THE IMPACT OF DATA VISUALIZATION ON BUSINESS DECISION MAKING: AN OVERVIEW

[1]Dr.M.Moorthy, [2]Nobledhas. S
Department of MCA
Muthayammal Engineering College Rasipuram, India
[1]director.mca@mec.edu.in, [2]noble.optim@gmail.com

Abstract - In every field and industry, good decision making is one of the principal building blocks to success. Whether you are a high or low level decision maker at your company, it's crucial to have visualized info at your fingertips in order to communicate ideas effectively. With business development comes growing volumes of data. Depending on how this info is presented, it could be easy or difficult to sort through all the facts, findings, and patterns that must be understood in order to take things to the next logical stage. In this paper we cover introduction to data visualization, types, data visualization and decision making, advanced data visualization,business mapping and decision making, benefits and challenges of data visualization to provide an in-depth knowledge on data visualization to researchers to go the next step.

Keywords: Data visualization; Advanced data visualization; Dynamic data visualization; business mapping; heat mapping; territory mapping

I. INTRODUCTION

Data visualization is the graphical display of abstract information for two purposes: sense-making (also called data analysis) and communication. Important stories live in our data and data visualization is a powerful means to discover and understand these stories, and then to present them to others[1]. Data visualization is the process of transforming unstructured data into different types of visuals[2]. The definition of data visualization explains the importance of the data by placing the data in terms of visual context [6].

Data visualization technology provides a high-tech means for preparing the necessary information that enables sound business choices. It helps executives see the big picture all at once — from trends and numbers to hot spots and trouble areas. This allows people in different capacities of decision making to mutually identify the most likely routes for success, and to pinpoint the most efficient means for taking ideas forward.

Data visualization is generally presented in formats that are designed to make sets of information easily understandable. Data is often conveyed through percentages, graphs, green lights, stop signs, meters, and other indicators that communicate whether something is good or bad. From there, the decision makers can determine which route to take. If the indicators are discouraging, they will likely take a different course of action than if the data represents an encouraging trend.

Of all the formats used to present data visualization, audiences most commonly use and understand the basic chart as shown in figure-1. It's generally presented in one of three forms: the line chart, the bar chart, and the pie chart. The primary purpose of the basic chart is to present key pieces of information in a succinct and wholly digestible form, which in turn makes it easy for interested parties to absorb the data in as little time as possible

According to the visualization and analyzes of data the company can take better decision and they can also change their business flow according to it[7]. Data visualisation can be used to reach a wider audience, to persuade or influence, and to mobilise stakeholders for action. It is a, clear and efficient method of interpreting large amounts of data to convey new insights to others and to enable collaboration and interaction[10].

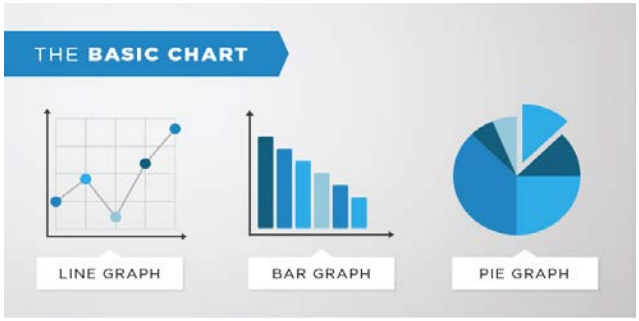


Figure-1: Basic charts

Data visualizations are the stepping stones to more advanced uses of business mapping software like territory mapping, work process maps, and the concept of cost reductions through process improvements such as fuel reductions through optimized routing.

Scientific visualization

- It is mostly concerned with:–Data defined in physical space, i.e. spatio-temporal data (2~4 dimensions)
- Data describes continuous events in continuous space, however, the representation is discrete (i.e. sampled data)
- Examples include simulation and measurement data from physics, chemistry, geo-science, medical-biological, climate, oceanography, energy,etc
- Features are well-defined

Information visualization

- It focuses on:–high-dimensional (>>4), abstract data (i.e. tree, graphs, hierarchy, ...)
- Data is discrete in the nature
- Examples include financial, marketing, HR, statistical, social media, political,etc .....
- Feature are not well-defined, the typical analysis tasks including finding patterns, clusters, voids, outliers.

The rest of the paper is organized as section II data visualization and mprovement in decision making, section III criteria for getting most benefits out of data visualization, section IV reason for using advanced data visualization, section V business mapping and effective decision making, section VI dynamic data visualization and improvement in business communication,section VII benefits of data visualization, and section VIII problems with data visualization.

II. DATA VISUALIZATION AND IMPROVEMENT IN DECISION MAKING

Laying out data in a visualized format makes it easier to analyze a set of info, which in turn allows analysts to gain the most knowledge from a study or presentation. When paired with background and supplemental info, the visualizations are given additional context. In effect, the various forms of info complement one another. This combination of info makes it possible to quickly and easily recognize winning formulas, pinpoint areas with the greatest potential, and single out weak spots and cul de sacs. From there, decision makers joined by a common goal can pool together the knowledge and insights gained from all the info at hand and proceed to implement courses of action.

