Dashboards and Data Visualization, with Examples

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Abstract
A **data dashboard** is any visual display of data used to monitor conditions and/or facilitate understanding. In a car's dashboard, a small number of **key indicators** (speed, gasoline level, lights, etc.) need to be understood **at a glance** – data dashboards need to be designed with the same care.

Keywords
dashboards, data visualization

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1. Introduction

An analytical process is only as good as how it is **communicated** and/or **deployed**. Among the crucial questions that must be studied at that stage, we consider:

- who is in receipt of the report(s)?
- how are the workflows deployed into production?
- can data insights be turned into useful policies?

When dealing with huge throngs of data and analyses, it is becoming more and more common for the reporting process to be **automated**, making it (hopefully) easier to converge to actionable insights; consequently, the need for regular audits and validation has only increased.

In an ideal scenario, the analysis software doubles as reporting software, which minimizes human error related to cut-and-paste or manual editing, removes the need for keeping the analysis and the reporting components separated, and makes sharing the work with other project members substantially easier. In practice, however, most of the current commercial visualizing platforms do not possess the built-in flexibility to allow concurrent in-depth analysis and reporting.

2. Dashboards

Dashboards are a helpful way to **communicate** and **report** data. They are versatile in that they support multiple types of reporting. Dashboards are predominantly used in business intelligence contexts, but they are being used more frequently to communicate data and visualize analysis for non-business services. Popular dashboarding platforms include

- Tableau, and
- Power BI.

There are other options, such as Excel, R + Shiny, Geckoboard, Matillion, etc. These technologies aim to make creating data reports as simple and user-friendly as possible. They are intuitive and powerful; creating a dashboard with these programs is quite easy, and there are tons of how-to guides available online [1, 2, 9].

In spite of their ease of use, however, dashboards are suffer from the same limitations as other forms of data communication, namely: how can results be conveyed **effectively** and how can the **correct data story** be relayed to the desired audience? Putting together a "good" dashboard is more complicated then simply learning to use a dashboarding application.

2.1 Foundation of Dashboards

Effective dashboarding requires that the designers first plan and answer questions about what the dashboard is attempting to be/do:

- Who is the target audience?
- What value does the dashboard bring?
- What type of dashboard is being created?

Answering these questions can guide and inform the visualisation choices that will go into creating the dashboard.

Selecting the **target audience** helps inform data decisions that meet the needs and abilities of the audience. When thinking of an audience, consider their **role** (what decisions do they make?), their **workflow** (will they use the dashboard on a daily basis or only once?), and **data expertise level** (what is their level of data understanding?).

When creating a dashboard, its important to understand (and keep in mind) why it is needed. Is its value:

- to help managers make decisions?
- to educate people?
- to set goals/expectations?
- to evaluate and communicate progress?

Or some combination of these needs? Dashboards can be used to communicate numerous concepts, but not all of them can necessarily be displayed in the same time and space so it's important to know where to focus specifically to meet the individual dashboard goals.

Dashboard decisions should also be informed by the scope, the time horizon, the level of detail required, and the point of view of the dashboard.

- the **scope** of the dashboard could be either broad or specific – an example of a broad score would be displaying information about an entire organization, whereas a specific scope could focus on a specific product or process;
- the **time horizon** is important for data decisions – it could be either historical, real-time, snapshot, or predictive:
  - **historical** dashboards look at past data to evaluate previous trends;
  - **real-time** dashboards refresh and monitor activity as it happens;
  - **snapshot** dashboards show data from a single time point, and
  - **predictive** dashboards use analytical results and trend-tracking to predict future performances;
- the **level of detail** in a dashboard can either be high level or drill-able – **high level** dashboards provide only the most critical numbers and data; **drill-able** dashboards provide the ability to "drill down" into the data in order to gain more context.
- the dashboard **point of view** can be prescriptive or exploratory – a **prescriptive** dashboard prescribes a solution to an identified problem by using the data as proof; an **exploratory** dashboard uses data to explore the data and find possible issues to be tackled.

The foundation of good dashboards comes down to deciding what information is most important to the given audience in the context of interest; they should have a core theme based on the essence of either a problem or data story, while removing extraneous information from the process.

2.2 Dashboard Structure

The dashboard structure is informed by four main considerations:

- **form –** format in which the dashboard is delivered;
- **lay-out –** physical look of the dashboard
- **design principles** – fundamental objectives to guide design
- **functionality –** capabilities of the dashboard

Dashboards can be presented on paper, in a slide deck, in an online application, over email (messaging), on a large screen, on a mobile phone screen, etc. Selecting a format that suits the dashboard needs is a must; various formats might need to be tried before arriving at a final format decision.

The structure of the dashboard itself is important because visuals that tell similar stories (or different aspects of the same story) should be kept close together, as physical proximity of interacting components is expected from the viewer/-consumers. Poor structural choices can lead to important dashboard elements being undervalued. Figure 9 provides an example of group visuals that tell similar stories.

Knowing which visual displays to use with the "right" data helps dashboards achieve structural integrity:

- **distributions** can be displayed with **bar charts** and **scatter plots**;
- **compositions** with **pie charts**, **bar charts**, and **tree maps**;
- **comparisons** use **bubble charts** and **bullet plots**, and
- **trends** are presented with **line charts** and **area plots**.

An interesting feature of dashboard structure is that it can be used to guide **viewer attention**; critical dashboard elements can be highlighted with the help of visual cues such as use of **icons**, **colours**, and **fonts**.

Using **filters** is a good way to allow dashboard viewers of a dashboard to customize the dashboard scope (to some extent) and to investigate specific categories of data closely. Figure 10 provides an example of a dashboard that makes use of an interactive filter to analyse data from specific categories.

2.3 Dashboard Design

An understanding of design improves dashboards; a dissonant design typically makes for poor data communication. Design principles are discussed in vivid detail in [**?**, 4–8]. For dashboards, the crucial principles relate to the use of

- grids;
- white space;
- colour, and
- visuals.

When laying out a dashboard, **gridding** helps to direct viewer attention and to make dashboards more readable; note, in Figure 9, how the various visuals are aligned in a grid format to lay the data out in a clean, readable manner.

In order to avoid viewers being overwhelmed by clutter or information overload, consider leaving a large-enough amount of **blank space**; note, in Figure 10, that while there is a lot of information provided in the dashboard, there is also a lot of blank/white space left in-between the various visuals to provide viewers with space to breathe. Too much clutter shuts down the communication process (see Figures 4 to 8).

Colour provides meaning to data visualisations – bright colours, for instance, should be used as indicators of alarm as they immediately draw the viewer's attention. Colour themes create cohesiveness, which improves the overall readability of a dashboard.

There are no perfect dashboards – no collection of charts will ever suit everyone who encounters it. That being said, dashboards that are **elegant** (as well as **truthful** and **functional**) will deliver a bigger bang for their buck.

In the same vein, keep in mind that all dashboards are **incomplete**. Good dashboards may still lead to dead ends, but they should allow users to ask: "Why? What is the root cause of a problem?"

Finally, we would be remiss in our duties if we didn't remind potential designers and viewers that a dashboard is only really as good as the data it uses; a dashboard with badly processed or un-representative data, or showing the results of poor analyses, cannot be an effective tool, no matter how spiffy its design.

2.4 Examples

Dashboards are used in multiple and varied contexts, such as:

- interactive displays that allows people to explore motor insurance claims by city, province, driver age, etc.;
- a PDF file showing key audit metrics that gets e-mailed to a Department's DG on a weekly basis;
- a wall-mounted screen that shows call centre statistics in real-time;
- a mobile app that allows hospital administrators to review wait times on an hourly- and daily-basis for the current year and the previous year;
- etc.

In what follows, we present examples of dashboards that run the gamut from Good to Bad to Ugly.

The Good: Course Metrics Dashboard

Scenario: (taken from [9]) the head of an academic department would like to know

- how a given professor's course is rated compared to other courses in the department and at the university in general;
- the overall course load, the number of students, and the overall growth or decline in the enrolment for a particular course;
- how many courses an instructor has been teaching over time, and
- the detailed ratings of the most recent course and instructor feedback.

What type of data is required? How could a dashboard be arranged/designed to help answer these questions?

A sample of the data used at the University of Cincinnati is shown in Table 1, with a screenshot of the dashboard found in Figure 1.

This is considered to be a good example of a dashboard as it displays easy-to-see key metrics, uses a simple yet elegant colour scheme, has the potential to be either static or interactive, and both the dashboard as a whole and its details are clear. The Tableau file can be downloaded at **https://bigbookofdashboards.com/dashboards.html**.

Another great example from [9] (an interactive dashboard developed by [12]) is displayed in Figure 2.

The last example of this section (see Figure 3) shows that dashboards do not need to be exceedingly fancy in order to be useful.

