

**WORKBOOK**

# **THE RIGHT DECISION**

**Evidence-based Decision Making for Government Professionals**



**Paul Maxim, Len Garis, Darryl Plecas, Mona Davies,  
Yalda Asadian, Tammy Britton, Ron Gill and Trent Hatfield**



For more information about this book or its authors, contact Len Garis at the University of the Fraser Valley, B.C., at [len.garis@ufv.ca](mailto:len.garis@ufv.ca) or 604-543-6701. For additional public safety publications, please visit <http://cjr.ufv.ca>

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Ron Gill has a Master's degree in Planning from the University of Waterloo. He is a full member of both the Planning Institute of British Columbia (PIBC) and the Canadian Institute of Planners (CIP) and is a Registered Professional Planner (RPP). Ron is currently a section manager for the North Surrey Area Planning & Development team at the City of Surrey.

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Trent Hatfield has a Bachelor of Applied Science in Natural Systems and Wildlife Management from the University of Queensland. Building on environmental management expertise gained in the private sector, he has more than a decade of developing and running programs for municipalities. Joining the City of Surrey in 2006, he has developed and managed the City's Erosion and Sediment Control program, which received several awards, including the UBCM Community Excellence Award in 2014 for Operational Best Practice. As a founding member and continuing president of the Erosion and Sediment Control Association of British Columbia, he looks forward to increased engagement between provincial municipalities and training providers.





## About this Workbook

This workbook is designed to be used in conjunction with the text, *The Right Decision: Evidence-based Decision Making for Government Professionals*. It can be used as a self-study guide or in either a classroom or workshop setting. While many of the techniques outlined in the text can be used very effectively by an individual working with a paper and pencil or a laptop, many are best implemented in a group setting. Environmental scans and SWOT (strengths, weaknesses, opportunities and threats) analyses are good examples of this.

Each section of this workbook starts with a review of the relevant material in *The Right Decision*. A number of exercises are then outlined.

We have also provided accompanying examples drawn from the field as starting points.

To get the most out of the exercises, however, we would suggest you choose an issue or example within your own organization. Using material with which you are most familiar makes the exercises much more relevant. It also helps to illustrate the strengths and limitations of the techniques outlined in the text. The procedures we present are not meant to make decisions for you but, instead, to help you make better informed decisions. Using the procedures we outline will also provide you with an evidence-based rationale for justifying the choices you make.

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This project was commissioned by the City of Surrey, British Columbia, as part of its Emerging Leaders Program, which seeks to develop high performing individuals through education, workplace experience, and mentorship. An integral component of the program is the application of newly developed skills through real business projects. This edition of *The Right Decision: Evidence-based Decision Making* manual and workbook is an important project outcome that benefits the City, the participants, and all municipal staff who will gain from its application. Other partners include the University of the Fraser Valley, B.C.



This project was adapted from *The Right Decision: Evidence-based Decision Making for Fire Service Professionals* manual and workbook developed through the support of the Canadian Safety and Security Program, led by Defence Research and Development Canada's Centre for Security Science, in partnership with Public Safety Canada.

# Forward

Government employees, whether they work for municipal, provincial or federal governments, are key to providing effective and efficient services to residents of our cities, provinces and country. This is true both for those on the front lines providing assistance to the general public, and for those who work behind the scenes, helping to develop sound policies and effective programs under the leadership of elected officials. Government service workers—civil servants—are a key part of sound government. These are people who are tasked with making government and their policies work: with helping to refine the structures of civil programs and ensuring that they are implemented as planned.

Government service workers, both as employees and as citizens, have a vested interest in ensuring government programs meet the needs they were designed to address. Typically, government employees are accountable to both the public and their political leaders. Those in managerial positions are particularly responsible for ensuring that priorities are met, and that programs are doing what they are supposed to do, and in a cost-effective manner. While this states the obvious, in practice this can be a difficult task to assess thoroughly.

The only firm way of thoroughly measuring our effectiveness and efficiency is to examine our programs and services by measuring the outcomes of our programs and policies.

In other words, what evidence do we have that we are doing the right things in the right ways? One framework for assessing this is evidence-based decision making. This strategy brings together a series of techniques under a basic approach that uses hard evidence (often in the form of data), to measure our success. Evidence-based decision making is a transparent tool that helps us become more effective in our decision making in developing, nurturing and maintaining government programs.

This workbook is designed to complement *The Right Decision: Evidence-based Decision Making for Government Professionals*. It includes concrete case studies from the City of Surrey and other sources that will help the reader put in perspective the theories elaborated. By becoming familiar with the general approach and the techniques presented here, I think you will find that your decision making will become more effective. Data-driven, or evidence-based approaches, are also more effective ways of justifying what we are doing. By looking at objective indicators, civil servants, politicians and the public have a firmer basis for assessing the worth of our policies and programs and ensuring the public gets the best value for our efforts and their tax dollars.



Vincent Lalonde, M. Sc., P. Eng  
City Manager, City of Surrey



# Defining the Problem

## Introduction

The objective of this chapter is to provide you with a basic guide and some tools to design a framework for decision making—such as constructing a strategic plan.

Effective evidence-based decision making is tightly linked to an organization's plan.

## Why is Evidence-based Decision Making so Important?

Evidence-based decision making uses the best available information generated through research, experiments and observation, and other factual sources, to influence the best possible decisions and policies. It takes a systematic and rational approach to researching and analysing available evidence to inform the policy making process.

Evidence based decision making:

- Helps ensure policies are responding to the real needs of the organization or community which, in turn, can lead to better outcomes for the population in the long term.

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A good plan will allow you to clarify what issues are relevant and what options are available for you to consider. It will help identify what evidence you will need to consider in weighing those options.

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- Can highlight the urgency of an issue or problem which requires immediate attention. This is important in securing funding and resources for the policy to be developed, implemented and maintained.
- Enables information sharing among other members of the public sector with regard to what policies have or have not worked. This can enhance the decision making process.
- Can reduce government expenditures which may otherwise be directed into ineffective policies or programs that could be costly and time consuming.

## Quick Review

Not all decisions are alike, and you will need to work through a formal process to identify whether the issue is something that is of value to your department.

Key points to consider:

- What is the issue? Can you propose a clear definition of the problem?
- Identify the options and alternatives.
- Generate new ideas—think creatively.
- How can we generate alternatives?

## What is the Issue?

The issue should be connected to the goals or mandate of the department or organization to ensure that the choices you are considering are consistent with these goals.

The mandate is usually part of the department's or organization's strategic plan or standard operating procedures (SOPs).

## Generating Ideas

Accept the fact that you will need to overcome your prejudices, and be willing to be open to new perspectives.

- Talk to people outside your normal circles—this helps get around a “group-think” mentality.
- Engage in group brainstorming sessions.
- Read widely, especially books and journals outside your area of interest; surf the web.
- Focus on your clients—in this case the general public.
- Hire a reputable consultant—consultants can be a valuable resource and can play a big role in helping you shape your organization's strategy and goals.

## Developing a Framework for a Strategic Plan

A strategic plan communicates the organization's goals, the actions needed to achieve those goals, and all of the other critical elements developed during the planning exercise.

Developing an effective strategic planning process is an important part of creating future excellence within your department or organization. It will provide you with guidance and direction to help your department excel, rather than simply responding to changes after they have occurred.

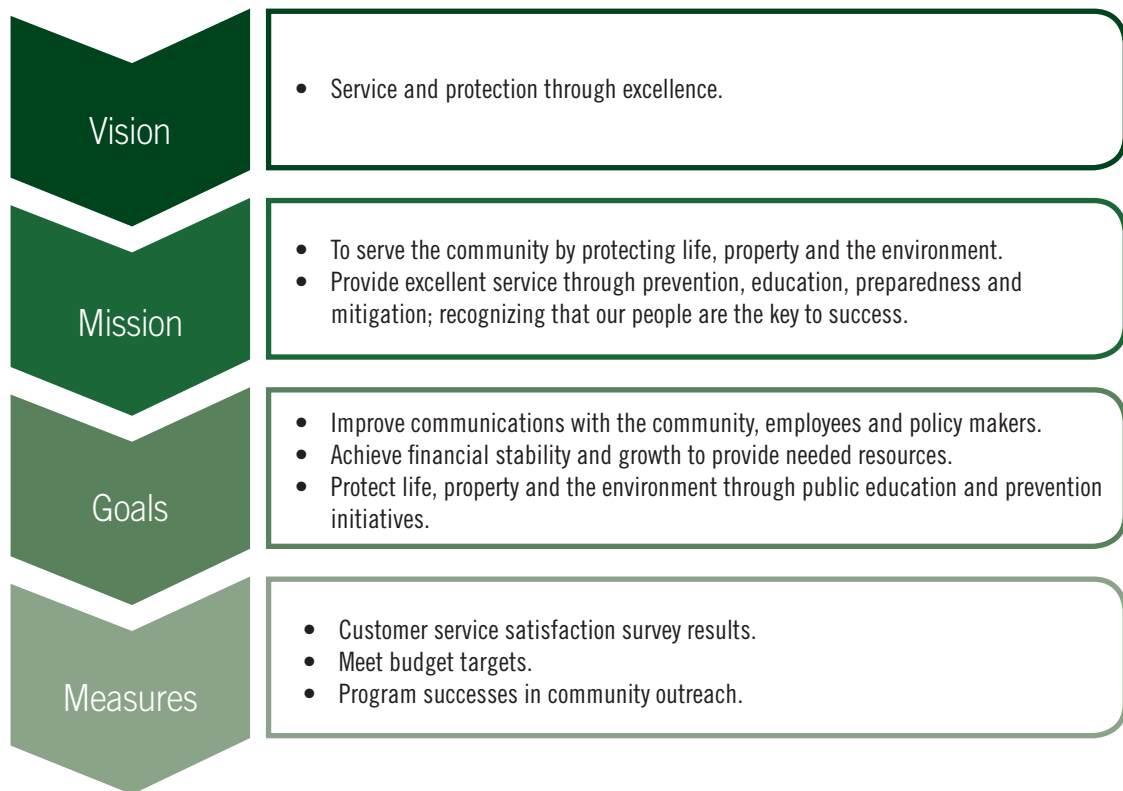
A plan should consist of the following elements:

- **Vision and mission statement:** a general statement of your department's or organization's values. It is essentially what your department or organization aspires to achieve. Mission statements are similar to vision statements, but they are more concrete. They are more "action-oriented" than vision statements. For example, your mission might be to develop a safe and healthy neighbourhood through collaborative planning, community action, and policy advocacy.
- **Objectives:** how much of what will be accomplished, and by when. These should be measurable results or outcomes.
- **Strategies and action plans:** how the initiative will reach its objectives and how strategies will be implemented to accomplish the objectives developed earlier in this process.
- **How to measure the results or success:** determine the indicators you will use to measure the outcomes. These can be either quantitative measures such as call response time or staffing per shift, or qualitative measures such as level of community satisfaction.



After having given the above some thought, you would then start to develop a framework.

As an example, a framework for a fire department could look something like the following:



### Logic Model

Once you have outlined your general direction, you can now start to develop a logic model. A logic model is like a roadmap you can use as a guide to help you achieve your goals. It outlines the intended results (that is, outcomes) of

the program, the activities the program will undertake, and the outputs it intends to produce in achieving the expected outcomes.<sup>1</sup> It is a very useful tool to help you evaluate and think about whether the goals and objectives you have outlined above are achievable and measurable.

### Main components of a Logic Model:

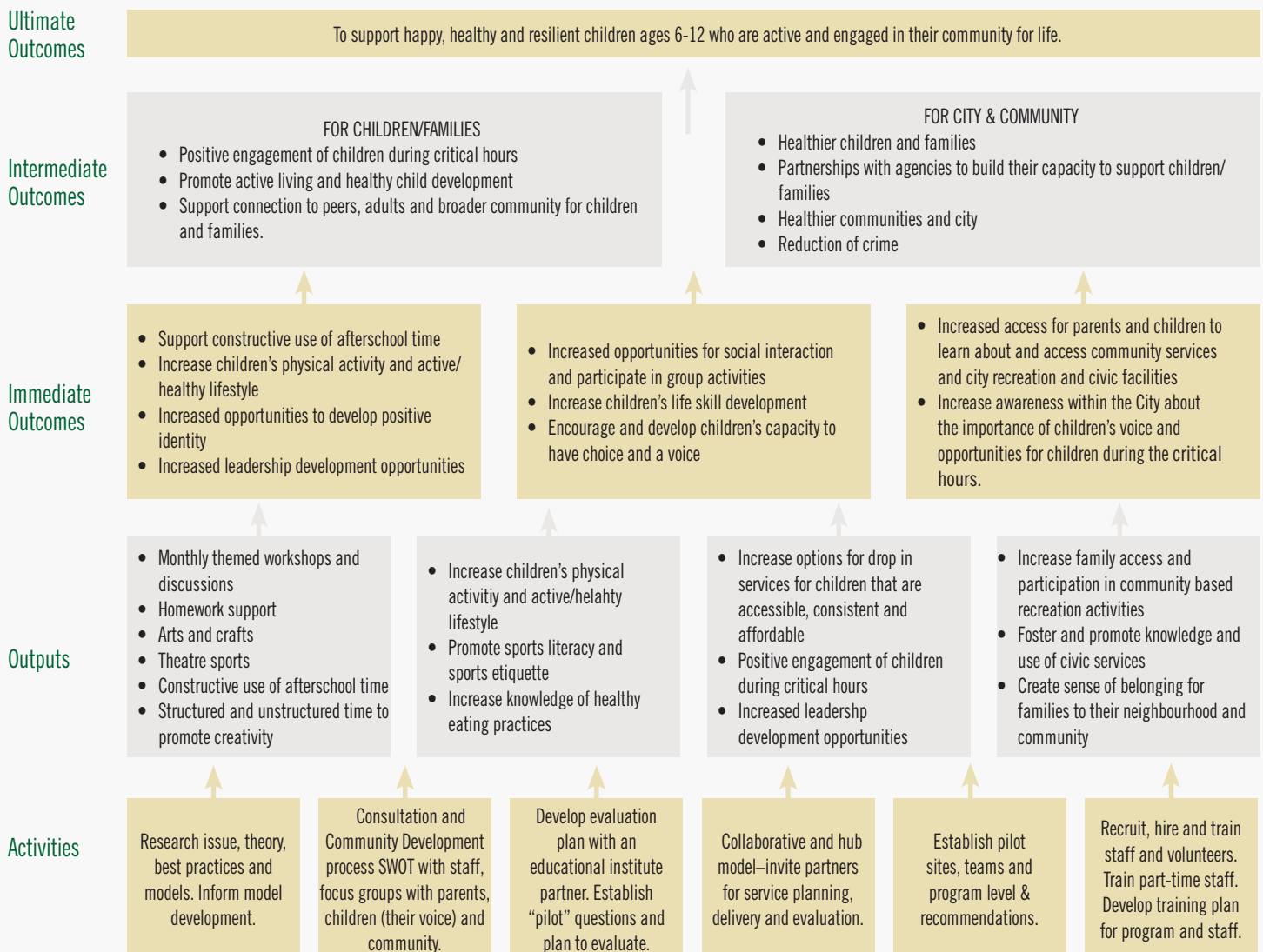


It is useful to present your thoughts using a flow chart or diagram as it will help you visualise your thought process. There are many examples of logic models but it is entirely up to you to come up with one that works for you and your organization.

