; Tomaselli, 2004; O'Flaherty, et al., 2005; Richman, 2002; Zerbe, 2012; Al-waraqi & Zahary, 2012) were expected in this study, but the findings of this study did not support the expectations.

The expectations of this study vary for different reasons:

- Different project size may affect the results;
- GIS project managers may not have skills in both GIS and project management (Richman, 2002);
- Some barriers keep out departments from sharing GIS data (Tomaselli, 2004);
- Isolated projects that fail to be completed and only completed projects are considered, which may affect the final results.

On other hand, the third null hypotheses found a statistically significant relationship between success percentage of the recently completed project and having GIS training courses. For many GIS users, practical training is the preferred method to learn and develop skills (Meaden & Aguilar-Manjarrez, 2013). Other researchers found that knowledge and training factors influenced the planning department staff in Kuala Lumper City by effective use of GIS (Ramzi & Hussain, 2011). Based on previous studies (Meaden & Aguilar-Manjarrez, 2013; Ramzi & Hussain, 2011) and the significance level in the research results (Null Hypotheses 3), the researcher confirms that training could improve the success level and deliver government projects within time, within budget, and with high quality.

6.2. Answer to Research Question 2

RQ2: What differences, if any, exist between the Riyadh Municipality and the Riyadh Development Authority in frequency of usage of external GIS factors to manage city projects?

Null Hypotheses 4 has three sub-hypotheses, which helped to address Research Question 2 (Table 23). The results shown in Tables 20, 21, and 22 indicate that he external factors used by Riyadh Municipality use (sharing data, hiring GIS consultants, and GIS training) and are the same as those of the Riyadh Development Authority. The results showed that there was no difference between the two organizations with regard to using external GIS factors. The mean rank in both organizations is similar for all three factors. This finding supports the previous result, as shown in Tables 12 and 13, regarding success level, which means that the respondents came from a single population. The researcher emphasizes that all respondents came from

a single population regarding the use of GIS tools for city projects. These findings for Hypothesis 4 are a good indication for future studies to consider these two organizations as a single population in using GIS tools to manage city projects.

6.3. Limitations and Suggestions for Future Studies

To understand the context of this research and to ensure that future studies can be directed carefully, several items are discussed, as follows:

- The population selected for this study was limited to the Kingdom of Saudi Arabia government sectors in Riyadh. Because there is a need to vary project techniques based on size and requirements, it may be useful to narrow down the projects' type (Urban projects, streets and highways projects, building and constructions projects, etc.) in future research efforts.
- Because the focus of this study was on the two main government organizations in Riyadh, future research may focus on one organization such as the Riyadh Development Authority.
- The research methodology used for this study was descriptive. It is suggested that future studies should consider an experimental methodology. An experimental study could help future researchers to draw cause and effect conclusions.

6.4. Conclusion

Geographic information technology has penetrated many fields, including project management, where GIS tools are used to manage project tasks and processes. As noted, the results indicated that GIS training could improve the success level of city projects. Also, training can be considered as a factor that affects GIS project management. The methodology used in this research can also be used for other factors that may affect the output of a city's project management.

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