The Bad: CVUS Dashboard

Dashboards for which a plethora of visuals are provided might seem like a good idea in theory; in practice, even with plenty of white space, it is easy to get lost in piles of graphics. The following example showcases the importance of remaining succinct, of using attention-grabbing graphics and colours, and, of course, of designing the dashboard with a story in mind – what is the world is the story even *supposed* to be, here?

Scenario: (personal files) the **Canadian Vehicle Survey** (CVS) was sponsored by *Transport Canada* (TC) and *Natural Resources Canada* between 1999 and 2009. The quarterly survey employed a **two-stage sample design**: a sample of vehicles was selected and then a period of travel within the quarter was selected for each vehicle.

Vehicles were grouped into three categories: *light vehicles* (passenger cars and light trucks/vans) and two types of *heavy vehicles*, based on the gross vehicle weight. A **paper questionnaire** was then mailed out to the owners of the selected vehicles, requesting that they record the *number of*

Year	Semester	Students	Average
'12	S	42	52
	F	16	52
'13	S	71	52
	US	14	52
	F	27	52
'14	S	69	52
	S	55	52
	US	28	52
	F	27	52
	F	61	52
'15	S	46	52
	S	80	52
	US	43	52
	F	61	52
	F	69	52
'16	S	62	52
	S	80	52
	US	50	52
	F	62	52
	F	65	52
	F	69	52
		1097	

year	enrollments
'12	58
'13	112
'14	240
'15	299
'16	388
	687

Year	# classes
'12	2
'13	3
'14	5
'15	5
'16	6
	21

Year	Semester	Rating
'12	S	6.6
	F	6.5
'13	S	6.7
	US	7.7
	F	6.9
'14	S	6.4
	S	6.7
	US	7.5
	F	7.3
	F	7
'15	S	6.4
	S	7
	US	6.8
	F	7.3
	F	7.7
		7.7

Semesters	Questions	Mean Rating	Entity	Shaffer	BANA	College
2015 Fall Semester 002	The instructor was well organized	7.5	Shaffer	7.5	6.8	7
2015 Fall Semester 002	The instructor communicated clearly	7.6	Shaffer	7.6	6.5	6.9
2015 Fall Semester 002	The instructor interacted well with students	7.7	Shaffer	7.7	6.6	7
2015 Fall Semester 002	The Instructor graded fairly	7.6	Shaffer	7.6	6.8	7.1
2015 Fall Semester 002	I developed specific skills and competencies	7.2	Shaffer	7.2	6.3	6.5
2015 Fall Semester 002	Overall, this instructor was excellent	7.7	Shaffer	7.7	6.4	6.8
2015 Fall Semester 002	Overall, this was an excellent course	7.4	Shaffer	7.4	5.9	6.4
2015 Fall Semester 001	The instructor was well organized	7.3	Shaffer	7.3	7	6.9
2015 Fall Semester 001	The instructor communicated clearly	7.4	Shaffer	7.4	6.7	6.7
2015 Fall Semester 001	The instructor interacted well with students	7.3	Shaffer	7.3	6.8	6.8
2015 Fall Semester 001	The Instructor graded fairly	7.5	Shaffer	7.5	7.1	7
2015 Fall Semester 001	I developed specific skills and competencies	6.9	Shaffer	6.9	6.8	6.7
2015 Fall Semester 001	Overall, this instructor was excellent	7.3	Shaffer	7.3	6.7	6.7
2015 Fall Semester 001	Overall, this was an excellent course	7.1	Shaffer	7.1	6.6	6.5

Table 1. Data related to course evaluation metrics at the University of Cincinnati [9].

trips, *distance driven*, and *fuel consumption* during the observation period. The CVS was hampered by low participant response rates over its duration ($\approx 20\%$), caused in large part by the **burdensome paper collection** methods. The quality of the estimates was also weakened by **significant errors** in the way in which the vehicle fleet was classified due to mistakes in the *Vehicle Identification Number* (VIN) decoder.

As a result, TC decided to conduct a pilot **Canadian Vehicle Use Study** (CVUS) to validate (or invalidate) the CVS methodology and results. Improvements included

- the use of **electronic data loggers** to reduce reporting burden;
- the introduction of a more **robust** VIN decoder to increase the accuracy of the in-scope fleet, and
- a **modified sampling design** that incorporated additional strata to enhance the ability to carry out more detailed analyses of motor vehicle use.

The pilot study was carried out in the 4th quarter of 2010 on $n = 1011$ light vehicles, selected via **simple random sampling** (SRS) from a list of vehicles registered with the *Ministry of Transportation of Ontario* (MTO) having an adress whose *Forward Sortation Area* (FSA) code was associated with Ottawa and surrounding Ontario areas.

In order to evaluate the performance of the pilot CVUS, *vehicle-km traveled* (VKT) tallies were compared against corresponding CVS observations for the 4th quarter of 2009 ($n = 1016$).

The pilot CVUS was found to have a smaller number of observations at low VKT values than the CVS, whereas that trend was reversed at medium VKT values. The empiri-

cal means also seemed substantially different, at $\overline{x}_{\text{CVUS}} = 16,716$ km/year vs. $\overline{x}_{\text{CVS}} = 14,237$ km/year, although the high standard deviations $s_{\text{CVUS}} = 11,616$ km/year vs. $s_{\text{CVS}} = 13,844$ km/year made for inconclusive point comparisons.
Perhaps more importantly, the proportion of non-active vehicle in the fleet was much higher for 2009 in the CVS (8.7%) than it was for 2010 in the pilot CVUS (2.1%), and the distribution ranges are quite dissimilar: down to 79,500 km/year in 2010 from 112,500 km/year in 2009.

In any event, a **Kolmogorov-Smirnov test** rejected the null hypothesis that the two samples were drawn from the same distribution at the 99.9% significance level.

The CVS project management team steadfastly refused to update their survey in the face of this evidence, which gave TC the impetus to go ahead with a full-fledge CVUS survey.

The dashboard (see Figures 4-6) covers the survey results for the first quarter of 2012 in Ontario. An extract of the data fed into the dashboard is shown in Tables 2 and 3.

The Ugly

While the previous dashboards all have some strong elements, it is a little bit harder to be generous for the two examples provided by Figures 7 and 8. Is it easy to figure out, at a glance, who their audience is meant to be? What are their strengths (do they have any)? What are their limitations? How could they be improved?

The first of these is simply "un-glanceable" and the overuse of colour makes it unpleasant to look at; the seond one features 3D visualizations (rarely a good idea), distracting borders and background, lack of filtered data, insufficient labels and context, among others.

Golden Rules and Two Examples

In a (since-deleted) geckoboard.com article, Nick Smith posted his 6 Golden Rules of Dashboard Design:

- **consider the audience** (who are you trying to inform? does the DG really need to know that the servers are operating at 88% capacity?);
- **select the right type of dashboard** (operational, strategic/executive, analytical);
- **group data logically, use space wisely** (split functional areas: product, sales/marketing, finance, people, etc.);
- **make the data relevant to the audience** (scope and reach of data, different dashboards for different departments, etc.);
- **avoid cluttering the dashboard** (present the most important metrics only), and
- **refresh your data at the right frequency** (real-time, daily, weekly, monthly, etc.).

Let's see how some of these can be applied to two datasets (*Global Cities Index* [15], *2015 NHL Draft Data* [16]). Screenshots of associated (Power BI) dashboards are provided in Figures 9 and 10, respectively.

Figure 9 displays data collected from various cities ranked on the **Global Cities Index**. The dashboard goal is to allow a **general audience** to **compare and contrast** the various globally ranked cities – statistics that contribute to a "higher" ranking immediately pop out. Viewers can also very easily make comparisons between high- and low-ranking cities. The background is kept neutral with a fair amount of blank space in order to keep the dashboard open and easy to read. The colours complement each other (*via* the use of a colour theme picker in Power BI) and are clearly indicative of ratings rather than comparative statistics.

Figure 10 displays the current of the professional statistics (as of August 2019) of hockey players drafted into the NHL in 2015, as well as their overall draft position. This dashboard allows **casual hockey fans** to **evaluate the performance** of players drafted in 2015. It provides demographic information to give context to possible market deficiencies during this draft year (i.e. defence players were drafted more frequently than any other position). This dashboard is designed to be interactive; the filter tool at the top allows dashboard viewers to drill-down on specific teams.