After you have considered all of these components, your logic model could look something like the one below. Again, it is entirely up to you to come with your own model. There are hundreds of examples on the internet.

### Example of a Logic Model: My Zone Program<sup>2</sup>

Description: MYZone is a low-cost recreation based program that provides positive engagement of children ages 9-12 during the critical time of day, 3-6pm Monday through Friday, when research shows children less supervised or engaged with community and recreation. The program supports healthy child development through activities that promote active living, personal and life development, connection to peers and adults and to raise awareness and connection to the broader community and civic services. We believe that children need an opportunity to have a voice and be recognized as assets in their community.



## Case Study 1

Case Study 1<sup>3</sup> uses the strategic plan from the Federation of Canadian Municipalities as its starting point. A copy of the document can be found at: [https://www.fcm.ca/Documents/corporate-resources/FCM\\_Strategic\\_Plan\\_2012%E2%80%932017\\_EN.pdf](https://www.fcm.ca/Documents/corporate-resources/FCM_Strategic_Plan_2012%E2%80%932017_EN.pdf)

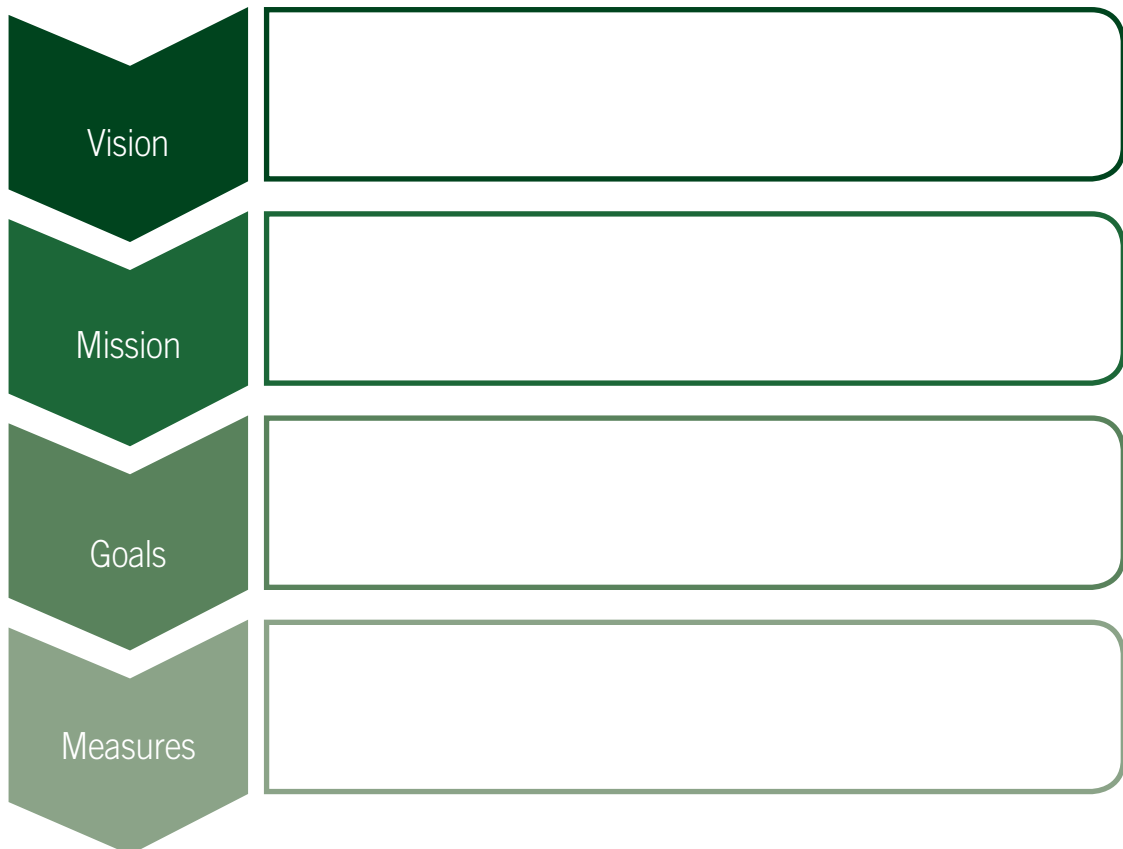
### Exercise 1

Drawing on the case study you have just read and using the process outlined earlier in the chapter:

1. Create the strategic plan for the organization. Use the chart below as a guide.

The first three, vision, mission and goals (what is called “priority results” in this

example) can be easily gleaned from the document itself. However, you will need to give the last point—measures—some thought as to how you would go about measuring the performance and goals. Before completing the last point, you will have to go through the logic model exercise (see below) to give you a better sense of how you would measure your goals.

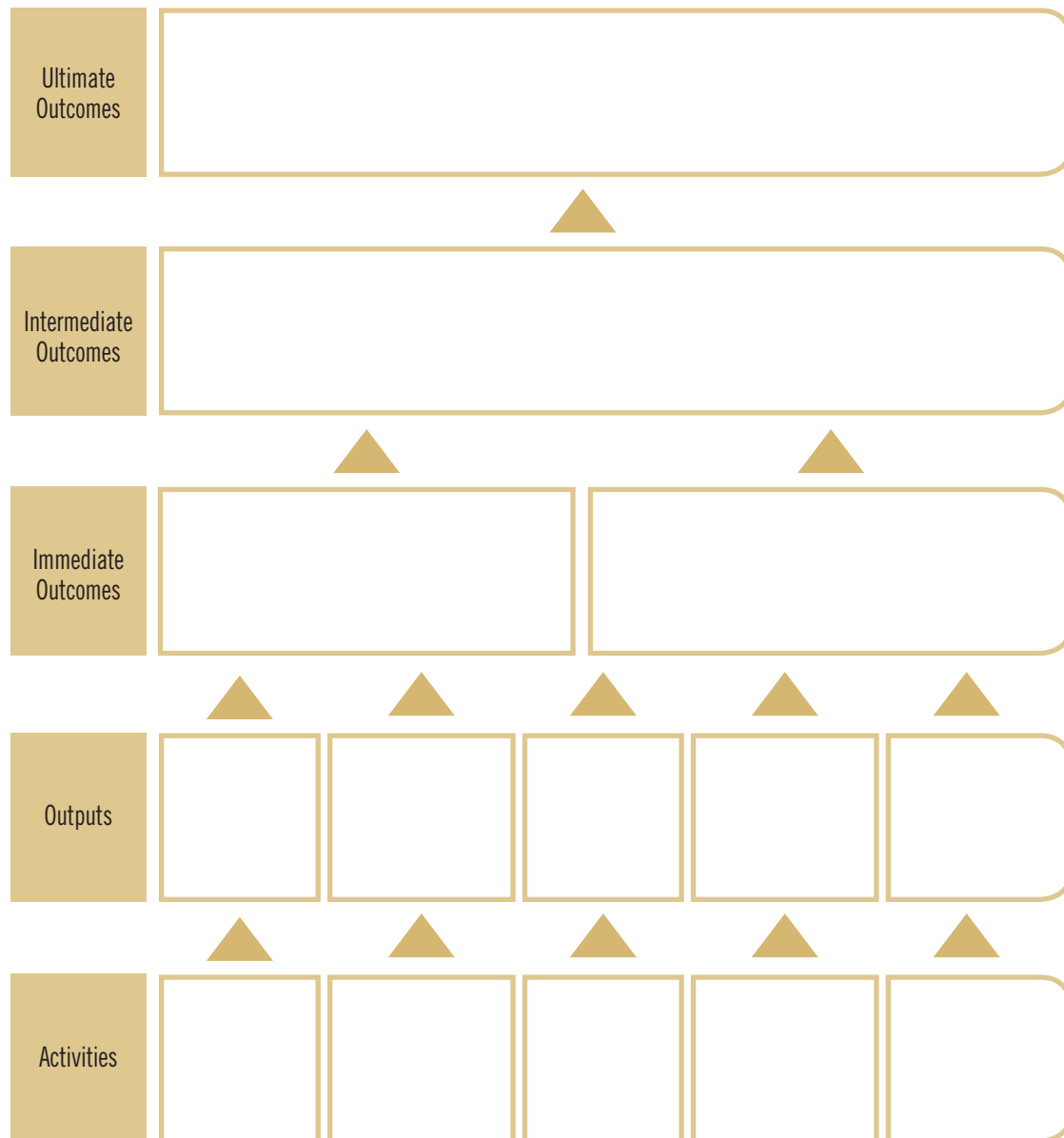




2. Create a logic model. Do not feel discouraged if you are having difficulty filling in the blanks; it may be that the plan itself has shortcomings. Logic models will help you identify weaknesses in your plan and guide

you to making logical, achievable goals. This will require some thinking especially for the input section.

Use the table below as a guide to help you plan it out.



### Exercise 2 (Group)

1. The City of Surrey has a number of strategic plans in various departments (e.g. Transportation Strategic Plan, Parks Strategic Plan, Library Services etc.). Read through the 12 strategic plans at <http://www.surrey.ca/city-government/13293.aspx>.

Your team been tasked to develop an overall strategic plan for the City of Surrey for the next two years. Based on the department strategic plans you have reviewed, develop an outline of a general strategic plan for Surrey.

The vision, mission and goals for each department can be easily gleaned from their plans, but you will need to consider how you would develop a cohesive overall plan, and how you would measure the performance and goals, such as measuring the impact of a successful media strategy, outreach or community strategy.

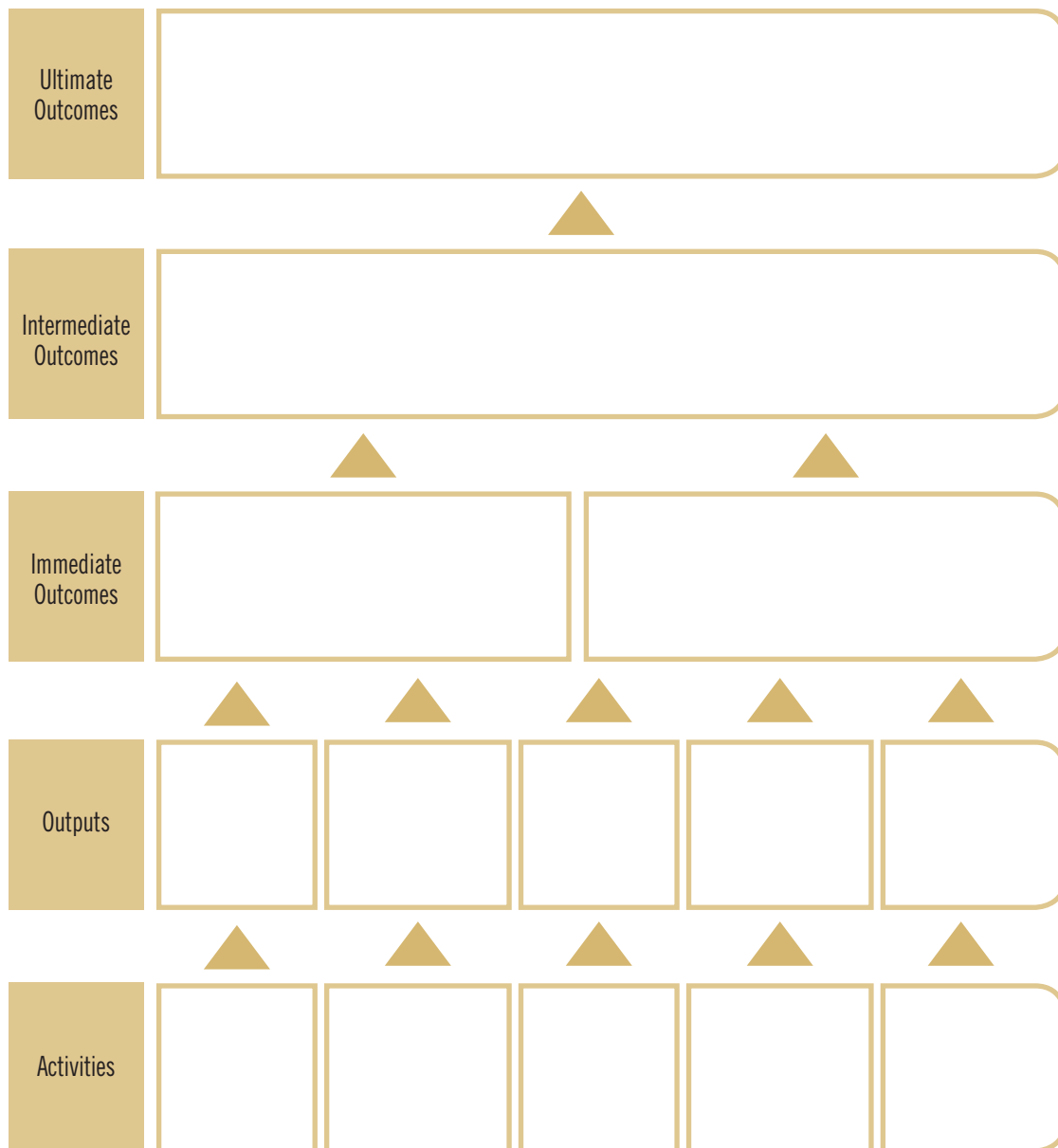
Before starting to develop the plan, consider how you and your team would go about gathering information to have better idea of what each department's goals are. Who will you need to consult with, how will you approach going about doing this?

Vision	
Mission	
Goals	
Measures	

2. Based on your outline, create a logic model. Remember, not all boxes may be relevant for your plan. Logic models will help you identify weaknesses in your plan and guide you to making

logical, achievable goals. This will require some thinking, especially for the input section.

Use the table below as a guide.





### Exercise 3 (Group Optional)

Your municipality/city is geographically large with a widespread population. The City Hall is located in the heart of the central business district, which is the core of business activity in the city. Although appropriately located from a business perspective, the City Hall location is less convenient for those members of the public who may live and/or work in areas outside of the central business district. It has been suggested that the municipality/City should consider introducing satellite offices to better serve the public.

