



Optimal Design Cost of Sewer Network

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

مَا تَعْلَمُونَ

صَدَقَ اللَّهُ الْعَظِيمَ

Dedication

I dedicate this work to my country, Jordan

I dedicate this thesis to my lovely family

I dedicate this work, first and foremost, to all

**The people who contributed towards the success of this
thesis.**

**In addition, I would like to thank all people who help and
supported me during the duration of my research.**

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Nisrein Al-Nizami

May 2018

Authorization Form

I, Nisrein H. Al-Nizami, authorized Isra University to supply copies of my thesis to libraries or establishments or individuals on request, according to the Isra University regulations.

Signature:

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Committee Decision

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Table of Contents

<i>Item</i>	<i>Title</i>	<i>Page</i>
	Dedication	I
	Acknowledgement	Ii
	Authorization Form	Iii
	Committee Decision	Iv
	Abstract	Viii
<i>Chapter One: Introduction</i>		
	Introduction	1
	The Research Objective	3
	Methodology	3
	Chapters of Present Work	4
<i>Chapter Two: Literature Review</i>		
	Introduction	5
	Introduction to optimization using linear programming	6
	Integer Linear Programming	8
	Solving Methodology of ILP Problems	10
	The Wastewater Collection Systems	11
	Pipes and network design consideration	17
	The Study Area	20

	Other Factors Affecting Design Consideration	24
	Cost Of Sewer System	31
	Previous Studies	32
<i>Chapter Three: Methodology</i>		
	Introduction	36
	Research Procedure	36
	Mathmatical Model	38
	Design Consideration	39
	Cost Calculation	42
	Cost Estimation	50
	Model Formulation	51
<i>Chapter Four: Results and Discussion</i>		
	Introduction	57
	The result of mathematical model	57
	Problem Oriented Sensitivity Analysis Run	61
<i>Chapter Five: Conclusions and Recommendations</i>		
	Conclusions	68
	Recommendations	69
	Future Studies	70

List of Tables

Title	Page
Table 2.1 : Objective function and constrains of three types of ILP	9
Table 2.2 : Advantage and disadvantage of the combined sewerage	13
Table 2.3 :Advantages and disadvantages of the separate sewer system	14
Table 2.4: Advantages and disadvantages of conventional gravity sewer systems	15
Table 2.5: Advantage and disadvantage of vacuum sewer system	17
Table 2.6: Coefficient of the materials of sewer pipes	19
Table 2.7: Average rainfall (mm)	23
Table 2.8: Population of Jerash municipalities	24
Table 2.9: Advantages and Disadvantages of pipe material	25
Table 2.10: Photos of Pipe Material	27
Table 2.11: Elevation of municipality center	29
Table 2.12: Elevation of Midpoint routes between municipalities	30
Table 3.1: Areas that winQSB have modulus	38
Table 3.2: Main advantages and disadvantage of winQSB	39
Table 3.3 : Peak factors for different population	40
Table 3.4 : Recommended slope for minimum velocity	41
Table 3.5 : Flow rate for Jerash municipalities	41
Table 3.6 : Diameter of pipe and length of routes	42
Table 3.7: Description and defination of constants included in model formulation	49
Table 3.8: Total cost of sewer network	50

Table 4.1: Calculated variable cost for different pipeline alternatives	58
Table 4.2: Calculated fixed cost of suggested sewer network	59
Table 4.3: Total cost of suggested sewer network	60
Table 4.4: Fixed, variable and total cost of optimum sewer network	60
Table 4.5: The increment of population	59
Table 4.6: The decrement t in population.	62
Table 4.7 : Change in flow rate by influence of population change	63
Table 4.8: Fixed, variable and total cost in decrements of population case	63
Table 4.9: Fixed, variable and total cost in decrements of population case	64
Table 4.10: The decrement in cost in 20% percentage	65
Table 4.11: The increment in cost in 20% percentage	66

List of Figures

Title	Page
Figure 2.1: Hierarchy of optimization levels	7
Figure 2.2: Types of sewer systems	12
Figure 2.3 Combined sewer system	13
Figure 2.4: Separate sewer system	14
Figure 2.5: Vacuum sewer system	17
Figure 2.6 :Location of Jerash city in Jordan	24

Figure 2.8: Climate graph Jerash	26
Figure 2.9: Difference of elevation in selected arc 2,4 in suggested network	36
Figure 3.1 : Flow chart of research methodology	37
Figure 3.2: Schematic layout of a regional wastewater pipeline and treatment plant system	55
Figure 4.1: Sewer system routs obtained from present study	53
Figure 4.2: Variable and variable cost for suggested sewer network	59