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[13] **Poor Use of Dashboard Software**

[14] **Two Terrible Dashboard Examples**

[15] **Globalization and World Cities Research Network**

[16] **2015 NHL Entry Draft**

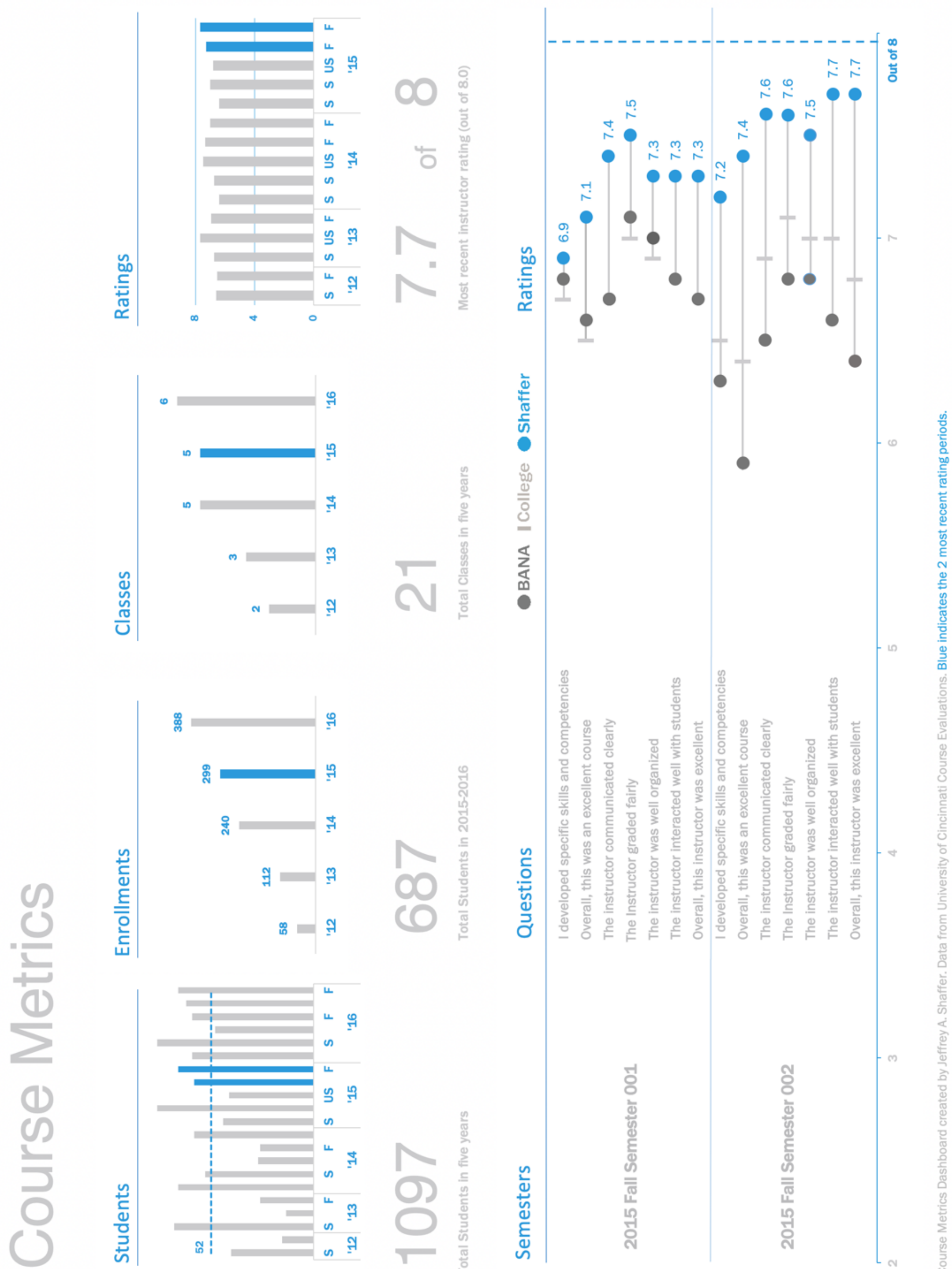

Figure 1. An exploratory dashboard showing information related to course evaluation metrics at the University of Cincinnati [9].

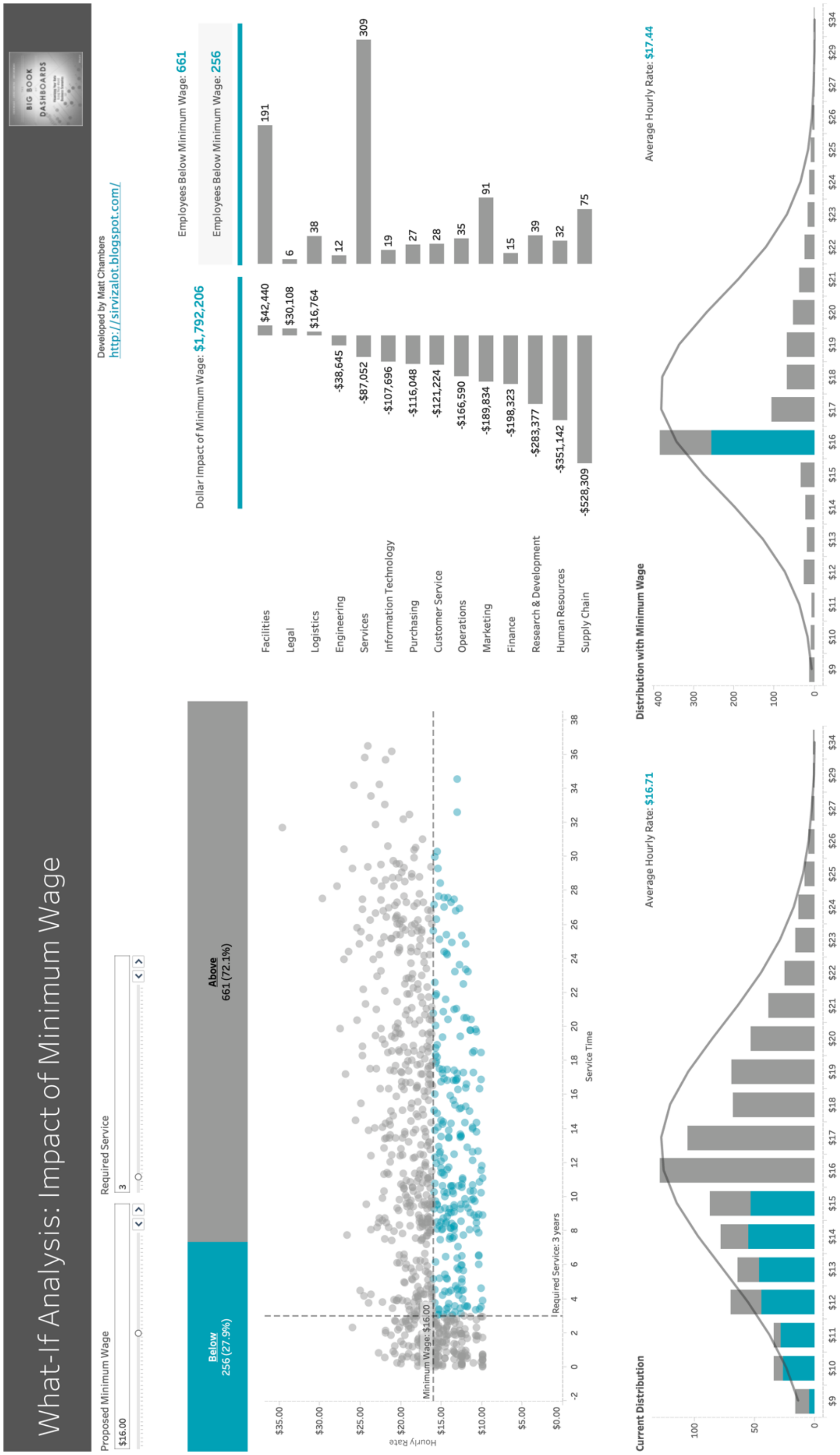

Figure 2. An interactive dashboard showing the ramifications of modifying the minimum wage [9, 12].

Figure 3. An interactive dashboard showing the ramifications of modifying the minimum wage [**https://dashboard.edmonton.ca**].