One of your key priorities upon taking on this assignment is to ensure operational efficiencies in the provision of these services. In deciding whether to establish a satellite operation, the City must consider factors such as the cost of renting and furnishing additional offices, the cost of hiring additional staff to work in that office, and whether existing employees will be burdened by the need to travel to and from the main City hall to the satellite operation. There are also threats, such as new technologies that make it less necessary for residents to visit City hall to apply for services, pay bills, or discuss problems etc.

#### *The task:*

If you are doing this as a group exercise, break into small groups (ideally four to five people). Brainstorm and come up with a strategic plan on how you would approach this plan. Remember, strategic planning is a joint exercise and the more feedback and input you get from a variety of sources the more comprehensive your plan will likely be.

Think of all possible issues/challenges/advantages when devising your plan.

How might you accomplish a successful transition and maintain satisfaction and community support? Will there be sufficient accessible services in the satellite offices? Do you need to lease/buy additional land, hire/downsize your staff? How will you budget or provide for this? How should you staff the station and schedule your staff? Will you need to change the composition of your staff? Remember that consultation is key in implementing such plans, consider who and how you will conduct consultations.

Many questions come to light. The best approach is to break it down piece by piece. Once you have come up with a strategic plan, work out your logic model to determine if your plan is achievable based on your goals and objectives. Use the charts in this chapter as a guide.

<sup>1</sup> Supporting Effective Evaluations: A Guide to Developing Performance Measurement Strategies. Treasury Board of Canada Secretariat. <http://www.tbs-sct.gc.ca/cee/dpms-esmr/dpms-esmr05-eng.asp>

<sup>2</sup> City of Surrey Parks and Recreation

<sup>3</sup> Federation of Canadian Municipalities, Strategic Plan 2012-2017

[https://www.fcm.ca/Documents/corporate-resources/FCM\\_Strategic\\_Plan\\_2012%E2%80%932017\\_EN.pdf](https://www.fcm.ca/Documents/corporate-resources/FCM_Strategic_Plan_2012%E2%80%932017_EN.pdf)

# Thinking Critically

## Introduction

Let us assume that part of your responsibility in your role as leader of your department oversees improving road safety in your city. You have been asked to conduct research into the frequency of traffic accidents in the major intersections in your city. What are the likely factors that could influence these incidents? Are most of these incidences caused by cars, bicycles or pedestrians? Does the neighbourhood and time of day have any influence on this? How would you go about conducting your research?

This research can help you make sound and useful decisions. Your research findings could also play a strong role in changing road safety policy, thus contributing to overall public safety.

This is where you would have to apply yourself, think critically and approach your research rationally and logically. The research you conduct will be heavily dependent on data, and reliable and rational evidence.

This chapter will lay out the steps that can serve as guide for you to prepare a research report.



## Quick Review

Be careful to avoid being caught up by the following when conducting your research:

- **Logical Fallacies** – contradictions and irrelevancies. If the argument does not appear to make sense, stop and question it. Ask for more details or evidence.
- **Personal Arguments** – arguments or attacks targeted at undermining someone's credibility. The key here is to separate the argument or assertion from the speaker. The assertions, "Trust me" and "Don't listen to him, he is a fool" do not speak to the validity or worth of the argument a person is making.
- **Red Herrings** – irrelevant issues. Sometimes people raise issues that are unrelated to the problem at hand. Question how the red herring is actually related to the problem being considered.
- **Pink Herrings** – when the issue raised is sufficient to address the problem but is NOT necessarily a solution to the problem.

- **Circular Arguments** – logical fallacies. Essentially the argument is that if the premises are true, the conclusion must be true. For example, someone may state that they are poor because they have no money. You ask them, “Why do you have no money?” Their answer will be, “Because I am poor.” That is circularity and it provides you with little useful information for action. If, however, they indicate they have no money because they are unemployed, then you have an item on which action can be taken—dealing with their unemployment.

## Causal Linkages

Just because two things appear associated does not necessarily mean that one causes the other, or that they are causally connected in any way.

As a guide, consider these three conditions for a causal relationship:

- The cause and effect must coincide or occur together.
- The cause must come before the effect.
- There is no other underlining factor resulting in the cause and effect appearing together. In other words, you want to be confident that the cause really is producing the effect rather than just appearing to do so.

Remember, it is very difficult to prove something is true; it is much easier to show that something is not true.

## Testing a Theory

Let us assume that your hypothesis is that most household fires are caused by children who live in rental housing. Now you will have to test this theory.

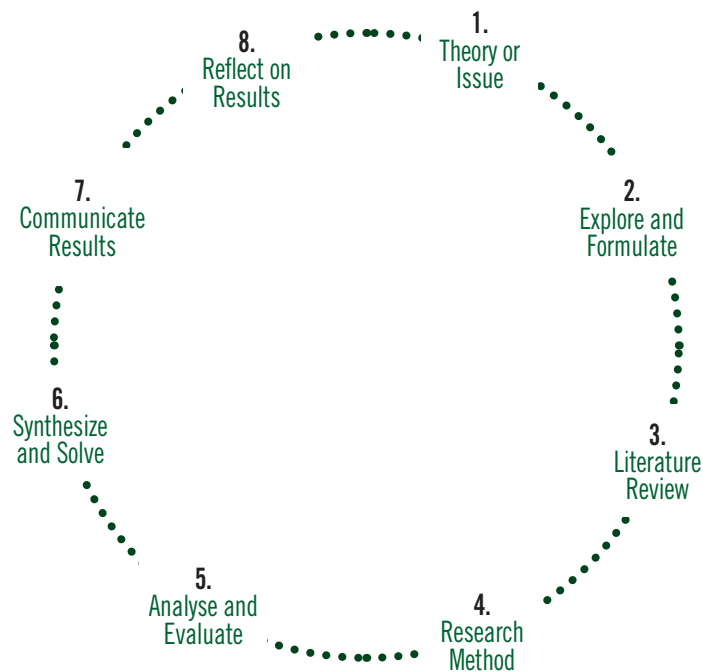
To test a theory:

- You must find an explanation that is consistent with at least most of the evidence you have collected to date.
- You must then conduct secondary tests to see whether those explanations hold up.

## The Research Report

You already have your working hypotheses; now you need to think of

how you would conduct your research. Typically you would follow these steps:



- 1. Identify the theory or issue:** Seek some preliminary background information on the issue.
- 2. Explore and formulate:** Brainstorm options, identify the problems and alternatives; frame your ideas.
- 3. Literature review:** Search, locate and identify useful sources of data; scan the sources for usefulness.
- 4. Develop your research:** Develop your methodology; sort and organize the information based on your criteria: cause/effect, compare/contrast, chronological etc.

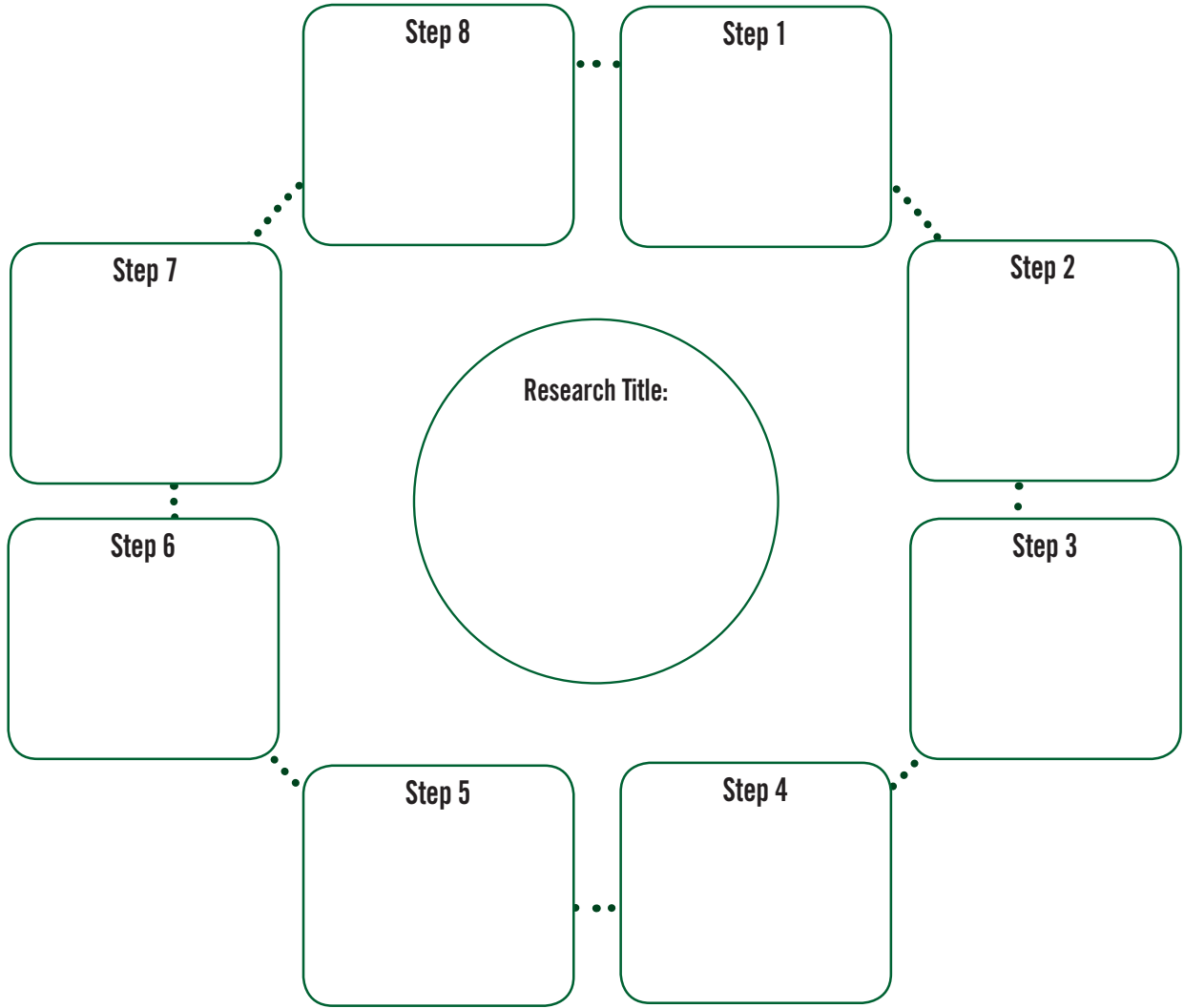
- 5. Analyse and evaluate:** Determine importance of the information and its relevance to the essential question; identify trends, interpret data.
- 6. Synthesize and solve:** Draw conclusions and if necessary create new meaning based on sound reasoning and authenticity of information.
- 7. Communicate and present:** Communicate your findings using effective communication skills.
- 8. Reflect:** Transfer the knowledge to solve new problems.



## Case Study 2

Go to <http://tram.mcgill.ca/Research/Publications/Diagnosing%20transportation.pdf> to read Case Study 2.<sup>1</sup> This case study is a research report on how a group of researchers approach developing key performance indicators to assess urban transportation systems.

As you are reading this case study, use the chart below to try identifying the various elements of the research project that were highlighted above.



## Exercise

City A has slowly been working to improve its online services. It is continually adding to and improving the information that is available on its website. In addition, City A has recently introduced an online Plumbing and Electrical Permit Applications and a variety of Online Inspection Requests in response to property owners and developers requests.

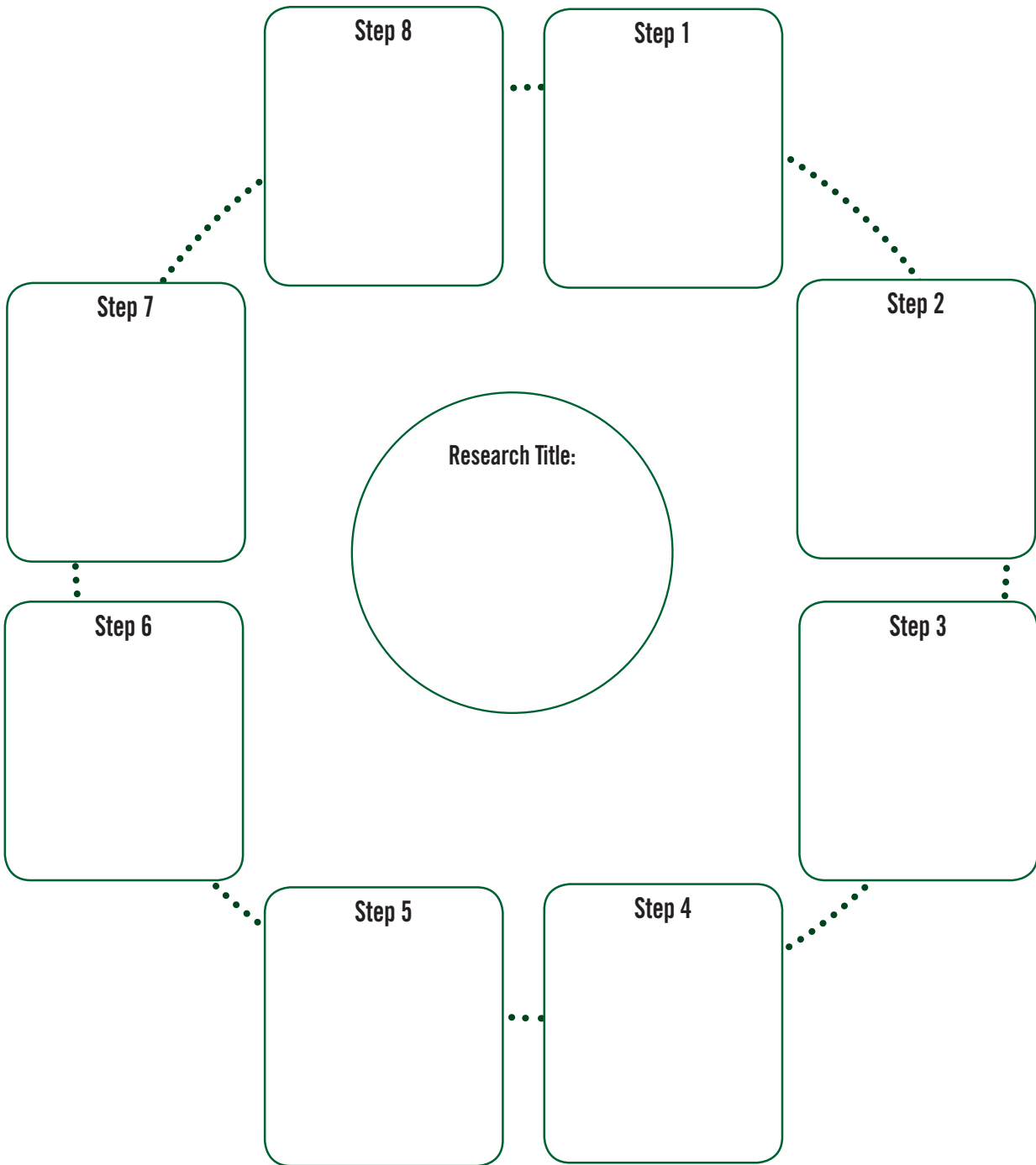
The move to a full online application submission process for such things as land development applications (rezoning, subdivision, development permits etc.), building permits, tenant improvements and sign permits, is being explored, but there may be obstacles such as computer hardware and software requirements, staff training, online storage requirements, privacy and security.