When it comes to identifying problem areas in a set of prior actions under review, data visualization puts all the negative results on display, alongside the positive, and gives analysts a clear contrast by which to base conclusions and subsequent changes. At its most successful, data visualization serves as a communication tool that instantly exposes the good and bad aspects of a given set of findings, and does so in a succinct yet thorough manner that leads experienced analysts to the most logical conclusions.

Data visualization is not a recent invention, yet it's often underrated and neglected among certain business organizations that could no doubt benefit by putting the tools to use. Businesses that successfully harness the tools of visualization have enormous advantages over those that don't. Businesses in the latter category are generally less equipped to distinguish strong from weak areas within their operations, and they often lack the insights to take the proper courses of action. The business people are forced to know about the every piece of information about their data[8].

Data visualization empowers organizations to create actionable conclusions

from their data, thereby leading to both better and faster decision making[3]. Data visualization turns raw data into a universally, consumable form. By providing access to valuable information, you give people the tools to develop more informed opinions and empower them to contribute their perspective in the decision-making process[4].

III. CRITERIA FOR GETTING MOST BENEFITS OUT OF DATA VISUALIZATION

- The visualizations used in a given presentation must be the most relevant and befitting to the body of information in question, usually the source data.
- The data must be combined with background information that puts the charts, figures, and symbols into context for easy comprehension by all interested parties.
- The visualizations must present key data in a manner that points to sound courses of action.

As long as data visualization is implemented with all three of the above factors in place, analysts can quickly put the insights they glean into action, all with great confidence that the next step will bring about newfound levels of success.

IV. REASONS FOR USING ADVANCED DATA VISUALIZATION

1. Accelerated response speeds. When successfully incorporated into a report or presentation, data visualization tools enhance the information at hand and allow analysts to absorb all the relevant info, distinguish positives from negatives, draw conclusions, and from there take logical actions with improved speed and efficiency. Data visualization not only saves tremendous amounts of time — it actually allows people to absorb info at their own natural processing speeds, which are much faster than conventional charts typically allow.

2. Improved, simplified focus on what matters most. The combination of visualizations and contextual info allows analysts to see everything at once and instantly zero in on the most important details. Effectively, data becomes simplified because everything is simultaneously presented, but the key facts take center stage. As businesses grow more competitive with each passing year, the most crucial facets of any operation will generally involve the correlation between market performance and operating conditions.

3. Easier viewing of trends and patterns. Traditional data formats have often been notorious for making it difficult to distinguish patterns within large bodies of information. In a given document, there could be so many lines of flat text with key info scattered about from paragraph to paragraph that it could take hours of reading, highlighting, and sorting just to cull the most important details. When visualization tools are incorporated, however, the most important details are brought immediately to the fore — no wasted time mining for stats, figures, or other key essentials. Simply put, it's far easier to understand trends and patterns when they're laid out in charts, maps, and trees, and when they’re represented with varying types of graphics.

4. Ability to modify and interrelate with data. Perhaps the foremost benefit of data visualization is the way that it presents actionable ideas in ways that can be easily understood by all interested parties. Whereas traditional charts and graphs are merely meant to be viewed, analysts can interact with data when the modern tools of visualization are at hand.

5. Ability to develop a new language for business. One of the most unique things about data visualization is that it tells stories through image representation, as opposed to merely presenting static facts.

An example of stories being conveyed through visualization could be in the form of a heat map, which would show a lot more detail about revenue growth for a particular company across the United States. In an older format, such as a static bar chart, there wouldn't be any details to show how figures vary on a city by city, state by state basis. It would only show whether overall figures are going up or down.

6. Improved collaboration among work teams. Data visualization makes it easier to collaborate because key info across all areas of a study are presented with equal clarity. As such, the unique skills of each member on a working team are brought to the fore. With everyone up to speed on a given project, decisions can be made and implemented faster

than in situations where certain areas of data are presented more clearly than others. With proper visualization tools, you don't have situations where a few of the analysts receive their info upfront and others have to sift through tons of text. Everyone learns what they need to know within seconds.

V. BUSINESS MAPPING AND EFFECTIVE DECISION MAKING

One of the greatest innovations of data visualization is business mapping, which allows company executives to analyze marketing info on a geographic basis and from there craft new initiatives based on location awareness. The tools provided through business mapping allow executives and work teams to study trends from numerous variables, including the following:

Data point labeling options. Business mapping allows viewers to see multiple callouts at once, all of which can be modified and customized to enhance the data visualization message.

Chart illustration. Map point labels can be graphically enhanced to indicate the value of location data like fulfilled orders throughout an area of service or sales values over a 3-year period. With bar or pie charts, imported numeric data columns can be displayed for instant comparison.