Canada* – 1st Quarter, 2012

Canadian VEHICLE USE Study — Powering Informed Decisions

Trip Characteristics — VEHICLE TYPE AND AGE (NRCan & TC)

Vehicle Type	Age	Fleet Size	Sample Size	Average Number of Study Days	Average Number of Active Days	Daily Number of Trips	Daily Vehicle km Traveled	Daily Passenger km Traveled	Daily Fuel Consumption (L)	Daily Driving Time (h)	Fuel Consumption Ratio (L/100km)	Idling Ratio	Average Vehicle Occupancy	Average Speed (km/h)	Average Trip Length (km)	Average Trip Duration (min)
Canada*		12,241,791	966	21.7	16.8	3.9 [a]	38.4 [b]	63.4 [b]	4.4 [a]	0.91 [a]	9.7 [b]	19.9% [a]	1.5 [a]	37.5 [a]	8.7 [b]	12.2 [a]
	0 TO 8	7,904,065	625	19.1	15.8	4.0 [a]	40.1 [b]	66.9 [b]	4.7 [b]	0.95 [a]	9.3 [a]	19.2% [a]	1.4 [a]	35.7 [a]	8.5 [b]	11.9 [a]
	9+	4,337,726	341	26.4	18.5	3.7 [b]	35.2 [c]	57.0 [c]	3.9 [b]	0.83 [b]	10.5 [c]	21.2% [b]	1.6 [b]	40.9 [b]	9.1 [c]	12.8 [b]
	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
PASSENGER CAR		7,038,090	494	23.5	17.2	3.7 [b]	36.8 [b]	57.6 [b]	3.4 [b]	0.86 [b]	8.0 [a]	19.7% [b]	1.4 [a]	38.0 [a]	8.9 [b]	12.5 [b]
MINIVAN		1,260,008	124	15.0	13.2	3.6 [a]	34.0 [b]	68.9 [b]	4.8 [b]	0.86 [b]	9.4 [b]	17.8% [a]	1.4 [a]	27.8 [a]	6.6 [b]	10.0 [b]
PICKUP/CARGO		1,651,513	132	18.7	13.9	3.3 [b]	33.7 [b]	55.4 [d]	5.6 [b]	0.75 [b]	13.1 [e]	18.2% [a]	1.4 [c]	37.1 [a]	8.2 [c]	10.6 [b]
SUV		2,292,180	216	22.0	19.5	5.1 [a]	49.0 [c]	83.9 [c]	6.4 [c]	1.20 [b]	12.8 [a]	22.9% [a]	1.7 [a]	41.8 [a]	9.7 [b]	13.9 [b]
PASSENGER CAR	0 TO 8	4,379,977	306	19.0	15.6	3.6 [b]	37.1 [b]	58.8 [b]	3.5 [b]	0.85 [b]	7.4 [a]	18.4% [a]	1.3 [a]	35.6 [a]	8.5 [b]	11.8 [a]
PASSENGER CAR	9+	2,658,113	188	30.8	20.0	3.8 [c]	36.4 [d]	55.6 [d]	3.4 [c]	0.86 [c]	9.0 [b]	21.8% [c]	1.5 [b]	41.9 [b]	9.4 [d]	13.6 [c]
PASSENGER CAR	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
MINIVAN	0 TO 8	693,433	69	14.9	13.2	4.0 [b]	34.1 [b]	67.7 [b]	5.0 [b]	0.89 [c]	9.8 [a]	18.1% [a]	1.4 [a]	26.6 [a]	6.0 [b]	9.5 [b]
MINIVAN	9+	566,575	55	15.1	13.2	3.2 [b]	34.0 [c]	70.3 [d]	4.5 [b]	0.82 [b]	8.8 [e]	17.5% [b]	1.5 [b]	29.3 [b]	7.3 [b]	10.6 [b]
MINIVAN	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
PICKUP/CARGO	0 TO 8	1,047,204	80	17.5	13.0	3.4 [b]	36.9 [b]	60.3 [c]	6.0 [b]	0.81 [b]	11.3 [a]	15.8% [a]	1.1 [a]	31.9 [a]	7.4 [b]	9.6 [a]
PICKUP/CARGO	9+	604,309	52	20.6	15.5	3.1 [c]	28.2 [e]	46.9 [f]	4.8 [d]	0.65 [d]	16.2 [f]	22.4% [b]	1.9 [d]	46.1 [b]	9.6 [e]	12.5 [c]
PICKUP/CARGO	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
SUV	0 TO 8	1,783,451	170	21.6	19.2	5.3 [b]	51.9 [c]	90.2 [d]	6.7 [c]	1.28 [c]	12.6 [a]	23.5% [b]	1.7 [a]	41.5 [a]	10.0 [c]	14.4 [b]
SUV	9+	508,729	46	23.1	20.5	4.5 [b]	38.9 [c]	62.1 [d]	5.3 [b]	0.91 [b]	13.4 [b]	20.7% [b]	1.6 [b]	42.6 [b]	8.6 [b]	12.1 [b]
SUV	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]

VEHICLE TYPE AND AGE (EC)

Vehicle Type	Age	Fleet Size	Sample Size	Average Number of Study Days	Average Number of Active Days	Daily Number of Trips	Daily Vehicle km Traveled	Daily Passenger km Traveled	Daily Fuel Consumption (L)	Daily Driving Time (h)	Fuel Consumption Ratio (L/100km)	Idling Ratio	Average Vehicle Occupancy	Average Speed (km/h)	Average Trip Length (km)	Average Trip Duration (min)
Canada*		12,241,791	966	21.7	16.8	3.9 [a]	38.4 [b]	63.4 [b]	4.4 [a]	0.91 [a]	9.7 [b]	19.9% [a]	1.5 [a]	37.5 [a]	8.7 [b]	12.2 [a]
	0 TO 3	3,206,273	213	14.8	13.0	3.4 [a]	37.1 [b]	61.9 [c]	4.3 [b]	0.84 [b]	7.8 [a]	16.2% [a]	1.2 [a]	30.6 [a]	7.5 [b]	10.2 [a]
	4 TO 8	4,697,792	412	22.0	17.7	4.4 [a]	42.2 [b]	70.3 [b]	4.9 [b]	1.02 [b]	10.4 [a]	21.3% [a]	1.5 [a]	39.1 [a]	9.2 [b]	13.1 [a]
	9+	4,337,726	341	26.4	18.5	3.7 [b]	35.2 [c]	57.0 [c]	3.9 [b]	0.83 [b]	10.5 [c]	21.2% [b]	1.6 [b]	40.9 [b]	9.1 [c]	12.8 [b]
	OLD	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
	V.OLD	0	0	0.0	0.0	0.0 [e]	0.0 [e]	0.0 [e]	0.0 [e]	0.00 [e]	0.0 [e]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
PASSENGER CAR		7,038,090	494	23.5	17.2	3.7 [b]	36.8 [b]	57.6 [b]	3.4 [b]	0.86 [b]	8.0 [a]	19.7% [b]	1.4 [a]	38.0 [a]	8.9 [b]	12.5 [b]
LIGHT TRUCK		5,203,701	472	19.3	16.2	4.2 [a]	40.5 [b]	71.2 [b]	5.8 [b]	0.97 [b]	12.1 [b]	20.2% [a]	1.5 [a]	36.9 [a]	8.5 [b]	11.9 [a]
PASSENGER CAR	0 TO 3	1,707,720	88	11.9	10.8	2.7 [a]	28.6 [b]	45.3 [b]	2.5 [b]	0.66 [b]	4.8 [a]	12.5% [a]	0.9 [a]	23.3 [a]	5.6 [b]	7.7 [a]
PASSENGER CAR	4 TO 8	2,672,257	218	23.6	18.6	4.1 [b]	42.5 [b]	67.5 [c]	4.1 [b]	0.97 [b]	9.1 [a]	22.2% [b]	1.6 [a]	43.4 [b]	10.4 [c]	14.4 [b]
PASSENGER CAR	9+	2,658,113	188	30.8	20.0	3.8 [c]	36.4 [d]	55.6 [d]	3.4 [c]	0.86 [c]	9.0 [b]	21.8% [c]	1.5 [b]	41.9 [b]	9.4 [d]	13.6 [c]
PASSENGER CAR	OLD	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
PASSENGER CAR	V.OLD	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
LIGHT TRUCK	0 TO 3	1,498,553	125	18.1	15.6	4.2 [b]	46.8 [c]	80.9 [d]	6.2 [c]	1.05 [b]	11.3 [a]	20.5% [b]	1.5 [a]	38.9 [a]	9.7 [c]	12.9 [b]
LIGHT TRUCK	4 TO 8	2,025,535	194	19.8	16.6	4.7 [a]	41.8 [c]	73.9 [c]	6.0 [c]	1.07 [b]	12.0 [a]	20.0% [a]	1.4 [a]	33.4 [a]	7.5 [b]	11.4 [b]
LIGHT TRUCK	9+	1,679,613	153	19.5	16.2	3.6 [b]	33.4 [b]	59.4 [d]	4.9 [b]	0.79 [b]	12.9 [e]	20.2% [a]	1.7 [b]	39.4 [a]	8.5 [c]	11.7 [b]
LIGHT TRUCK	OLD	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
LIGHT TRUCK	V.OLD	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]