### *The task:*

You and/or your team has been tasked to address the electronic application submission issue and to implement a plan to improve the efficiency in the delivery of these services but you first need to research and analyse what the real problems are and where the gaps are before you can implement the plan.

Using the chart on the next page, work through how you would approach this research. Be as detailed as possible. The more you think through the process the more robust your research will be.

Work through the steps using the guide outlined in this chapter.



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<sup>1</sup> Diagnosing Transportation, Developing Key Performance Indicators to Assess Urban Transportation Systems, Yousaf Shah, Kevin Manaugh, Madhav Badami, and Ahmed El-Geneidy  
<http://tram.mcgill.ca/Research/Publications/Diagnosing%20transportation.pdf>

# Collecting Evidence

## Introduction

Now that you have gone through the basics of how to structure a research project, it is time to get your hands dirty and dive into the nitty-gritty of data gathering and crunching.

The data or evidence that you will use for your research can come from a variety of sources. Some is available administrative data from government sources or other formal organizations that routinely collect information. Evidence can also come from formal policy and program evaluations, as well as from the work of government and academic scientists.

Don't overlook the fact that your own organization, department or division could also be a valuable source of information.

It is up to you to decide on your research method – decide on the methods you will use in order to be able to assess and study your research and data. Will you conduct research by studying behaviours of existing groups of individuals? Will you collect numerical data or anecdotes? The “method” is essentially a strategy for conducting an investigation to answer a research question.

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## Quick Review

### Environmental Scan

Before deciding on what sort of information you are going to rely on, you might want to conduct an environmental scan. A key part of conducting an environmental scan is finding sources to help guide your knowledge, thinking, research process, and any direction you might want to take.

It also gives you an informed, comprehensive picture of the current

circumstances or environment in which your organization exists. It is a sequential process that involves gathering information from both primary and secondary sources.

Primary sources of information are data you put together by directly contacting or speaking with groups or individuals. Secondary sources come from the review of existing research reports, statistics and other information.



An environmental scan can provide:

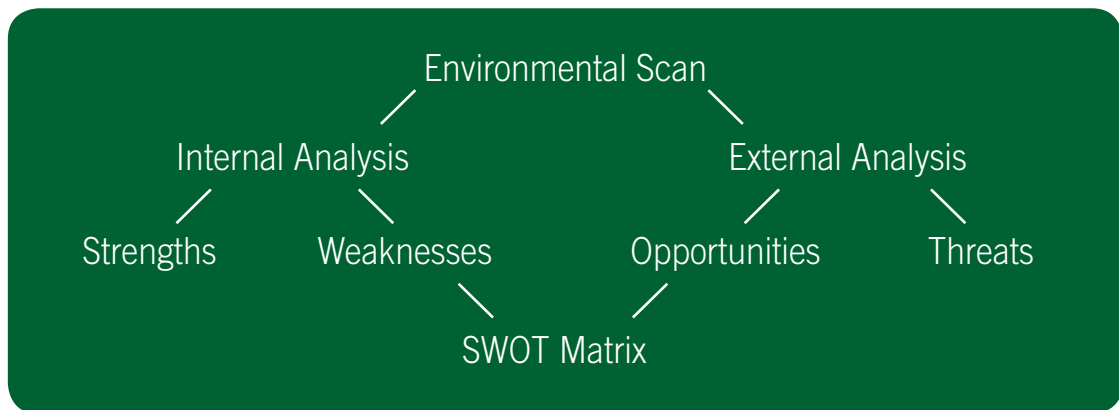
- a fresh, objective look at issues within your organization's, department's or division's mandate;
- ideas on how to rank your objectives effectively;
- an opportunity to access existing research, information, statistics and other data;
- an opportunity to engage community stakeholders, organizations, individuals and groups in decisions that affect them;
- an opportunity to discover the strengths and assets in the larger community;
- a framework to understand the assets and strengths possessed by your own organization; and,
- an opportunity to learn how your organization's programs and practices are affecting other organizations, agencies, groups or individuals and to what degree your programs are meeting your mandate.

There are two types of environmental scans:

- Primary (internal) research, which is based on your own knowledge and experience, or research you conduct yourself.
- Secondary (external) research, based on reviews of journals, news articles, policy documents, government publications, etc.

The internet has a wealth of information and is literally your oyster when it comes to information gathering. Where possible, engage your municipal librarian or a college/university librarian. Reference librarians are an important resource and will know how to glean and narrow your research focus.

The diagram below breaks down the thought process on how you would analyse your research.



## Framing Your Environmental Scan

It is easy to be overwhelmed by the wealth of information out there and what you read and gathered from discussions. You could spend hours, days and sometimes weeks just going through the material. To avoid this, and in the interest of time and costs, it really helps to frame your environmental scan.

Focus your question:

- What is the key issue?
- What do you need to know about the issue?
- What are the trends and drivers affecting these factors?

Once you have gathered your information from both primary and secondary sources, it is time to analyse it.

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## SWOT Analyses

Environmental scans are often accompanied by a SWOT analysis of **strengths, weaknesses, opportunities, and threats** affecting the organization's ability to fulfill its organizational mandate. A SWOT analysis is an excellent tool that can be used to create a long-term plan by which your organization or department can properly direct its future.

It is best conducted in a collective group environment with a diverse cross-section of members from your organization or department. The more perspectives that can be brought to bear on your organization or department, the more likely you will be able to identify the full range of opportunities and challenges it faces. Too often, while focusing on our day-to-day jobs, we miss important issues in other areas of the organization.

The SWOT exercise will be more effective if you share the results of the environmental scan with the team in advance.

Consider each of the four SWOT areas in turn, and make note of all the ideas, suggestions and comments made. These can be reviewed and edited after the brainstorming session.

### Strengths

Consider your organization's or department's strengths from your own point of view and from that of your clients and the general public. Be realistic and honest.

Try answering the following questions:

- What is it that you do well?
- What advantages do you have over other municipal organizations or departments?
- What makes you different from them?

## Weaknesses

Weaknesses are areas capable of improvement. Is your organization or department lacking skills or requiring upgrades? Do you have a higher cost base than other municipalities or departments? Are you experiencing high staff turnover?

You must face any unpleasant truths and be realistic and objective in your analysis.

- Can the organization or department do anything better?
- Is it doing anything badly?
- What are the causes of problems or complaints you receive?

## Opportunities

Identify any new opportunities or untapped areas that your organization or department can focus on. Are there any interesting technologies you can take advantage of? The focus of opportunities is not solely on existing service, but on expanding and developing new possibilities both inside and beyond the traditional service area.

Examples of opportunities include:

- Changes in technology and equipment
- Changes in government policy or regulations or legislation
- Social factors, for example, population increases or changes in social demographics

## Threats

Threats are usually anything that can adversely affect your organization or department. External threats could be budget cuts, new legislation, or changes in demographics. Internal threats could include a skill or staff shortage, or pressure to deliver under budgetary constraints.

Try answering the following questions:

- What challenges are your organization or department experiencing?
- What are other similar organizations or departments doing?
- Are there any changes in products, services or technology that could threaten your delivery methods?
- Is your organization or department facing any budget cuts?

Once you have completed your SWOT analysis, it is essential that you make note of the following:

- What must you address immediately?
- What can be handled now?
- What needs researching further?
- What needs to be planned for the future?

## Case Study 3

Read Case Study 3 at [http://www.surrey.ca/files/Sustainability\\_Charter.pdf](http://www.surrey.ca/files/Sustainability_Charter.pdf). This is the City of Surrey's Sustainability Charter.

Many municipalities have been working toward having a Sustainability Charter. For example, the City of Surrey's Sustainability Charter was adopted by City Council in 2008 and is the City's comprehensive framework for implementing a progressive, long-term, 50-year vision for a Sustainable City. The Charter guides policy and decision-making, and ensures social, environmental and economic factors are always taken into account.

The Sustainability Charter also demonstrates the City's commitment to responsible growth. The Charter defines sustainability, identifies what Surrey residents think about sustainability, shows the challenges and opportunities, and reveals the City's long-term vision for sustainability in the City of Surrey.

The City of Surrey has made considerable progress on the implementation of the Sustainability Charter since its adoption in 2008. The City's Sustainability Dashboard is where the City continually monitors its progress towards achieving the established sustainability goals.

Most strategic plans are much more detailed, but this one is succinct and to the point. The department's SWOT analysis was a key component of the overall plan.

In putting the charter together they embarked on a SWOT analysis so that they could:

1. Determine key areas to focus on over the course of the charter.
2. Establish goals pertaining to these areas.
3. Put in place strategies to achieve these goals.

The charter will give you a general idea as to how to list out your SWOT, and how to collate, analyse and summarise your findings.

After reviewing the charter, proceed to answer the exercise on the next page.



### Exercise 1

1. Taking the case study above let's work backward. How do you think the objectives and evaluated during the creation of the Charter? Specifically what quantitative and qualitative data do you think were used to establish appropriate sustainability targets?

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2. What the tools and indicators do you think should be used to monitor and evaluate progress over time?

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**Conduct a SWOT Analysis**

Based on the information in the charter and your answers on the previous page, list out the Strengths, Weaknesses, Opportunities and Threats (SWOT) in the chart below.

Internal Analysis of  
Organization or Department

External  
Influences

Strengths

Opportunities

Weaknesses

Threats

## Exercise 2

City A is constantly receiving pressure from different communities to construct new facilities (e.g. ice rinks, swimming pools, rec centres, soccer fields etc.). You and/or your team have been tasked to develop a plan to assist in the decision of where specifically to locate these facilities to ensure optimal use of taxpayer dollars and how to prioritize what facilities are built first.

*The task:*

Use the steps outlined in this chapter to work your way through the process on the following pages.

This exercise should ideally be completed as a group brainstorming exercise, especially step 2. If necessary, Step 1 and 3 can be done individually (not ideal), but step 2 should be completed as a group if possible.

### Step 1: Conduct Your Environmental Scan

1. What is the key issue? Consider what other departments you should be consulting with to help you with your information gathering.

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2. What do you need to know about the issue? What do you already know about the issue? (internal research). List the information - in doing so it is important to understand what relevant information to consider. Sometimes too much information can detract from the core issue you are considering.

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3. What are the trends and drivers affecting these factors? (external research). List your sources for this additional information (magazines, government policy papers, case studies, and so on).

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**Step 2: Conduct a SWOT Analysis**

Fill in the matrix below to help you visualise your thought process.

Internal Analysis of  
Organization or Department

External  
Influences

Strengths

Opportunities

Weaknesses

Threats

**Step 3: Explore Your SWOT Analysis**

From your matrix, identify the following.

- 1. What must you address immediately? For example, were there any gaps that if not addressed could pose a risk (such as transition issues, staffing issues, essential services being affected)?

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- 2. What can be handled now? Can some interim processes be put in place immediately?

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3. What needs researching further? For example, you may need to do more research on what facilities or services can be amalgamated. Are there cheaper alternatives to acquiring and building new facilities that could produce the same outcomes?

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4. What needs to be planned for the future? Will you need staff training or a change in the management structure? How will you account for a change in demographics or population?

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# Statistics

## Introduction

The key to understanding data analysis is to see it as a way of organizing and making sense of a world dominated by uncertainty. Many professionals feel daunted but the concepts are fairly simple. Generally, what we want to know is how “typical” something is, and how much variability is there in a bunch of observations. Keep in mind that the origins of statistics lie in games of chance such as playing cards and dice.

Statistics however, can reveal a lot of latent information that you would not normally know. It can be a very powerful tool and can be used to great advantage even if you do not have the underlying math or technical aspects. Statistics are a vital source of evidence as they provide us with clear, objective, numerical data on important aspects of your community, city, province or country.

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## Quick Review

The study of statistics is usually divided into two categories:

- **Descriptive statistics** are methods of organising, summarising, and presenting data.
- **Inferential statistics** (or statistical inference) are methods used to determine something about a population on the basis of a sample.

## Descriptive Statistics

A variable is a quantity or characteristic of interest that is allowed to change within a particular problem. There are two basic types of variables:

- **Quantitative variables** are measures, values or counts expressed as numbers.
- **Qualitative variables** are descriptive in nature, for example, a person’s gender, religious affiliation, type of automobile owned, place of birth, and eye colour. That is, the characteristic being studied is nonnumeric.



## Examples of Quantitative vs. Qualitative Data

Data unit	Numeric variable = Quantitative data	Categorical variable = Qualitative data
A person	"How many children do you have?"	4 children
	"How much do you earn?"	\$60,000 p.a.
	"How many hours do you work?"	38 hours per week
A house	"How many square metres is the house?"	200 square metres
A business	"How many workers are currently employed?"	264 employees
A farm	"How many milk cows are located on the farm?"	36 cows

### Other Important Key Measures and Terms

**Mean:** the arithmetic average. The sum of the value of each observation in a dataset divided by the number of observations.

**Median:** the middle value in distribution when the values are arranged in ascending or descending order.

**Mode:** the most common value occurring in a distribution or set of observations.

**Range:** the difference between the smallest value and the largest value in a set of observations. The range represents the actual spread of data. It is the difference between the highest and lowest observed values. As with calculation of the median, it is helpful to order data observations to find the highest and lowest values.

**Standard deviation:** measures the scatter in a group of observations. It is a calculated summary of the distance each observation in a data set is from the mean. Standard deviation gives us a good idea whether a set of observations are loosely or tightly clustered around the mean or average.

**Variability:** how widely the measures range or vary.

**Variance:** measures the spread of the data around the mean.

### Reading Tables, Graphs and Maps

It is common when conducting data research to be presented information in the form of tables, graphs and maps. When reading data in tables, graphs and maps, it is helpful to follow a logical process.

The following steps may help you analyse and interpret data in tables, graphs and maps:<sup>1</sup>

- Observe the layout in order to understand how the data are arranged. Check the row and column names in a table; the x and y axis in a graph; or the key of the map to get a clear idea of the variables being displayed. Are there just numbers, or are percentages also used?
- Next, scan any totals as this may assist you to get an idea of any overall trends in the data.
- Also, make sure you look at any additional information and footnotes as they may contain important information that can be used to assess the accuracy of the data, or to understand the limitations of the data.
- Now, have a look at the data and how it is represented. Does anything stand out? Are there any trends in the data? Are the data uniform? What relationships can you see between the data? What summary measures could you use to gain a better understanding of the data? What conclusions can be drawn?