Abstract

Many countries such as Jordan are suffering from the problem of funding for infrastructure projects. This problem is very clear, especially, for the wastewater sewers and water pipes systems construction. The population of Jordan increased from five million in 2003 to ten million in 2017. Besides, the migration waves resulted in an increase in the population number in a short period of time. Under these circumstances Jordan must develop techniques and planes to build more efficient infrastructure projects. This issue was in focus by many governmental agencies, scientific workers, and engineers in order to find a successful methodology that take into consideration the high construction costs for sewerage systems. Therefore, this study is written to partially solve this problem and to find the optimum route of sewer system in cities. Jerash governorate is chosen as a case study because this city suffers from poor performance of the sewerage system. Finally, the total cost of the optimum system is calculated.

In this study, the optimization methods is used to determine the optimal cost of sewer network that covers five municipalities of Jerash governorate. The integer linear programming is employed to developed and solve mathematical model equations with the helpful of using computer programs of WinQSB and MS-EXCEL program.

The results showed that using optimization method is an efficient tool to find the optimum routes of sewer network system. The optimum routes of sewer systems is presented taking nto account the topography, population, fixed and variable costs. The total cost of the optimum route was found to be equal to (41,405,538) US\$ US\$ which

means a reduction equal to 44%. The model is very efficient, as shown by sensitivity analysis in chapter four. The increase and decrease of the population values have the negligible effects on the calculation of total cost. This study could be adopted by the authorities responsible for the design of sewerage systems in Jordan. ALSO, it is expected that the results of the present work can contribute to optimize an integral model for optimizing a total regional wastewater treatment plants.

الخلاصة

الكثير من الدول ومن بينها الأردن تعاني من قلة التمويل لمشاريع البنية التحتية. إذ تظهر هذه المشكلة بوضوح خاصة في مشاريع الصرف الصحي ولمشاريع مد خطوط المياه, حيث أن عدد السكان تزايد في الأردن من خمسة ملايين عام 2003 إلى عشرة ملايين عام 2017, بسبب الزيادة الطبيعية بالإضافة إلى حركة الهجرة المفاجئة في وقت قياسي, وأصبح لزاماً على الأردن كسائر الدول وضع خطط وتطوير تقنيات لبناء مشاريع بنية تحتية فعالة من خلال الجهات الحكومية المهمة, والقطاع الهندسي والقطاع العامل في مشاريع البنية التحتية للحصول على منهجية واضحة تأخذ بعين الاعتبار التكلفة المرتفعة لمشاريع البنية التحتية, لذلك قدّم هذا البحث لتقديم حل جزئي لمشكلة الصرف الصحي ولإيجاد الشبكة التصميم الأمثل والتكلفة المثلى لشبكة المياه في منطقة جرش, حيث أن منطقة جرش تعاني من سوء عام في تنفيذ مشاريع البنية التحتية, وفي نهاية الدراسة تم حساب الكلفة الإجمالية للشبكة المثلى.

في هذه الدراسة تم استعمال تقنيات التحسين الرياضية لتحديد الكلفة المثلى لشبكة صرف صحي تغطي مدينة جرش بأكملها, حيث أنها مقسمة جغرافياً إلى خمس بلديات, حيث تمّ توفير تقنية برمجة الأعداد الصحيحة لبناء وحل معادلات النموذج الرياضي, بالإضافة إلى استعمال برنامج WinQSB وبرنامج MS-EXCEL.

وبينت نتائج البحث أن استخدام تقنيات التحسين الرياضية فعّالة لإيجاد الشبكة المثلى لشبكات الصرف الصحي, وبعد هذا تمّ إيجاد الشبكة المثلى مع الأخذ بالحسبان طوبوغرافياً مدينة جرش, وعدد سكان كل بلدية من البلديات الخمس والكلفة الثابتة والمتغيرة, بعد هذا تم إيجاد الكلفة الكلية للشبكة المثلى وكانت تساوي US\$ (41,405,538) حيث تم تخفيض الكلفة الكلية بنسبة تصل إلى 44% من الكلفة الكلية للشبكة المقترحة مما يثبت فعالية الدراسة, وهذا ما يتضح جلياً في الفصل الرابع في جزء تحليل الحساسية, إذ أن الشبكة تحافظ على نسبة ارتفاع كلفتها وانخفاضها نسبياً عند تغيير المعاملات الأساسية في النموذج الرياضي من الكلف وعدد السكان, مما يشجع الجهات الحكومية من وزارة المياه والري ووزارة الأشغال اعتماد هذا النوع من الدراسات كأداة تصميمية إدارية لتغطية منطقة جرش وجميع مناطق المملكة بشبكات الصرف الصحي بالتكلفة المثلى.