VEHICLE TYPE AND AGE

Vehicle Type	Age	Fleet Size	Sample Size	Average Number of Study Days	Average Number of Active Days	Daily Number of Trips	Daily Vehicle km Traveled	Daily Passenger km Traveled	Daily Fuel Consumption (L)	Daily Driving Time (h)	Fuel Consumption Ratio (L/100km)	Idling Ratio	Average Vehicle Occupancy	Average Speed (km/h)	Average Trip Length (km)	Average Trip Duration (min)
Canada*		12,241,791	966	21.7	16.8	3.9 [a]	38.4 [b]	63.4 [b]	4.4 [a]	0.91 [a]	9.7 [b]	19.9% [a]	1.5 [a]	37.5 [a]	8.7 [b]	12.2 [a]
	0 TO 8	7,904,065	625	19.1	15.8	4.0 [a]	40.1 [b]	66.9 [b]	4.7 [b]	0.95 [a]	9.3 [a]	19.2% [a]	1.4 [a]	35.7 [a]	8.5 [b]	11.9 [a]
	9+	4,337,726	341	26.4	18.5	3.7 [b]	35.2 [c]	57.0 [c]	3.9 [b]	0.83 [b]	10.5 [c]	21.2% [b]	1.6 [b]	40.9 [b]	9.1 [c]	12.8 [b]
	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
PASSENGER CAR		7,038,090	494	23.5	17.2	3.7 [b]	36.8 [b]	57.6 [b]	3.4 [b]	0.86 [b]	8.0 [a]	19.7% [b]	1.4 [a]	38.0 [a]	8.9 [b]	12.5 [b]
LIGHT TRUCK		5,203,701	472	19.3	16.2	4.2 [a]	40.5 [b]	71.2 [b]	5.8 [b]	0.97 [b]	12.1 [b]	20.2% [a]	1.5 [a]	36.9 [a]	8.5 [b]	11.9 [a]
PASSENGER CAR	0 TO 8	4,379,977	306	19.0	15.6	3.6 [b]	37.1 [b]	58.8 [b]	3.5 [b]	0.85 [b]	7.4 [a]	18.4% [a]	1.3 [a]	35.6 [a]	8.5 [b]	11.8 [a]
PASSENGER CAR	9+	2,658,113	188	30.8	20.0	3.8 [c]	36.4 [d]	55.6 [d]	3.4 [c]	0.86 [c]	9.0 [b]	21.8% [c]	1.5 [b]	41.9 [b]	9.4 [d]	13.6 [c]
PASSENGER CAR	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]
LIGHT TRUCK	0 TO 8	3,524,088	319	19.1	16.2	4.5 [a]	43.9 [b]	76.9 [b]	6.1 [b]	1.06 [b]	11.7 [a]	20.2% [a]	1.5 [a]	35.7 [a]	8.4 [b]	12.0 [a]
LIGHT TRUCK	9+	1,679,613	153	19.5	16.2	3.6 [b]	33.4 [b]	59.4 [d]	4.9 [b]	0.79 [b]	12.9 [e]	20.2% [a]	1.7 [b]	39.4 [a]	8.5 [c]	11.7 [b]
LIGHT TRUCK	PRE '96	0	0	0.0	0.0	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.00 [f]	0.0 [f]	0.0% [f]	0.0 [f]	0.0 [f]	0.0 [f]	0.0 [f]

Table 2. Data (extract) for the CVUS Dashboard (personal file).

Canada* – 1st Quarter, 2012

Canadian VEHICLE USE Study — Powering Informed Decisions

Group	Sub-Trip Characteristics	Fleet Size	Sample Size	Average Number of Study Days	Average Number of Active Days	Daily Vehicle km Traveled	Daily Passenger km Traveled	Daily Fuel Consumption (L)	Daily Non-Idling Time (h)	Daily Idling Time (h)
VEHICLE SPEED	**Canada***	**12,241,791**	**966**	**21.7**	**16.8**	**38.4** [b]	**63.4** [b]	**4.4** [a]	**0.73** [a]	**0.18** [a]
	IDLING					0.0 [a]	0.0 [a]	0.3 [a]	0.00 [c]	0.20 [b]
	1 km/h TO 24 km/h					1.9 [b]	3.0 [b]	0.5 [a]	0.15 [a]	0.00 [a]
	25 km/h TO 49 km/h					6.5 [b]	10.6 [b]	0.9 [a]	0.17 [b]	0.00 [a]
	50 km/h TO 79 km/h					11.7 [a]	18.9 [b]	1.1 [a]	0.19 [a]	0.00 [a]
	80 km/h TO 99 km/h					8.2 [b]	13.4 [b]	0.7 [b]	0.09 [b]	0.00 [a]
	100 km/h TO 119 km/h					8.2 [b]	14.4 [b]	0.7 [b]	0.08 [b]	0.00 [a]
	120+ km/h					1.8 [e]	3.0 [e]	0.2 [e]	0.01 [e]	0.00 [a]
IDLING TYPE	**Canada***	**12,241,791**	**966**	**21.7**	**16.8**	**38.4** [b]	**63.4** [b]	**4.4** [a]	**0.73** [a]	**0.18** [a]
	NOT IDLING					38.4 [b]	63.4 [b]	4.1 [a]	0.70 [a]	0.00 [a]
	IDLING DURING TRIP					0.0 [a]	0.0 [a]	0.2 [b]	0.00 [a]	0.13 [b]
	TRIP START IDLING					0.0 [a]	0.0 [a]	0.1 [a]	0.00 [a]	0.05 [b]
	TRIP END IDLING					0.0 [a]	0.0 [a]	0.0 [b]	0.00 [a]	0.02 [b]
TIME OF DRIVING	**Canada***	**12,241,791**	**966**	**21.7**	**16.8**	**38.4** [b]	**63.4** [b]	**4.4** [a]	**0.73** [a]	**0.18** [a]
	EARLY (06:00-08:59)					5.9 [c]	8.9 [c]	0.7 [b]	0.11 [b]	0.03 [b]
	MORNING (09:00-11:59)					5.9 [b]	9.9 [b]	0.7 [b]	0.11 [b]	0.03 [b]
	MIDDAY (12:00-14:59)					7.0 [a]	11.8 [b]	0.8 [a]	0.13 [a]	0.04 [b]
	AFTERNOON (15:00-17:59)					10.1 [b]	16.6 [b]	1.1 [b]	0.19 [b]	0.05 [b]
	EVENING (18:00-20:59)					5.6 [b]	9.9 [b]	0.6 [b]	0.10 [b]	0.03 [b]
	NIGHT (21:00-05:59)					4.0 [b]	6.5 [b]	0.4 [b]	0.07 [b]	0.02 [b]
ENGINE TEMP.	**Canada***	**12,241,791**	**966**	**21.7**	**16.8**	**38.4** [b]	**63.4** [b]	**4.4** [a]	**0.73** [a]	**0.18** [a]
	COLD (< 50°C)					1.2 [a]	1.7 [a]	0.3 [a]	0.04 [a]	0.04 [b]
	WARM (50°C to 80°C)					5.6 [a]	8.5 [a]	0.8 [a]	0.13 [a]	0.05 [b]
	HOT (> 80°C)					31.6 [b]	53.2 [b]	3.3 [b]	0.53 [b]	0.11 [b]
	NO DATA					0.1 [f]	0.1 [f]	0.0 [f]	0.00 [f]	0.00 [f]

Quality of Estimates (cv)
a: less than 5% (excellent)
b: between 5% and 10% (good)
c: between 10% and 15% (acceptable)
d: between 15% and 20% (use with caution)
e: between 20% and 35% (unreliable)
f: more than 35% (unusable)

Vehicle Age
0 TO 3: 3 years old and younger
4 TO 8: between 4 and 8 years old
9+: 9 years old and older with model year post-1995
OLD: model year between 1981 and 1995
V.OLD: model year pre-1981

Notes on Driver Age and Gender
The estimates provided in the DRIVER AGE and GENDER categories are VEHICLE characteristics, not DRIVER characteristics. Without further information on the distribution of drivers in a given jurisdiction (by AGE and GENDER), the estimates of the basic characteristics (nTrips, VKT, PKT, Fuel, Use, UseNI) cannot be used to predict the average driving behaviour of various combinations of DRIVER AGE and GENDER for that jurisdiction.

Values in columns may not add up or average (weighted) exactly to the corresponding column header due to round off errors.

Table 3. Data (extract) for the CVUS Dashboard (personal file).