**Example 1**

	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
Fire service deaths	4	8	5	5	15	6	7	6	6	13

Let's now interpret the data in the table above.

1. What is the **mean or average** number of fire service deaths for the last 10 years?

*Answer:*

$$\begin{aligned} \text{Total number of deaths} &= 75 \\ \text{Total number of years} &= 10 \\ \text{Mean or average (total deaths} \div \text{total number of years)} &= 7.5 \text{ round up to } 8 \end{aligned}$$

This means that there has been an average of **eight fire service deaths** for the past 10 years.

2. What is the **mode (the most frequent value)** for these deaths?

*Answer:* The mode is 6.

3. What is the median for fire service deaths for the past 10 years?

*Answer:* If you re-arrange the table in an ascending order, you will see that the median falls in the middle point between the two middle values: 6 and 6.

$$\text{i.e. } [6+6] \div 2 = 6$$

**Example 2**

					<u>Median</u>					
Fire service deaths	4	5	5	6	6	6	7	8	13	15

4. Now referring to the table above again, is there any variability in the data?

In datasets with a small spread, all values are very close to the mean, resulting in a small variance and standard deviation. Where a dataset is more dispersed, values are spread further away from the mean, leading to a larger variance and standard deviation.

The smaller the variance and standard deviation, the more the mean value is indicative of the whole dataset. Therefore, if all values of a dataset are the same, the standard deviation and variance are zero.

**To calculate the standard deviation:**

**Step 1:** Calculate the mean of the dataset:  
 $4+5+5+6+6+6+7+8+13+15] \div 10 = 8$

**Step 2:** Calculate the deviation of the individual values from the mean by subtracting the mean from each value in the dataset [value – mean]:  
 -4, -3, -3, -2, -2, -2, -1, 0, 5, 7

**Step 3:** Square each individual deviation value:  
 16, 9, 9, 4, 4, 4, 1, 0, 25, 49

**Step 4:** Calculate the mean of the squared deviation values. This will give you your variance.  
 $16+9+9+4+4+4+1+0+25+49] \div 10 = 12$

**Step 5:** Calculate the square root of the variance.

**Standard deviation = 3.5**



## Inferential Statistics

Inferential statistics are used to infer or deduce conclusions about a population from a sample of that population. It is the result of techniques that use the data collected from a sample to make generalisations about the whole population from which the sample was taken.

## Random Selection and Equal Chance

In statistics, inferences are made on a random sample of the population, meaning a random selection of the population chosen using a chance mechanism. A lottery draw is a good example of simple random sampling, where the numbers are randomly generated from a defined range of numbers (for example, one through to 45) with each number having an equal chance of being selected.

## Analysing, Interpreting and Evaluating the Information

Once you have analysed and computed some statistics from the data and feel you have a grasp of what the data is saying, you can start looking at drawing conclusions about the data. Your analysis can provide you with the basis for describing what happened but there may be many possible reasons for why this has occurred.

Try to think about the interrelationships between social, economic and environmental factors that could influence the data.

Some things to consider when drawing conclusions may be:

- Do the results support your theory/suspicions? Are they different?
- What are the main results or conclusions that can be drawn?
- What other interpretations could there be?
- Can the results or conclusions be supported statistically?
- Do the conclusions make sense?

## Communicating your Statistical Findings

Now that you have your statistical findings, you will need to communicate them accurately. Effective communication of your statistical findings is vital for sound effective decision-making.

The strength of statistics is that it provides an opportunity to present your analysis in a way that tells a story about the data. Statistical writing can bring data to life, making it real, relevant and meaningful to the audience. The numbers are hard evidence that can change the mind of a skeptic. It could get you that equipment upgrade your department has long needed, or it could get you additional personnel.

When communicating statistical information, it is important to ensure the information presented is clear, concise and accurate. It is also important to provide contextual information and to draw out the main relationships, causal linkages and trends in the data.

Here are some basic guidelines to follow when writing your report:

- Describe the context within which the topic sits.
- Present the complete picture to avoid misrepresentation of the data.
- Accurately convey the main findings clearly and concisely.
- Include definitions to support correct interpretations of the data.
- Where necessary, include information on how the data was collected, compiled, processed, edited and validated.
- Include information on data quality and data limitations.
- Use plain, simple language where possible; minimise the use of jargon.
- Ensure your information and data are accurate.
- Use tables and graphs to present and support your written commentary.

### Using Tables, Graphs and Maps

Presenting statistical information in tables, graphs or maps can be highly effective, but it is important to ensure the information is presented in a manner that is accurate and not misleading to the reader.

The key to presenting effective tables, graphs or maps is to ensure they are easy to understand and clearly linked to the issue you are trying to address. Ensure that all the necessary information required to understand what the data is showing is provided, as the table, graph or map should be able to stand alone.

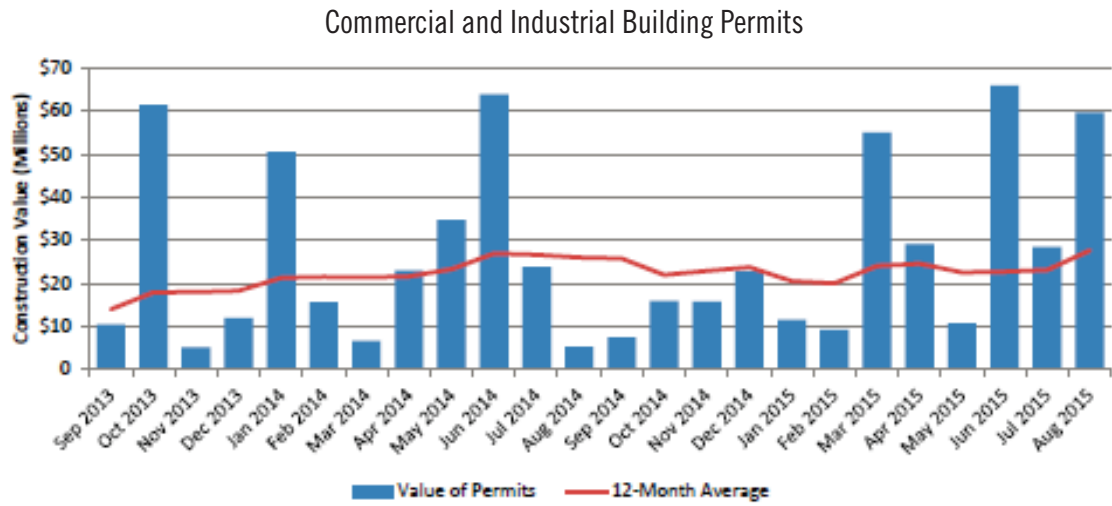
Tables, graphs and maps should:

- relate directly to the argument;
- support statements made in the text;
- summarise relevant sections of the data analysis; and
- be clearly labelled.

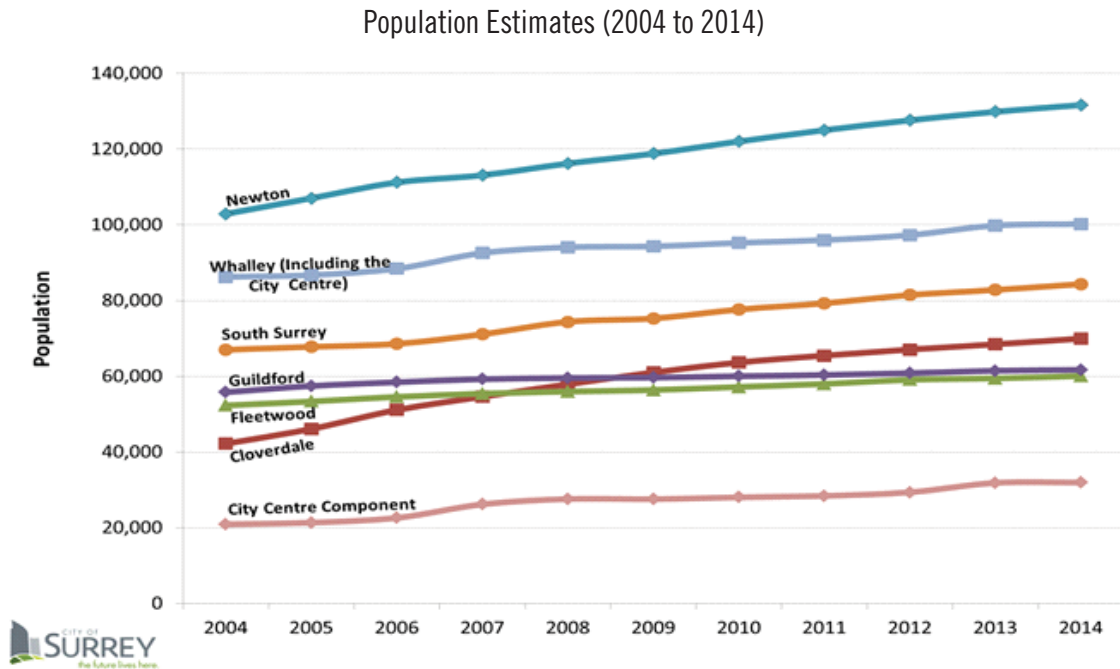
It is up to you to choose the most suitable visual representation of your findings. Sometimes a simple bar chart (or a table, pie chart, etc.) can effectively communicate the weight of your findings.

Following are some samples of how you can present your information visually.

Bar Chart<sup>2</sup>

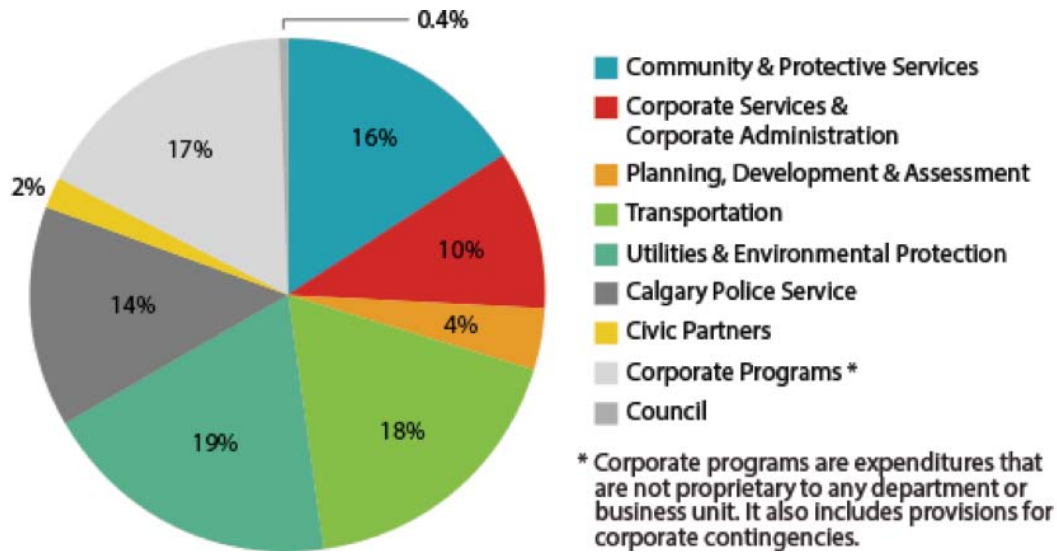


Time Series<sup>3</sup>



**Pie Chart<sup>4</sup>**

Spending the 2014 Operating Budget: \$3.2 Billion



**Case Studies 4-6**

Read the following:

Case Study 4:<sup>5</sup> [http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw\\_2010\\_factsheet.pdf](http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw_2010_factsheet.pdf)

Case Study 5:<sup>6</sup> <http://www.mah.gov.on.ca/AssetFactory.aspx?did=4475>

Case Study 6:<sup>7</sup> [http://www.dtpli.vic.gov.au/\\_\\_data/assets/pdf\\_file/0007/224782/Local-Government-in-Victoria-Report-2010.pdf](http://www.dtpli.vic.gov.au/__data/assets/pdf_file/0007/224782/Local-Government-in-Victoria-Report-2010.pdf)

The case studies present examples of how one would present research findings or information sheets (fact sheets). Some of these reports are voluminous and you need not read it thoroughly.

For the purposes of this exercise, reading the introduction or executive summary will give you a good idea of how the report is presented in general.



## Exercise 1

Below is a table<sup>8</sup> taken from the 2004 Indian and Northern Affairs Basic Department Data. Basic Departmental Data (BDD) provides a comprehensive portrait of the demographic, social and economic conditions of all Registered Indians and Northerners. The table below is a summary of listing the Potential Years of Life Lost (PYLL) by Cause of Death First Nations, 2001 and Canada, 2000. In itself, the listing of numbers is not that interesting. However, we can ask several questions of the data that make it more relevant.

For example, what is the typical cause of death per year for both columns?

How much variability is there in the amount of deaths between the disease classifications? Is there an overall pattern to the data or do the number of deaths just seem to be random? Is there much of a difference between the two – First Nations and the rest of Canada?

Data alone do not provide enough information to answer our questions, but with statistical analysis, we can use the data to find the answers or it can alert you to issues that require further investigation.

Potential Years of Life Lost (PYLL) by Cause of Death  
First Nations, 2001 and Canada, 2000

Disease Classification	First Nations	Canada
Injury	4,297	1,223
Circulatory	1,219	1,016
Cancer	873	1,824
Ill defined	813	161
Digestive	536	198
Endocrine	363	179
Respiratory	358	230
Perinatal	349	122
Infectious	327	193
Nervous System	326	169
Mental	204	65
Congenital	181	174
Genitourinary	104	44
Musculoskeletal	103	27
Blood diseases	40	19



5. Now let's see if there is any variability in the data. To do this you will need to calculate the **standard deviation** for death rates in the First Nations and Canada.

First Nations	Canada

## Case Study 7

### Example: Engineering Department –Traffic Signal Upgrades and Accident Rates

Traffic signals are a vital component of traffic operations at all level of governments, designed to facilitate the safe and efficient movements of cars, buses, trucks, bicycles, and pedestrians. In the City of Surrey, high population growth pressures see an average of 1,000 new residents arriving each month, requiring constant planning and upgrading of the City's transportation network.

Evidence-based decision making plays a crucial role in evaluating which intersections are upgraded and where to allocate transportation funding, an example of which is a traffic signal warrant. Traffic signal warrants are a standardised assessment methodology that allows the assessor to determine if current traffic patterns meet the minimum criteria for traffic signal upgrades over a range of criteria.