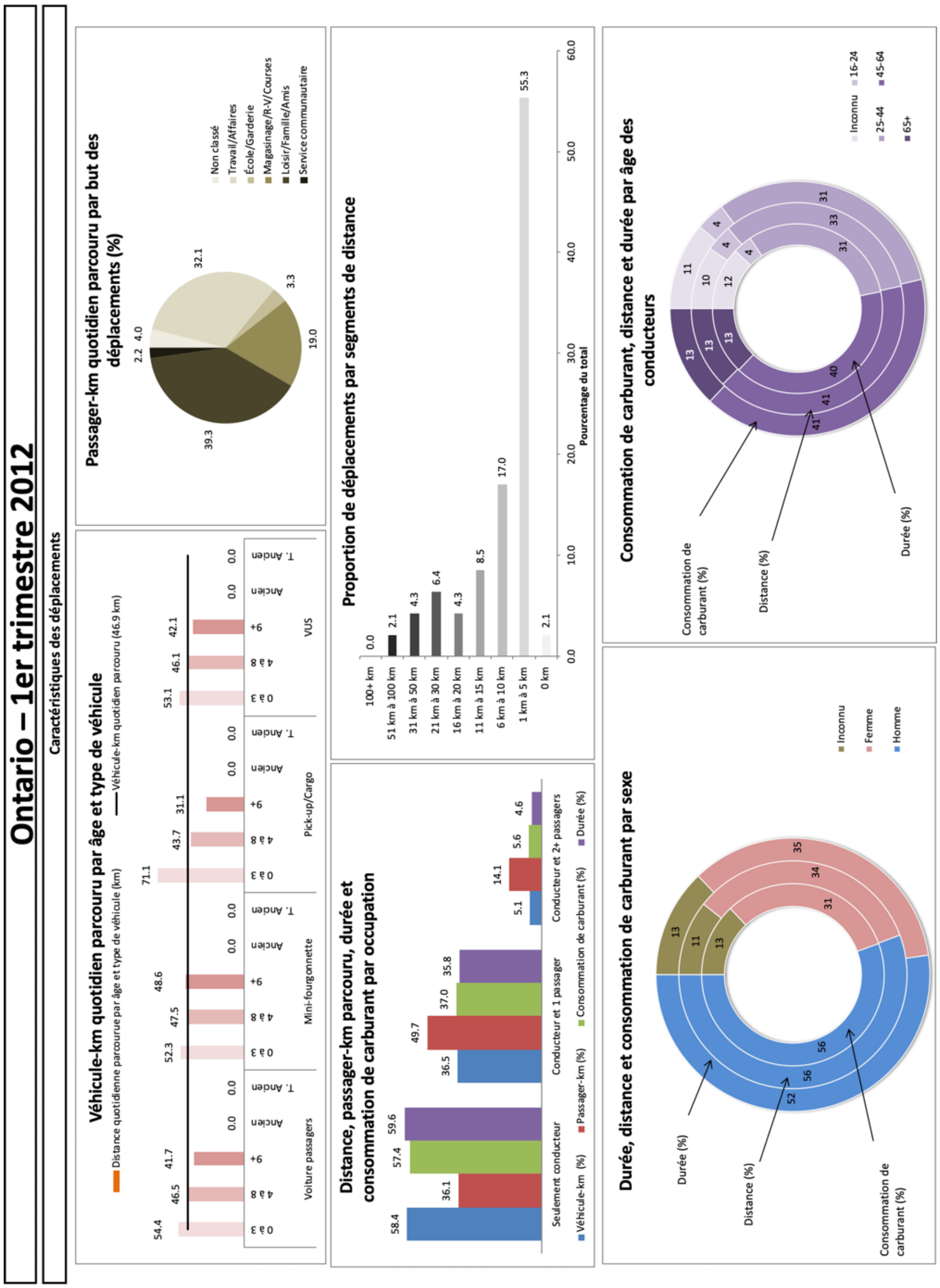

Figure 4. Exploratory dashboard for the CVUS – Ontario (Q1, 2012), page 1, French version (personal file).

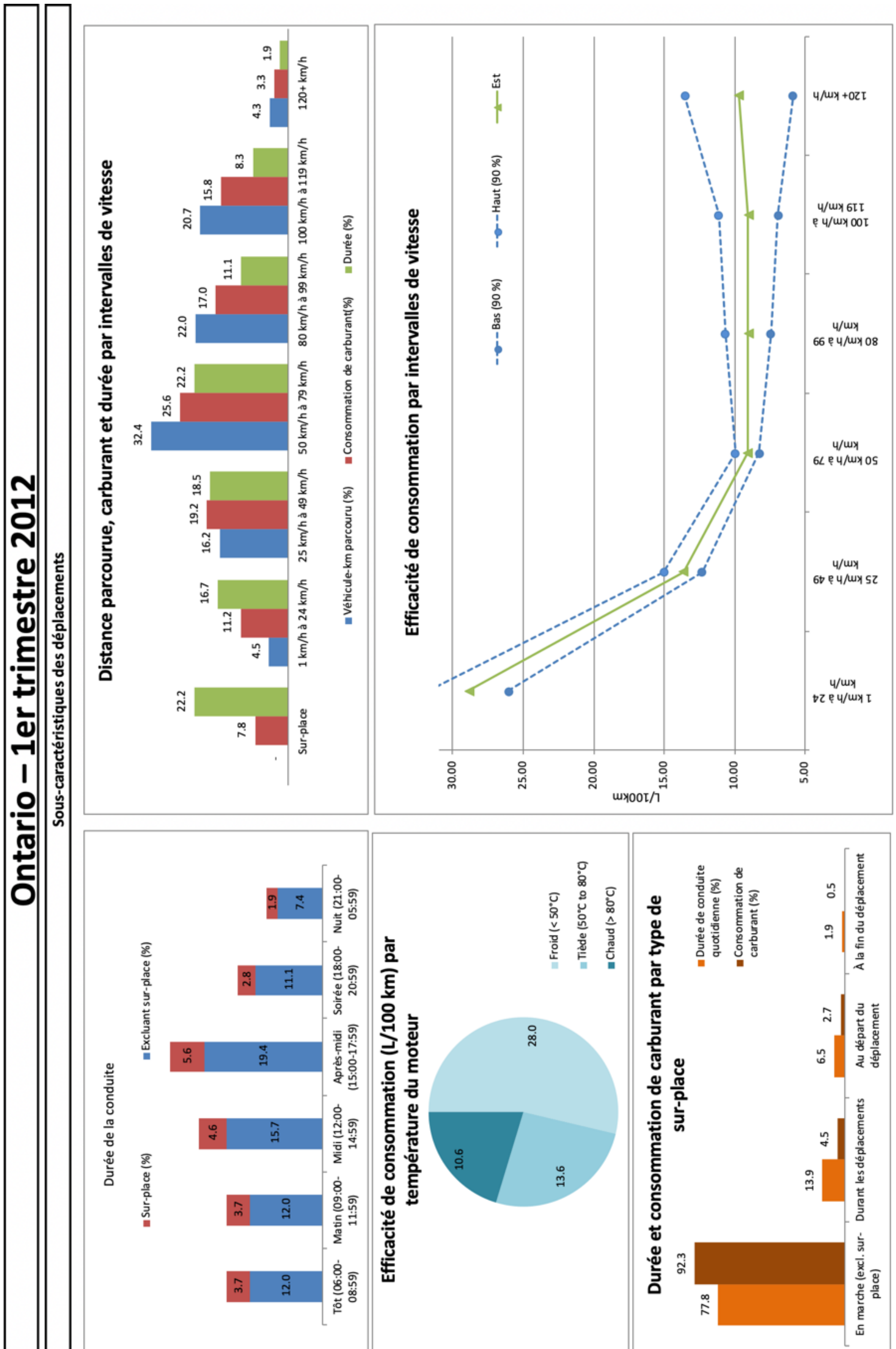

Figure 5. Exploratory dashboard for the CVUS – Ontario (Q1, 2012), page 2, French version (personal file).