For the example provided in this case study, the following criteria were used for the warrant:

1. Minimum vehicle volumes,
2. Delays to cross traffic,
3. Collision experience, and
4. Combination assessment of criteria 1 to 3.

In June 2009, the City conducted an assessment of an intersection in the vicinity of the City centre that was characterised by a four-legged intersection, whereby, north/south traffic had a two-way stop procedure (minor road) and the east/west traffic had the right-of-way and was “free flowing” (main road). The average 24-hour weekday volume was 5,300 and 9,500 vehicles respectively.

This intersection assessment involved on-site manual traffic counts to determine both the traffic volume and the movement of the different types of modes of transport using the intersection. A traffic signal warrant was then completed using the data to determine whether or not the intersection should be upgraded to a four-way signal-controlled intersection.

Seven hours of observations were used as part of the intersection assessment based around the known peak utilisation periods: 7 a.m. to 9 a.m., 11 a.m. to 1 p.m., and 2 p.m. to 5 p.m. The following tables are examples of the count data and the subsequent traffic warrant that was conducted.



Table 1: Extract of the 7 a.m. and 8 a.m. Raw Count Data

Groups Printed- Cars - Trucks																					
Start Time	Southbound					Westbound					Northbound					Eastbound					
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	1	0	0	0	1	0	58	0	0	58	1	4	12	1	18	4	37	0	0	41	118
07:15 AM	0	1	3	1	5	0	71	2	2	75	2	2	17	1	22	9	47	0	1	57	159
07:30 AM	0	1	2	0	3	1	58	1	0	60	1	4	18	0	23	9	46	2	1	58	144
07:45 AM	0	1	2	0	3	3	75	2	1	81	2	3	27	0	32	7	61	0	3	71	187
Total	1	3	7	1	12	4	262	5	3	274	6	13	74	2	95	29	191	2	5	227	608
08:00 AM	2	1	3	0	6	2	62	1	1	66	5	2	15	3	25	12	76	1	5	94	191
08:15 AM	0	3	1	0	4	2	74	2	9	87	2	3	14	0	19	11	91	2	2	106	216
08:30 AM	3	2	3	2	10	2	75	1	9	87	2	3	11	0	16	8	82	3	1	94	207
08:45 AM	0	0	1	0	1	2	71	1	3	77	2	6	5	0	13	5	81	3	1	90	181
Total	5	6	8	2	21	8	282	5	22	317	11	14	45	3	73	36	330	9	9	384	795

Count usage statistics are used to help the traffic engineer understand the raw data. Table 2 and 3 below show the total daily and peak hour vehicle count values with

some statistical analysis. They quantify the volume of traffic, vehicle and pedestrian, as well as the motor vehicle variation, comparing cars and trucks.

Table 2: Total Usage Summary Based On Raw Count Volumes

	Southbound					Westbound					Northbound					Eastbound					Int. Total
	right	Thru	Left	Peds	App. Total	right	Thru	Left	Peds	App. Total	right	Thru	Left	Peds	App. Total	right	Thru	Left	Peds	App. Total	
Grand Total	37	46	79	25	187	85	2142	42	82	2351	68	94	323	25	510	302	2326	52	86	2766	5814
Apprch %	19.8	24.6	42.2	13.4		3.6	91.1	1.8	3.5		13.3	18.4	63.3	4.9		10.9	84.1	1.9	3.1		
Total %	0.6	0.8	1.4	0.4	3.2	1.5	36.8	0.7	1.4	40.4	1.2	1.6	5.6	0.4	8.8	5.2	40	0.9	1.5	47.6	
Cars	36	46	77	25	184	85	2075	39	82	2281	66	92	316	25	499	297	2264	51	86	2698	5662
%Cars	97.3	100	97.5	100	98.4	100	96.9	92.9	100	97	97.1	97.9	97.8	100	97.8	98.3	97.3	98.1	100	97.5	97.4
Trucks	1	0	2	0	3	0	67	3	0	70	2	2	7	0	11	5	62	1	0	68	152
%Trucks	2.7	0	2.5	0	1.6	0	3.1	7.1	0	3	2.9	2.1	2.2	0	2.2	1.7	2.7	1.9	0	2.5	2.6

Table 3 shows a summary of the midday peak period, which was determined to be between 11:30 a.m. and 12:30 p.m. One trend that was evident in review of the three

peak periods was that the morning peak period had no truck traffic, whereas there were more trucks using the intersection at both the midday and evening peak periods.

Table 3: Midday Peak Period Usage Summary

Start Time	Southbound					Westbound					Northbound					Eastbound					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
Peak Hour Analysis From 10:00 AM to 01:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 11:30 AM																					
11:30 AM	1	3	6	0	10	3	70	0	0	73	3	4	8	2	17	3	81	2	1	87	187
11:45 AM	0	1	6	0	7	1	62	2	5	70	0	1	4	2	7	9	74	1	4	88	172
12:00 PM	2	0	3	0	5	1	57	2	3	63	3	6	11	0	20	6	80	2	2	90	178
12:15 PM	0	2	2	0	4	4	70	2	2	78	1	3	11	0	15	3	71	0	3	77	174
Total Volume	3	6	17	0	26	9	259	6	10	284	7	14	34	4	59	21	306	5	10	342	711
% App. Total	11.5	23.1	65.4	0		3.2	91.2	2.1	3.5		11.9	23.7	57.6	6.8		6.1	89.5	1.5	2.9		
PHF	.375	.500	.708	.000	.650	.563	.925	.750	.500	.910	.583	.583	.773	.500	.738	.583	.944	.625	.625	.950	.951
Cars	3	6	17	0	26	9	247	5	10	271	6	14	33	4	57	20	292	5	10	327	681
% Cars	100	100	100	0	100	100	95.4	83.3	100	95.4	85.7	100	97.1	100	96.6	95.2	95.4	100	100	95.6	95.8
Trucks	0	0	0	0	0	0	12	1	0	13	1	0	1	0	2	1	14	0	0	15	30
% Trucks	0	0	0	0	0	0	4.6	16.7	0	4.6	14.3	0	2.9	0	3.4	4.8	4.6	0	0	4.4	4.2

**Analysis of the Intersection Against the Intersection Traffic Warrant Criteria**

As previously stated, the traffic warrant uses standardised criteria so that all types of intersections can be compared using the same criteria. It is important to note that each criteria being assessed is based on statistical analysis of the count data. The threshold parameters being used for the assessment are derived by engineering experts using very large data sets and decades of research. The selection of

the appropriate threshold values are further determined based on a range of factors that consider the setting of the intersection, such as the surrounding land use, its configuration (tee or four-legged) and number of lanes of traffic.

The first step in the traffic warrant is the creation of the summary table below to extract the primary values from the raw count data that will be used in the analysis. Table 4 is the summary table for all the raw data collected over the seven hours.

Table 4: Summary Of The Raw Count Data To Be Used In The Traffic Signal Warrant

**Justification 1**

*Vehicle Volume:*

Direction	08:00	09:00	12:00	13:00	16:00	17:00	18:00	Total
Northbound	93	70	42	56	76	69	79	485
Southbound	11	19	26	20	29	32	25	162
<b>Minor Road</b>	<b>104</b>	<b>89</b>	<b>68</b>	<b>76</b>	<b>105</b>	<b>101</b>	<b>104</b>	<b>647</b>
Eastbound	222	375	339	324	405	444	571	2680
Westbound	271	295	266	289	363	351	434	2269
<b>Main Road</b>	<b>493</b>	<b>670</b>	<b>605</b>	<b>613</b>	<b>768</b>	<b>795</b>	<b>1005</b>	<b>4949</b>
<b>Total Vehicles</b>	<b>597</b>	<b>759</b>	<b>673</b>	<b>689</b>	<b>873</b>	<b>896</b>	<b>1109</b>	<b>5596</b>

*Pedestrian Volume Crossing:*

North Leg	3	22	8	5	21	9	14	82
South Leg	5	9	10	15	13	20	14	86
East leg	2	3	8	0	0	9	3	25
West Leg	1	2	3	1	5	5	8	25
<b>Total Pedestrians</b>	<b>11</b>	<b>36</b>	<b>29</b>	<b>21</b>	<b>39</b>	<b>43</b>	<b>39</b>	
<b>Total Vehicles + Peds</b>	<b>608</b>	<b>795</b>	<b>702</b>	<b>710</b>	<b>912</b>	<b>939</b>	<b>1148</b>	<b>5814</b>

**Justification 2B**

Peds (Crossing Main):	3	5	11	1	5	14	11	50
Both Left Turns (Minor):	81	53	37	44	66	60	61	402
Higher Through (Minor):	13	14	12	12	17	13	16	97
Higher Left Turn (Main):	5	9	12	7	7	9	9	58
Opposing Through (Main):	191	282	251	291	346	383	403	2147
<b>Total</b>	<b>97</b>	<b>72</b>	<b>60</b>	<b>57</b>	<b>88</b>	<b>87</b>	<b>88</b>	

**Justification 3**

Year:	2008	2009	2010
Number of Collisions:	6	8	6

*Justification #1: Minimum Vehicle Volume*

The first justification examines the minimum traffic volumes on the intersecting streets to determine if the average hourly volume exceeds the compliance threshold over any of the given seven-hour periods.

In Table 5, you will notice that compliance is calculated as a percentage against the

threshold value for each hour, and then there are subsequent analyses looking at the number of hours that meet both the 100 per cent and 80 per cent compliance criteria and the average compliance rate. At the bottom of the table is the required criteria used to determine if the upgrade is warranted. In this case, the intersection doesn't meet the criteria.

Table 5: Warrant Justification 1: Minimum Vehicle Volume

Justification	Guidance	Hour Ending							Threshold	No. of Hours with Compliance		Average Compliance
		08:00	09:00	12:00	13:00	16:00	17:00	18:00		≥ 100 %	≥ 80 %	
1A	Total Volume Entering Intersection (vph)	597	759	673	689	873	896	1109	720			96%
	Compliance	83%	100%	93%	96%	100%	100%	100%		4	7	
1B	Crossing Traffic Volume (vph)	104	89	68	76	105	101	104	170			54%
	Compliance	61%	52%	40%	45%	62%	59%	61%		0	0	
SIGNAL JUSTIFICATION #1:		BOTH 1A AND 1B 100% FULFILLED EACH OF 7 HOURS (YES/NO):								NO		
		LESSER OF 1A AND 1B AT LEAST 80% FULFILLED EACH OF 7 HOURS (YES/NO):								NO		

*Justification #2: Interruption Of Continuous Traffic*

The second warrant is used to determine if the traffic volume on the major thoroughfare is heavy enough so that the traffic on the minor street suffers excessive delays or hazard in entering or crossing the major street.

This justification uses a similar analysis as the first justification, but uses a different subset of the count data and a different threshold value to assess the degree of impact on the traffic on the minor street.

Table 6: Warrant Justification 2: Delay to Cross Traffic

Justification	Guidance	Hour Ending							Threshold	No. of Hours with Compliance		Average Compliance
		08:00	09:00	12:00	13:00	16:00	17:00	18:00		≥ 100 %	≥ 80 %	
2A	Main Road Traffic Volume (vph)	493	670	605	613	768	795	1005	720			90%
	Compliance	68%	93%	84%	85%	100%	100%	100%		3	6	
2B	Crossing Traffic Volume (vph)	97	72	60	57	88	87	88	75			93%
	Compliance	100%	96%	80%	76%	100%	100%	100%		4	6	
SIGNAL JUSTIFICATION #2:		BOTH 2A AND 2B 100% FULFILLED EACH OF 7 HOURS (YES/NO):								NO		
		LESSER OF 2A AND 2B AT LEAST 80% FULFILLED EACH OF 7 HOURS (YES/NO):								YES		



*Justification #3: Collision Experience*

The collision experience justification reviews the intersection accident data specifically looking at right-angle accidents, which are considered potentially preventable by installing a traffic signal (rear-end and single-vehicle collisions are excluded). This justification also factors in the outputs from the first two justifications to determine if either of them satisfied

the 80 per cent criteria, as opposed to the 100 per cent criteria used in the respective justification. Table 7 shows that for each of the years leading up to and including the year of the data analysis, the number of right-angle accidents exceeded the 100 per cent fulfillment criteria. The reassessment of the first and second justifications, when considering the 80 per cent criteria, also deems this justification to have been satisfied.

Table 7: Collision Experience Assessment

		Year	Number of Collisions	% Fulfillment
				≥ 5 equals 100%
A. Number of reportable collisions susceptible to prevention by a traffic signal.		2008	6	100%
		2009	8	100%
		2010	6	100%
		Total / 3 =		100%
B. Adequate trial of less restrictive remedies has failed to reduce collision frequency (YES/NO)		N/A		
C. Either Justification #1 (Minimum Vehicle Volume) or Justification #2 (Delay to Cross Traffic) satisfied to 80% or more (YES/NO)		YES		
<b>SIGNAL JUSTIFICATION #3:</b>	<b>ALL OF A, B AND C ABOVE ARE FULFILLED (YES/NO):</b>	<b>YES</b>		

*Justification #4: Combination of Justifications*

The fourth justification used is a combination assessment that assesses if any two of the three previous justifications satisfied their respective criteria by 80 per cent or more.

This justification considers the scenario whereby the previous warrants may not have met the criteria 100 per cent of the time, but there is a high enough justification across at least two of the warrants at 80 per cent or higher to justify the intersection upgrade.

Table 8: Combination Justification Assessment

Justification Satisfied 80% or More	YES/NO	Two Justifications Satisfied 80% or More
Justification #1 - Minimum Vehicle Volume	NO	<b>YES</b>
Justification #2 - Delay to Cross Traffic	YES	
Justification #3 - Collision Experience	YES	

Table 9 is the summary of the completed warrant analysis, showing the outcomes of the different types of assessments. The outcome of this assessment was for the

City to move forward with the intersection upgrade from a two-way stop procedure to a fully automated four-way traffic light -controlled intersection.

Table 9: Summary of the Traffic Signal Warrant

Justification		Findings	Average Compliance	Justified (YES/NO)
Justification # 1: Minimum Vehicle Volume	A: Total Volume	100% 4 of 7 Hours ≥80% 7 of 7 Hours	96%	NO
	B: Crossing Volume	100% 0 of 7 Hours ≥80% 0 of 7 Hours	54%	
Justification # 2: Delay to Cross Traffic	A: Main Road	100% 3 of 7 Hours ≥80% 6 of 7 Hours	90%	NO
	B: Crossing Road	100% 4 of 7 Hours ≥80% 6 of 7 Hours	93%	
Justification # 3: Collision Experience	A: Collisions	2008 6 Collision(s) 2009 8 Collision(s) 2010 6 Collision(s)	100%	YES
	B: Trial of Remedies	None	N/A	
	C: Justification 1 or 2 Compliance		90%	
Justification # 4: Combination	A: Minimum Volume (Justification 1)		54%	YES
	B: Delay (Justification 2)		90%	
	C: Collisions		100%	
Justification # 5: Pedestrian	A: Volume	NOT TESTED		
	B: Delay			
<b>Overall</b>	<b>At least one of Justifications 1 to 5 met?</b>			<b>YES</b>

With this evaluation process, at least one of the above justifications shall be fulfilled for a traffic control signal installation to be technically justified.