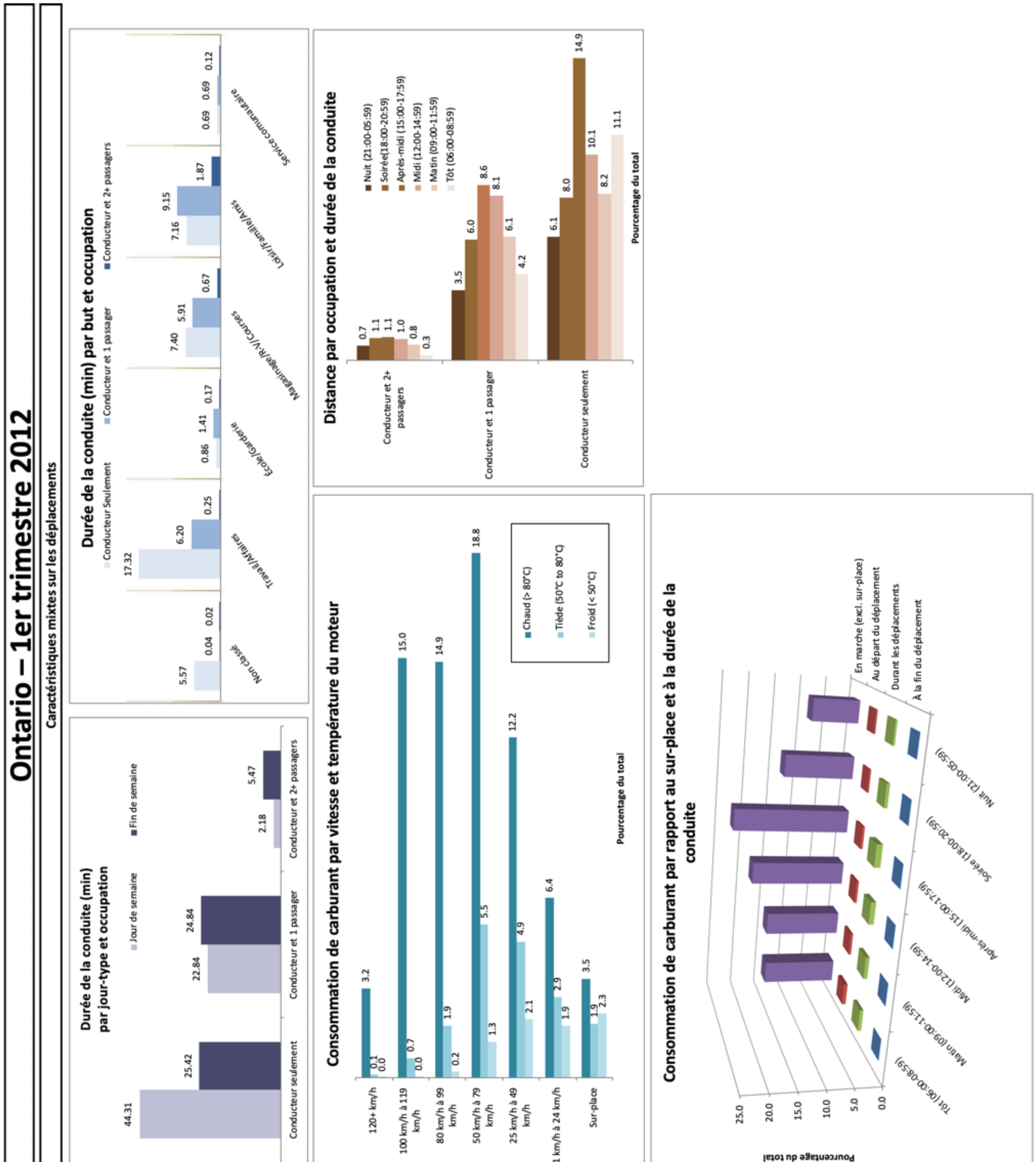

Figure 6. Exploratory dashboard for the CVUS – Ontario (Q1, 2012), page 3, French version (personal file).

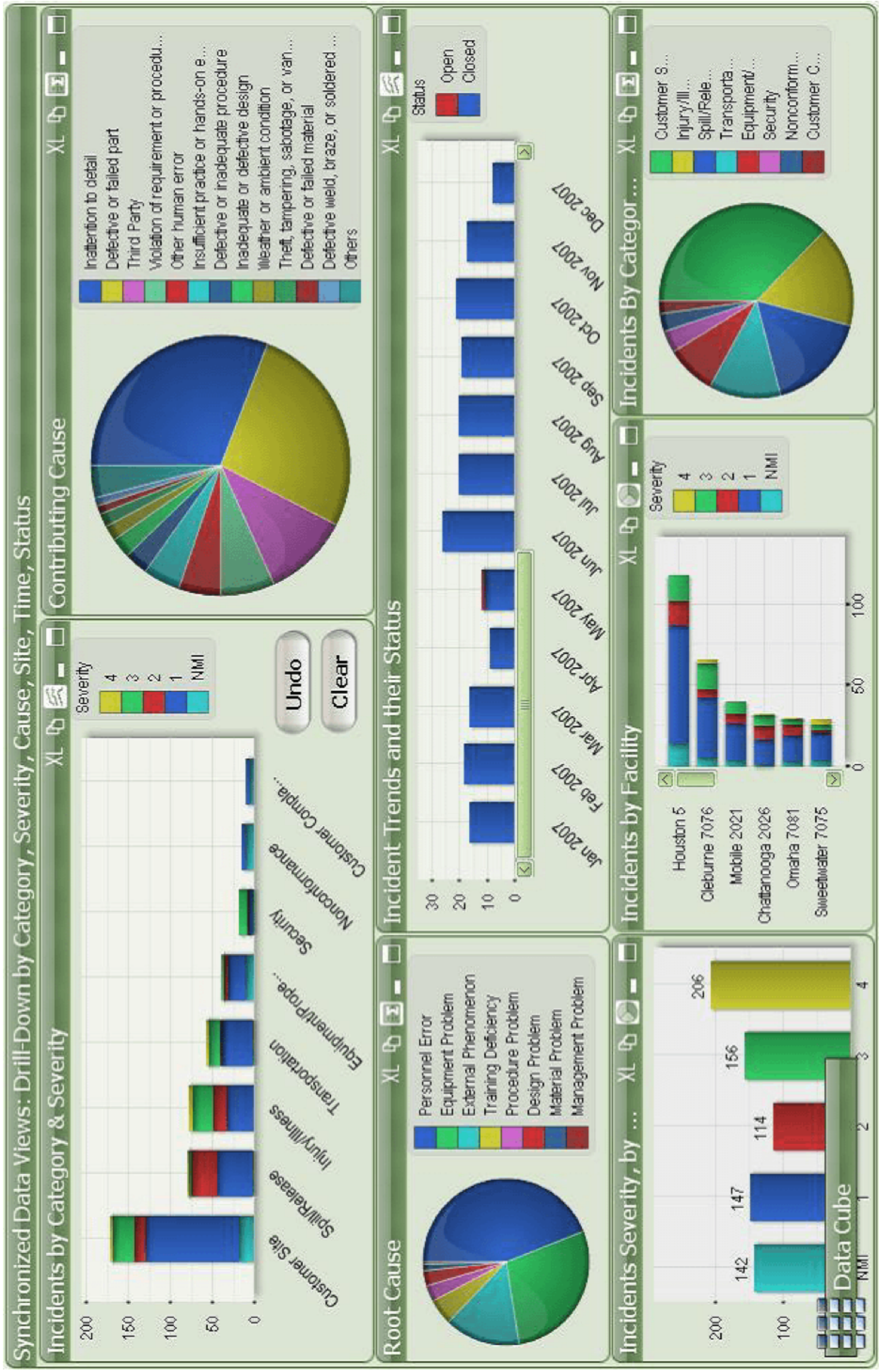

Figure 7. Anonymous "ugly" dashboard [13].

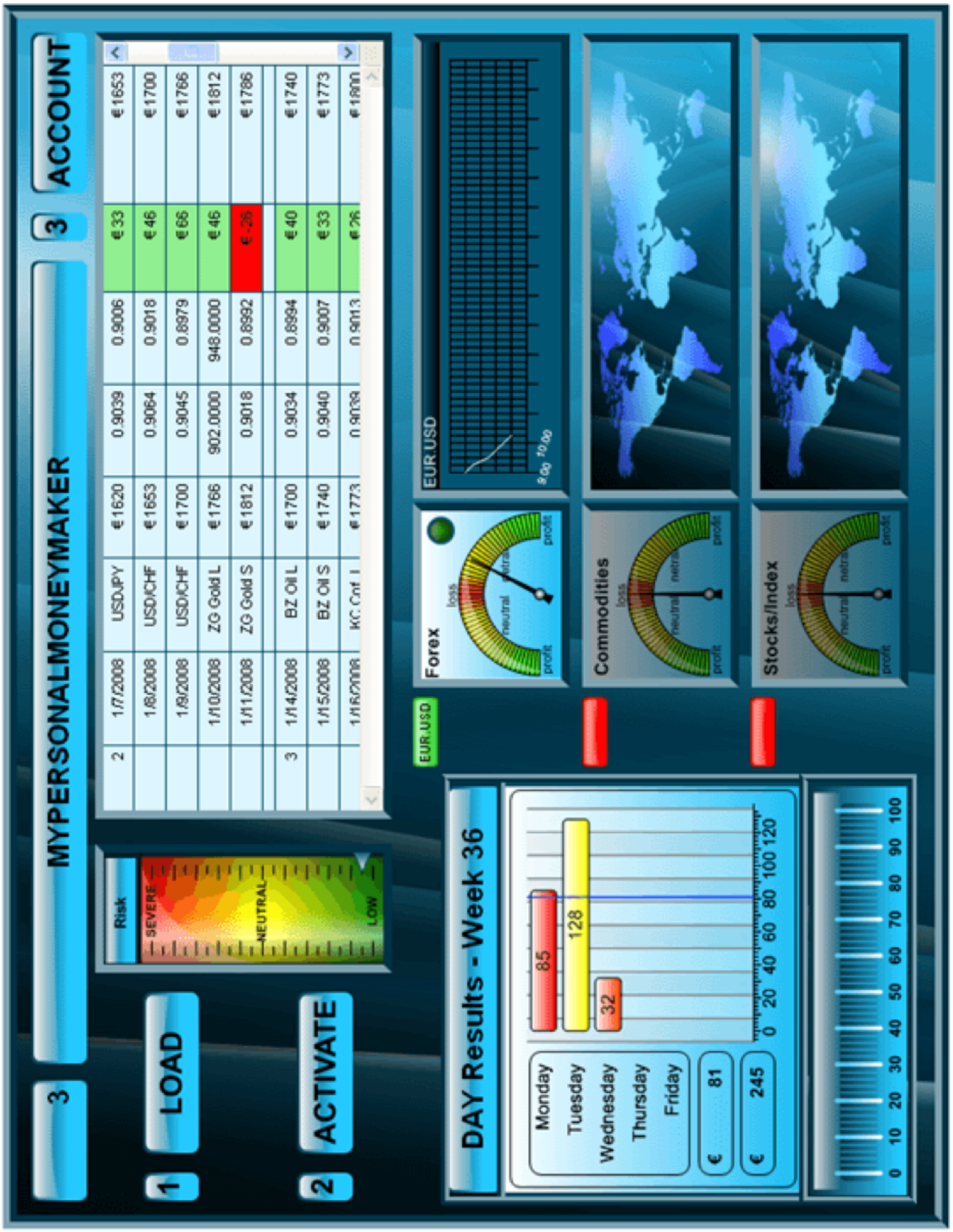

Figure 8. Anonymous "ugly" dashboard [14].