*Post Intersection Improvement Evaluation*

As noted in the above warrants, preventable collision history was one of the principle factors in the decision to upgrade this particular intersection.

Table 10 is a summary of the total number of collisions leading up to and after the installation of the four-way signal-controlled intersection. Total collision history includes both rear-end and right-angle collisions.

Table 10: Summary of the Total Collision History

	2008	2009	2010	2011	2012	Jan1- Apr 16 2013	Apr 18 - Dec 31* 2013
<b>Total Collisions</b>	11	8	9	4	8	1	3
<b>Right Angle</b>	6	8	6	1	4	1	0
<b>% of Accidents that were Right-Angle Collisions</b>	55	100	67	25	50	100	0

\* *The installation of a four-way traffic light-controlled intersection occurred in April 2013.*

In the collision experience justification (#3), accidents in which one vehicle crossed the path of oncoming vehicle are classified as a right-angle collision. These types of accidents most often result in more severe injuries compared to rear-end collisions, and are also deemed the most preventable through signalisation.

The accident history leading up to the installation of the new traffic lights showed the prevalence of right-angle collisions at this intersection.

While the available data after the installation is currently limited due to system upgrades at the insurance corporation, there were no right-angle collisions reported in eight months after the upgrade. One known consequence of installing traffic lights to control traffic on the major thoroughfare is that the number of rear-end collisions typically increases. The accident data after April does show that rear-end collisions still occur, however there wasn't a statistically significant change in their overall number.

### Exercise 2 (Group)

Each year your City receives complaints about deteriorating road conditions. The ratio of complaints the City receives each year for road conditions exceeds any other form of complaint by about 20 to one. However, solving this issue is not as straightforward as sending out crews to patch up potholes and resurface roads. The City first needs to conduct studies to determine the rate of pavement degradation on all the various types of roads across the City.

Let's assume you have been tasked with your team to conduct a more detailed review of the condition of the roads and to determine which roads have to be resurfaced and which ones rebuilt.

How would you and your team go about conducting this research?

What factors would you have to take into account? Who will you consult with? How will you go about getting the information?

Consider the following factors: road inventory and data collection; traffic counts and average daily traffic; and road surface assessment (e.g. asphalt roads, surface-treated roads and gravel roads).

How will you compile the data and obtain the information required to assist you in your decision?

Based on the information attained above, your analysis could look something like this:

Summary of Road Network Condition Needs<sup>9</sup>

Improvement Type	Now Needs	1-5 Year Needs	6-10 Year Needs	Total
Resurfacer	22.982 km	4.815 km	38.919 km	66.716 km
	\$6,553,225	\$2,245,408	\$6,372,371	\$15,171,004
Pulverize and Resurface PR	14.483 km	20.752 km		35.235 km
	\$3,889,826	\$5,319,196		\$9,209,022
Base and Surface BS	12.862 km			12.862 km
	\$6,325,248			\$6,325,248
Reconstruction REC	8.892 km			8.892 km
	\$6,907,988			\$6,907,988
<b>Total Length</b>	59.309 km	25.567 km	38.919 km	123.795 km
<b>Total Cost</b>	\$23,676,287	\$7,564,604	\$6,372,371	\$37,613,262



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- <sup>1</sup> Australian Bureau of Statistics  
<http://www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+quantitative+and+qualitative+data>
- <sup>2</sup> City of Surrey Commercial and Industrial permit  
[http://www.surrey.ca/files/Commercial\\_and\\_Industrial\\_BP\\_Trend\\_2015-08.pdf](http://www.surrey.ca/files/Commercial_and_Industrial_BP_Trend_2015-08.pdf)
- <sup>3</sup> City of Surrey Population Estimates <http://www.surrey.ca/business-economic-development/1418.aspx>
- <sup>4</sup> City of Calgary City Revenue and Expenditures  
<http://www.calgary.ca/CA/fs/Pages/Action-Plan/Budget-Kit/City-Revenue-and-Expenditures.aspx>
- <sup>5</sup> Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010. US Environmental Protection Agency .[http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw\\_2010\\_factsheet.pdf](http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw_2010_factsheet.pdf)
- <sup>6</sup> Ontario Municipal Housing Affairs Factsheet for Municipalities <http://www.mah.gov.on.ca/AssetFactory.aspx?did=4475>
- <sup>7</sup> Local Government in Victoria Report, 2010  
[http://www.dtpli.vic.gov.au/\\_\\_data/assets/pdf\\_file/0007/224782/Local-Government-in-Victoria-Report-2010.pdf](http://www.dtpli.vic.gov.au/__data/assets/pdf_file/0007/224782/Local-Government-in-Victoria-Report-2010.pdf)
- <sup>8</sup> Indian and Northern Affairs Canada Basic Departmental Data 2004  
[http://www.collectionscanada.gc.ca/webarchives/20071125233054/http://www.ainc-inac.gc.ca/pr/sts/bdd04/bdd04\\_e.pdf](http://www.collectionscanada.gc.ca/webarchives/20071125233054/http://www.ainc-inac.gc.ca/pr/sts/bdd04/bdd04_e.pdf)
- <sup>9</sup> Road Needs Study, Vehicle Traffic Count Program, Pavement Asset Management Program, Prepared by R.J. Burnside & Associates Limited 2012 Town of New Tecumseth  
<http://newtecumseth.ca/wp-content/uploads/2014/11/Road-Study-Report-2014.pdf>

# Experimental Design

## Introduction

A well-designed and constructed research project or experiment should be able to withstand questioning and criticism. The nature of the design of the research project determines whether and how well you can answer your research question.

Therefore, the experimental or research design you choose should clearly and effectively address the research problem in a coherent and logical way. Remember that the function of a research design is to ensure that the evidence obtained enables you to effectively address the research problem as clearly as possible.

Your research topic/problem will determine the type of design. Most of the research projects you will conduct in your role as a manager will be evidence-based, with repeatable observations that can be seen, shared and evaluated by others.

## Why is Research Design Important?

The type of research design used to evaluate a program is important because it determines how well we are measuring its effectiveness.

The more rigorous the research design:

- the better we can interpret outcomes;
- the better we are able to determine effectiveness of a program and be sure there is not some other explanation for measured outcomes; and
- the more confident we can be in our findings.

## Quick Review

What is good evidence?

- Evidence that has been rigorously tested, or evaluated.
- Evidence that helps produce the desired outcome.
- Evidence that exists to help determine that something other than this program/project is responsible for producing the desired outcomes.

**Evidence is rarely absolute** and it has varying degrees of reliability or credibility associated with it.

## Research Designs

Here are some research designs you could consider for your project.

### The One-shot Test – Comparisons with Targets

This is the simplest of designs, where the effects of an action, policy or program are measured against a set of standards or targets. The limitation with this design is that it does not account for alternate explanations for a result or for why the desired results were not met.

### The Before-and-after Design

This design allows one to measure change more objectively. It basically measures the results before and after the experiment or research. It shares similar limitations to the one-shot test in that you can never be sure if an intervention or some external influence had an impact on the results or if it was merely coincidental.

What makes sense logically does not always work out in the observable world. What you need is hard evidence based on repeatable observations.

### The Classical Experimental Design

This is the gold standard among evaluators and researchers. It is a combination of the before-and-after design with a control group added to the equation. It involves setting up two groups. One group (the control group) will remain constant, with no exposure to treatment or intervention. The other group (the experimental group) will be exposed to treatment. If the experimental group exhibits significant change and the control group does not, then you have strong evidence that the intervention or treatment does indeed have an effect on the outcome.

The key to the strength of classical design experiments is to ensure the comparison (control) group is equivalent to the experimental group. For practical purposes, this can include statistically equivalent groups. They need not always be physically or characteristically similar.

Remember that the intent of your research is to help you make the right decision. Choosing the right framework is an important element in helping you determine how credible your evidence and findings are.

When selecting a sample group, be careful to avoid sample selection bias. This means selecting a sample group that you know will most likely help you prove your

theory. Your research has to be objective. The best way to avoid sample selection bias is to conduct a random assignment to the conditions where possible.

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## Case Studies 8 and 9

### Case Study 8<sup>1</sup>

Download this case study:

[http://c40-production-images.s3.amazonaws.com/researches/images/11\\_HEBTP\\_20Report\\_20April\\_202013.original.pdf?1388095773](http://c40-production-images.s3.amazonaws.com/researches/images/11_HEBTP_20Report_20April_202013.original.pdf?1388095773)

This is a good example of a full research report. It lays out the information in a very structured manner. The introduction or executive summary is often the most read portion of a report. If you want to find out the key issues or findings of a research report, this is where you will find it.

As you read, consider the following:

- Take note of how the introduction/executive summary is structured and laid out.
- Can you identify the type of research design?

- Take notice of the different ways the data is presented; each table demonstrates a different finding but still relates back to the main key issue.
- Read the discussion section carefully and take note of how it repeatedly ties back its explanations to an evidence-based finding. Graphs/charts are helpful tools to visually show the findings.
- Every report **MUST** have a conclusion. This is where you restate your hypothesis, whether it is proven correct or not, and why you think so.

### Case Study 9<sup>2</sup>

Download this case study:

<http://www.wellesleyinstitute.com/wp-content/uploads/2013/12/Building-Population-Health-Into-Municipal-Policy.pdf>

This case study is different in the sense that it is based entirely on literature review and not on data ‘crunching’.

This is another way of conducting your evidence-based research.



## Exercise

1. Now that you have read the case studies, what are your impressions?

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2. Were they easy to follow?

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3. Would you present your research in a similar manner? Why?

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4. Is there an alternative approach to presenting this sort of research? How would you go about doing it?

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<sup>1</sup> Low carbon technologies can transform Latin America's bus fleets, C40 Initiatives, Clinton Climate Initiatives, IDB [http://c40-production-images.s3.amazonaws.com/researches/images/11\\_HEBTP\\_20Report\\_20April\\_202013.original.pdf?1388095773](http://c40-production-images.s3.amazonaws.com/researches/images/11_HEBTP_20Report_20April_202013.original.pdf?1388095773)

<sup>2</sup> Williams, Lisa Marie, Building Population Health Into Municipal Policy The Use of Health Impact Assessments, Wellesley Institute, December 2013 <http://www.wellesleyinstitute.com/wp-content/uploads/2013/12/Building-Population-Health-Into-Municipal-Policy.pdf>

# Costing Analysis

## Introduction

Government programs have become more complex with time. Furthermore, the public increasingly demands that departments integrate their functions with one another to include more comprehensive services. These services often require more sophisticated resources, processes, and better or differentially trained personnel. In today's environment of rising costs and funding cuts, municipalities and local government departments are forced to constantly watch their bottom line while making sure that the efficiencies and cost savings they are trying to achieve do not compromise the levels of service they are required to provide to the public. It is a difficult balance to maintain.

You are responsible for the efficient and, effective delivery of services to the general public, ensuring the safety of the community, as well as protecting the environment and civil property. And rounding all this up, you are also the operational manager of your department and are responsible for, among other things: budget administration and control; allocation of personnel and resources to achieve performance targets; dealing with external agencies; planning and resource management; and, dealing with political aspects of authority.

In essence, you wear many hats!

As the operational manager of your department you will have to oversee numerous financial aspects, such as equipment purchases and upgrades, and staffing costs. In order to be able to make the most cost-effective decision, you would do well to conduct a costing analysis to identify whether the investments you will make in purchasing, upgrading to new equipment or hiring additional personnel will bring you the desired returns or benefits.

### Costing studies will:

- Link the outcomes you wish to measure with the goals and objectives of your operational and strategic plans. It will help you focus on the question about whether the activity is within the organization's mandate.
- Help you focus on the many line items that make up actual costs.
- Provide a transparent and fairly mechanical way of helping you decide on options.

## Quick Review

The purpose of costing is not simply to collect cost data, but to provide managers with information they can use to make better management decisions.

There are two forms of costing:

- **Straight costing analysis:** determines the costs associated with doing something, such as the decision to purchase a document management software program, or the decision to purchase or update new equipment, computers or purchasing a new vehicle.
- **Cost-benefit analysis or cost-effectiveness analysis:** this is the weighing of all the costs associated with a decision against the value of the expected benefits.

Opportunity cost is a benefit, profit or advantage that you will have to give up so that you can acquire or achieve something else. For example, those choosing to become a police officer or firefighter are giving up predictability in their daily life, some loss of leisure time and possibly time with family.

Costing studies will allow you to identify the total cost of a decision and what the returns or benefits associated with that decision might be.

## Choosing the Type of Costing Analysis

There are five overall steps to consider when conducting either a straight costing analysis, or a cost-effectiveness or cost-benefit analysis:

1. Identify the issue or subject to which the analysis relates.
2. Set out the objectives that you want the decision to achieve.
3. Identify the options or choices that are available.
4. Conduct a financial (cost-benefit or cost-effectiveness) analysis of the option selected or the options under consideration.
5. Prepare an accounting statement or report summarising your findings.

## Cost Analysis

Straight costing involves estimating the total life cycle of a particular piece of equipment or service. The life cycle is the period during which you intend to use the product or service.

To conduct an accurate cost analysis, be sure to include all the relevant costs.

For capital-related costs, such as those for equipment, vehicles, buildings and fixtures, the costs could include:

- Depreciation rate—difference between the purchase price and selling price
- Interest on capital
- Maintenance fees
- Licensing or regulatory fees
- Operator or labour costs

### Example: Simple Depreciation Calculation

Assuming a new special service SUV costs \$80,000 and that it depreciates at a rate of 35% per year, you would like to know what it is worth at the end of the two years after purchasing it.

*Calculate the depreciation:*

Year 1:	$\$80,000 \times 0.35$	=	\$28,000
Year 2:	$\$52,000 \times 0.35$	=	\$18,200
Total depreciation after two years		=	\$46,200

**Residual value of the SUV after two years = \$33,800**



A key element in analysing cost-effectiveness is being able to identify appropriate output measures and being able to measure them appropriately.

### Fixed and Variable Costs

Fixed costs are also called “sunk costs” because they must always be paid. These include such items as loan payments, rent, insurance, and leasing fees.

Variable costs generally relate to operating and maintenance costs where the amounts or occurrence are not a constant. For example, these would include maintenance costs for municipal vehicles, building maintenance and upkeep.

### Direct and Indirect Costs

Direct costs are those absorbed by your department directly, such as new employee uniforms and safety gear, staff salary, and loan payments.

Indirect costs are those not directly incurred by your department but are necessary in order to run the department. These could include advertising costs for hiring, screening and testing of applicants, and equipment maintenance.



## Exercise 1

Your department has been experiencing dramatic increases in its overtime budget and is confronted with continual pressure from the city leadership to reduce this cost. To face this problem you, as head of your department, are tasked with conducting an analysis to determine whether it is more cost effective to hire additional personnel or to continue to use your current staff to work overtime to fill this shortages.

Using a municipal fire department as an example, the two tables on the next page summarise the annual and hourly salary for various positions. The hourly salary is

determined by the annual regular salary divided by 2,912 hours scheduled per year inclusive of any benefits. The overtime rate is the normal hourly rate multiplied by 1.5 times. Personnel working overtime are not paid benefit costs.

The second table outlines the salary breakdown costs if you were to hire more staff. The annual salary listed includes benefits but excludes overtime cost.

*The task:*

For the two tables, calculate the hourly and overtime rate for the current staff levels and for hiring new staff.

**Current Staff Annual Salary with Overtime Payment**

	<b>Salary</b>	<b>Hourly Rate (Salary / 2,912 Hours)</b>	<b>Overtime Rate (Salary / 2,912 Hours) x 1.5</b>
<b>Firefighter</b>	\$53,697		
<b>Firefighter/ paramedic</b>	\$57,908		
<b>Fire engineer</b>	\$60,894		
<b>Fire Captain</b>	\$70,490		

**New Personnel Hire: Annual Salary**

	<b>Salary</b>	<b>Hourly Rate (Salary / 2,912 Hours)</b>
<b>Firefighter</b>	\$81,799	
<b>Firefighter/ paramedic</b>	\$87,671	
<b>Fire engineer</b>	\$95,567	
<b>Fire Captain</b>	\$107,383	

Based on your calculations above, what are your findings? Is it more cost effective to hire new personnel or to pay overtime? How big is the difference in cost savings/increase?

If hiring additional staff is more cost effective based on this calculation, are

there any other additional costs that you would have to factor in when deciding to hire new personnel?

If you opt for overtime payments, what other cost factors could affect your departmental budget? Note: consider both the direct and indirect costs.

## Cost-benefit Analysis (CBA)

Literally, cost-benefit analysis means weighing the costs against the benefits or profits of a proposed project. It helps you evaluate several alternatives, and the one with the highest benefit ratio would be the prudent choice. For instance, the decision whether to hire more full-time staff over paying for overtime will identify both the potential benefits as well as who will incur the costs for either proposal.

You can use CBA to:

- decide whether a proposed project or programme should be undertaken;
- decide whether an existing project or programme should be continued; or
- choose between alternative projects or programmes.

As division head, it would be expected that you conduct such an analysis to show that the recommended option you propose maximises the economic, environmental and social benefits to the department, community, and government.

## Components of a CBA

1. Define the problem: link it back to your operational or strategic plan.
2. Identify any constraints or limiting factors: list out any challenges, which could include financial limitations, managerial or personnel challenges, environmental and other regulations.
3. List the alternatives: for example, whether to hire more full-time staff, amalgamating departments, or integrating services.
4. List the benefits: for the benefits identified, what is the return on investment? This could either be in monetary terms or in other items such as an increase in productivity. Health and safety are often the 'soft' benefits in these situations.
5. How are the costs and benefits to be quantified?

All benefits and costs should be expressed in discounted present values.

### Example: Cost-benefit Analysis

Assuming the net present value of the benefits of a program is \$13.5 million and the net present value (NPV – see next page) of the costs is \$10 million, the benefit cost ratio (BCR) would be:

$$\text{BCR} = \frac{(\text{NPV Benefits})}{(\text{NPV Costs})} = \frac{13.5}{10.0} = 1.35$$

### Net Present Value (NPV)

Net present value is the current worth of a future sum of money or stream of cash flow given a specified rate of return. It is used to calculate the total of all cash flow (in and out) that can be directly linked to your project.

If it is positive, good. Otherwise, you may want to reconsider the investment.

On a personal level, assume you have invested \$5,000 in a locked-in savings certificate with a five-year redemption at a 3% interest rate. How much will you get in return at the end of the five years?

	Interest Rate 3%	Total Growth in % (1 + Interest Rate)
Year 1	$1 \times 3/100 = 0.03\%$	$1 + 0.03 = 1.03\%$
Year 2	$1 \times 3/100 = 0.03\%$	$1 + 0.03 = 1.03\%$
Year 3	$1 \times 3/100 = 0.03\%$	$1 + 0.03 = 1.03\%$
Year 4	$1 \times 3/100 = 0.03\%$	$1 + 0.03 = 1.03\%$
Year 5	$1 \times 3/100 = 0.03\%$	$1 + 0.03 = 1.03\%$
<b>Total interest for 5 years</b> (1 + interest rate) <sup>#year</sup>		<b>1.03<sup>5</sup></b>
<b>Investment in 5 years</b>	$1,000 \times 1.03^5$	
<b>Total</b>	<b>\$5,769</b>	

Now consider the opposite – how much would you need to invest to get a return of \$5,000 after five years at a discount (interest) rate of 3%?

*Calculation:*

$$\text{Actual value} / (1 + \text{discount rate})^{\text{\#year}}$$

$$\$5,000 \times (1/1.03)^5 = \$4,313$$

In other words, what is the **net present value of your investment?**



## Exercise 2

Public transit, energy conservation, cost reduction and climate change are global issues. Many, if not all, major cities and transport authorities are seeking less dependence on fossil fuels and transitioning to new technologies such as hybrid-electric transport and biofuels.

The public transit in your city is considering switching its current fleet to a hybrid electric fleet. Hybrid buses are estimated to cut emissions by as much as 75 per cent when compared to conventional diesel buses. The emission reductions are a function of the electric drive, ultra-low-sulfur diesel (ULSD) fuel use in conjunction with particulate trap technology and improved fuel economy from the hybrid system.<sup>1</sup> Hybrid buses are also expected to last longer and to have lower maintenance costs, due to reduced stress and maintenance on mechanical

components such as brake linings, which may extend brake life by 50-100 per cent. In addition, the electric drive has fewer parts, therefore requiring less maintenance than a traditional transmission.<sup>2</sup>

*The task:*

Before the transit authority or city can make this decision, it needs to determine whether it is cost efficient to purchase or lease a hybrid electric bus. You have been tasked to conduct this analysis..

- Option #1: Lease a hybrid bus for \$90,000/year for five years, with a 3.4% discount rate.
- Option #2: Buy a hybrid bus for \$475,000, with a selling price of \$250,000 at the end of five years with a discount rate of 3.4%.

Which is the best value? Complete the calculations below.

### Option #1

Year	Payments	Discount Rate	Present Value
1	(90,000)	1	(90,000)
2	(90,000)	0.967	(87,030)
3	(90,000)		
4	(90,000)		
5	(90,000)		
NPV =			

**Option #2**

Year	Payments	Discount Rate	Present Value
0	(475,000)	1.0	(475,000)
5	250,000		
NPV =			

Which is the better option based on the NPV?



**Case Study 10**

**Focus: Engineering Department – Street Light Wire Replacement Program To Counteract Wire Theft Epidemic**

Since 2006, the City of Surrey has experienced a dramatic increase in copper wire theft from the City’s street light system, following the surge in the price metal recyclers were willing to pay as global prices soared.

Table 1 shows the physical repair costs incurred by the City each year, although it doesn’t account for the salaries of City staff: engineering staff, bylaw enforcement and police officers. Staff spent significant amounts of time administering and overseeing repairs and trying to tackle this crime issue. Other more qualitative values also aren’t accounted for, such as the cost associated with safety risks (for example, pedestrian safety caused by lack of light, and the risk of exposed live electrical wires following the theft).

Table 1: Street Light Wire Theft Repair Costs

Year	Repair Costs
2005	\$15,718.38
2006	\$215,696.80
2007	\$1,235,822.68
2008	\$1,168,381.74
2009	\$145,684.60
2010	\$1,268,529.95
2011	\$2,819,392.19
2012	\$2,113,746

Figure 1 on the following page shows global copper prices over time.

Figure 1: Historical Global Copper Prices \$USD (Price per Metric Tonne)<sup>3</sup>



Note the correlation between the 2009 market price drop and the dramatic drop in wire theft. In 2011, the annual costs to address wire theft from street lights equated to approximately 20 per cent of the annual traffic operations budget, seeing a significant diversion of resources away from other transportation initiatives.

In response, the City implemented a number of strategies to deter wire theft:

- The inclusion of “Wire Sentry” devices in all new street lights to physically prevent the removal of copper wire from the conduits.
- Public education initiatives to be on the lookout for wire thieves,
- New regulations for recycling facilities to record all transactions along with the sellers’ identification, and
- Adding locks to existing utility access points.

The installation of the Wire Sentry devices in new light poles proved to be an effective counter measure, although the cost to upgrade the 29,000 street lights across the City wasn't practical. In addition, while the other strategies made wire theft more difficult, it didn't eliminate the practice.

In 2013, City engineering staff identified an alternative to copper wire that uses a wire composed of an aluminum alloy. The new alternative had similar conductivity levels, while being both cheaper to purchase (50 per cent cost saving per meter) and having

only 10 per cent of the value on the scrap metal market.

In light of this wire alternative, a pilot project was undertaken to evaluate the cost of replacing the City's entire street lighting copper wire inventory of approximately 2,600 km. The City retained three contractors as part of a pilot project to determine the cost of completing this strategy across the entire City.

Table 2 below summarises the costs to the City incurred by each of the contractors to complete the work.

Table 2: Summary of Progress and Average Costs for Wire Replacement Pilot Projects

	Contractor #1	Contractor #2	Contractor #3
Days worked	13	23	17
Length of aluminum wire installed (m)	9,361	11,211	11,501
Material cost (\$)	\$51,523	\$61,682	\$51,525
Labour cost (\$)	\$25,238	\$44,884	\$48,997
Equipment cost (\$)	\$10,038	\$12,040	\$7,674
Weight of copper salvaged (lbs)	10,736	12,896	12,196
Value of copper salvaged (\$2.32/lb)	\$25,230	\$29,919	\$26,390
<b>Total cost to replace copper wire with aluminum (not. including GST)</b>	<b>\$61,569</b>	<b>\$88,687</b>	<b>\$81,806</b>
Avg. cost/metre	\$6.58	\$7.91	\$7.11
Avg. rate of installation (m/day)	720	487	677
Avg. cost/metre ( <i>Wire Sentry locations</i> )	\$25.41	\$14.62	\$11.24
Avg. rate of installation ( <i>Wire Sentry locations</i> ) (m/day)	200	400	400
Copper salvage (\$/m)	\$2.70	\$2.67	\$2.32
Aluminum price (\$/m)	\$5.03	\$4.58	\$4.48



In addition to identifying the real-world cost of conducting the work, another advantage of the pilot study was that it identified a number of procedural efficiencies that were incorporated into the ultimate project, such as using single-strand wires rather than multi-core to better handle obstructions in the wire conduits, and methods for pulling the wire through.

Once all the costs (labour, replacement wire, and salvaged material) were factored in, the linear cost per meter equated to roughly \$7 to \$8 for the parts of the system that didn't use wire sentries. As Wire Sentry-equipped street lights required lane closure and cranes to dismantle the street light to gain access, the cost at these locations were significantly higher. Due to the success of the Wire Sentry devices at reducing wire theft, combined with the added cost of replacing wire at these locations, it was decided to omit these locations from the City-wide replacement project.

Another cost benefit analysis that came out of the pilot study was the comparison between the time it would take to complete the works and the cost incurred by the City each month responding to wire theft. The study identified that each labour crew could install approximately 600 metres of wire per day. Based on a standard number of working days (251 work days/year), it would take nearly 8 years to complete the city wide retrofit using a single crew.

On average it costs the City \$83,000/month in wire theft repairs. In discussions with the contractors involved in the pilot study, it was agreed that additional crews could be provided to ensure the project could be completed within 24 to 36 months. This provided a significant cost savings due to reduced wire theft as the installation proceeded.

Ultimately the City decided to replace 1.2 million meters of copper wire at a projected budget of \$8.5 million. Upon completion, the project came in well under budget (under \$8 million) and ahead of time (completed in 18 months).

Following the project completion, wire theft has dropped off by nearly 100 per cent, resulting in approximately a \$2-2.3 million in savings per year (including staff time). In addition to the cost savings, there have been a number of secondary cost savings, such as:

- Staff that had been allocated to deal with wire theft repairs and enforcement programs could be reallocated to other initiatives,
- The City's street light system, which in some areas was over 30 years old, was upgrade to new wiring and now conforms to the latest electrical code, reducing future maintenance costs,
- Funding could be channeled into other system upgrades, and
- There was reduced risk to the public during the night-time hours.

<sup>1</sup> EESI Hybrid Buses Costs and Benefits [http://www.eesi.org/files/eesi\\_hybrid\\_bus\\_032007.pdf](http://www.eesi.org/files/eesi_hybrid_bus_032007.pdf)

<sup>2</sup> EESI Hybrid Buses Costs and Benefits [http://www.eesi.org/files/eesi\\_hybrid\\_bus\\_032007.pdf](http://www.eesi.org/files/eesi_hybrid_bus_032007.pdf)

<sup>3</sup> Table found at [https://malthusiannectar.files.wordpress.com/2011/12/copper1\\_historicalprices.jpg](https://malthusiannectar.files.wordpress.com/2011/12/copper1_historicalprices.jpg)

# Summary & Conclusion

In essence there are four main steps that you should follow when formulating a

good evidence-based strategy. Can you recall them?

## Identify and Frame the Question

- Should be drawn from your strategic plan or organizational plan.
- Helps to focus the issue on the key purpose or objective of your department/division.

## Gather the Evidence

- Both internal data from your organization and external data.
- Use a librarian.
- Get comfortable with sourcing.

## Organize the Evidence

- Present your data in a table, chart or a method that best suits the message you are trying to convey.
- Cite your data sources.
- Tie your data back to your question/theory. Put it in context.

## Review the Decision-making Process

- What did you learn?
- Could the process have been streamlined?

## ***The Right Decision: A Workbook***

This companion to *The Right Decision: Evidence-based Decision Making for Government Professionals* guides readers through the process required for sound decision making.

Using case studies, examples and exercises, this workbook will help you take the next step in ensuring your decisions are effective and justifiable because they are based on data and evidence.