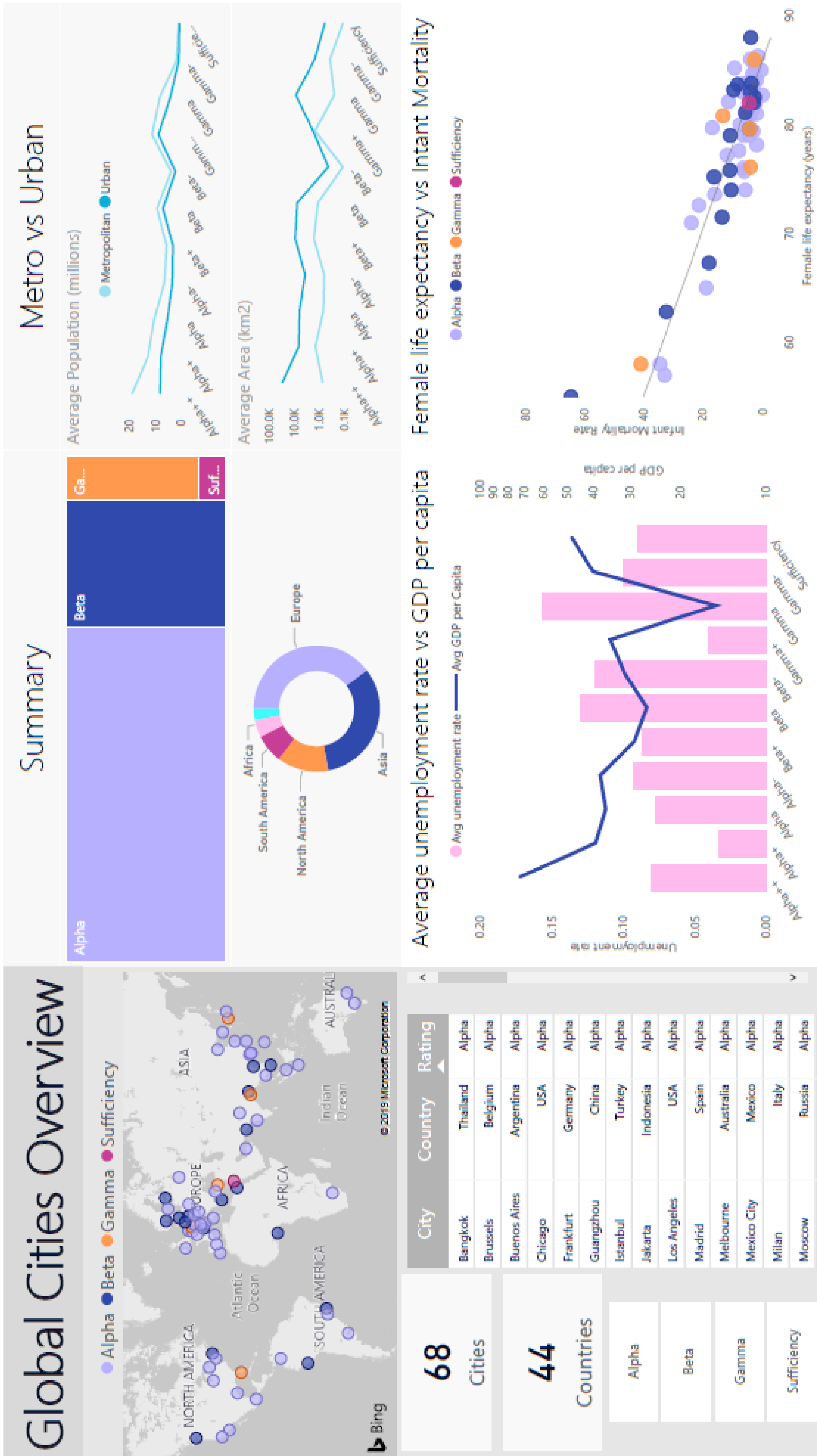

Figure 9. An exploratory dashboard showing metrics about various cities ranked on the Global Cities Index.

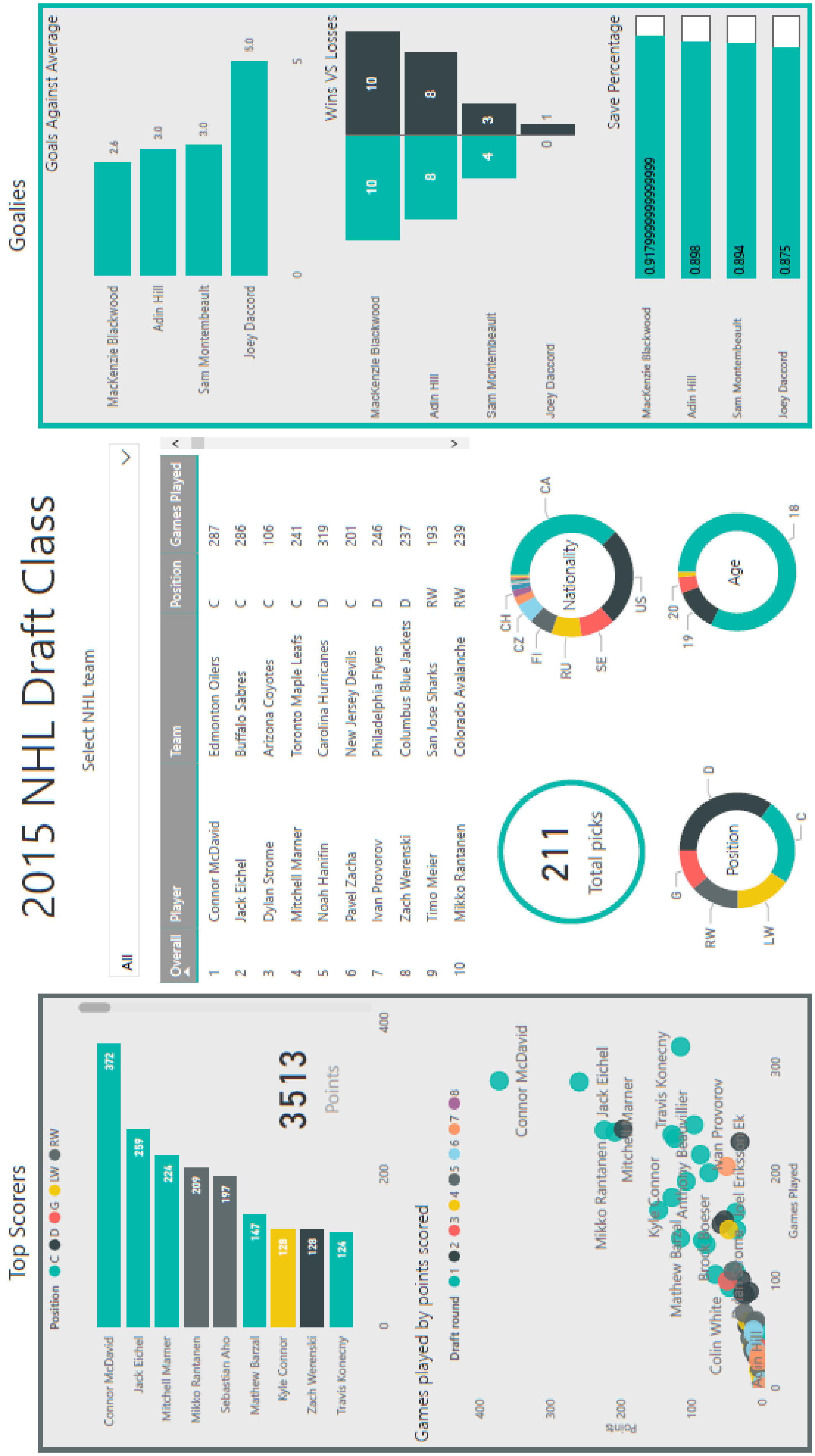

Figure 10. An exploratory dashboard showing information about the NHL draft class of 2015.