Color coding. When it comes to images, the use of opposing colors is the most effective way to invoke contrast to the naked eye. With business mapping, color coding [figure-2] can be employed to distinguish areas by county, ZIP code, state, or region. This provides an easier way to analyze marketing trends geographically, and in turn make better-targeted business decisions. Points can be color coded too, to quickly define categories in user imported data.

Figure-2: Color coding

Customer routing. Map routing tools help identify route directions to customers in any given locale. Determine how long it takes to get to the nearest location from a particular address, and map out all the optimized and quickest routes — all of which can generate more efficient travel times, increasing the number of visits and sales from happy customers.

Customized graphics. Business mapping allows you to draw various shapes and lines around different market areas of interest to create business sales territories. These defined areas of interest can be color coded, and associated with critical business and demographic data.

Demographic data. With any type of business, it's crucial to gather as much info as possible about each relevant market demographic. Business mapping aggregates such data according to drive time, locale, and other variables. Based on this info, you can positively identify the most profitable customer segments, suggesting potential targets that you've thus far failed to reach. This classic data visualization exercise can help you make decisions around market expansions – new stores, additional sales people or marketing and sales campaigns.

Fast mapping. Today's more advanced map visualizations allow you to organize info by city, street, ZIP code, and latitude and longitude coordinates. Web- based mapping tools enable rapid map construction complete with imported user data, mapping and color coding 250,000 or more points in just a few minutes.

Flexible viewing. Records can be searched, sorted, and filtered by customer account, business name, territory and geographic area of interest. Search results can be viewed on the map or exported for use outside the data visualization map application.

Heat mapping. Trying to determine whether a market is cold, warm, or burning red? Heat mapping [figure-3] will give each jurisdiction a color code with such precision that it becomes easy to see exactly which cities, counties, and ZIP codes are generating the strongest sales. From there, you can determine what could be different demographically, economically, or access-wise from areas where sales are moderate to slow. Heat mapping is a great way to enhance data visualizations because the map

view is similar to a tornado warning map; audiences tend to pay attention.

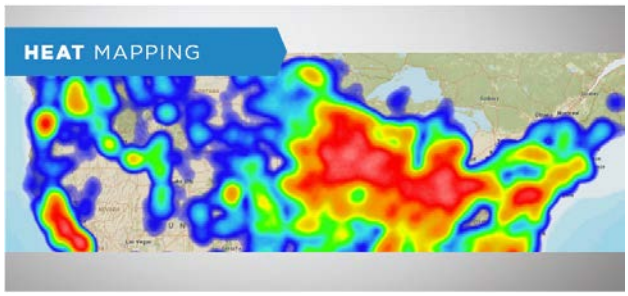


Figure-3: Heat Mapping

International mapping. Business mapping covers a whole lot more than the United States. If you court international customers, or operate locations abroad, it's important to have data maps that are specific to each region within your global market. With combined or separate maps for the markets of Canada, data can be generated more efficiently on the local demographics and sales trends, all of which can lead to more fluid growth within these potentially lucrative territories.

Map embedding. Another great function of business maps is embedding, which makes reports more effective by adding a geographic visual component that drives home the message. map image views tend to bring viewers to rapid consensus, which leads to actions and results. Map image files can be embedded in documents, PDF files or in Power point presentations for wall projection.

Map layering. Markets can be drawn up and analyzed according to trends within geographic areas. With business mapping, the user has many options for geographic boundary layers, these layer options allow you to split the same map into multiple uses. For instance, regional state or county boundaries can be used for general market definitions, while zip codes, Census tracts, MSAs could be applied to create individual territories.

Map printing. Maps can be saved as PDF files for large printouts, which can then be used during presentations. The option works on home printers, on which a larger map can be printed page by page or on plotter printers for a single sheet, 60" x 60" printout. Once your people see positive sales trends as color coded data visualizations on a large map, they'll be more convinced about your strategic plan.

Map sharing. Maps can also be shared with business colleagues, traders, suppliers, shippers, vendors, and customers, whether local, out of state, or abroad. Interactive business web maps can be saved as JPGs, PNGs, or PDF files for export, email, or use in presentation Microsoft documents such as PowerPoint.

Market-area analysis. With business mapping, data can be retrieved on any given number of locations. This allows businesses to create location-specific profiles, determine the geographic distances between storefronts and wholesale warehouses, and decide which areas are most ideally situated for increased sales and expansion.

Radius searching. Think of a business map as a visual search engine of geographic marketing data. By performing a radius search, you can gather data on sales, customers, or demographics within a particular radius, all of which can be used to create marketing campaigns. Once gathered, the information can be exported to spreadsheets and distributed among colleagues and vendors.

Sharable editing. Maps can be edited individually or collectively among co-editing teams. With sharable editing, pools of insight can be drawn together among teams when analyzing info on a region-by-region basis. By encouraging team participation, sharable editing leads to better communication among team members, faster problem solving, which in turn generates faster and more insightful decision making.

State/regional views. Does your business only cover one particular state, region, or group of states? If so, you use business mapping to filter out the parts of the nation that you don't require and create maps that focus data visualizations on critical areas that contain your storefronts and customer base.

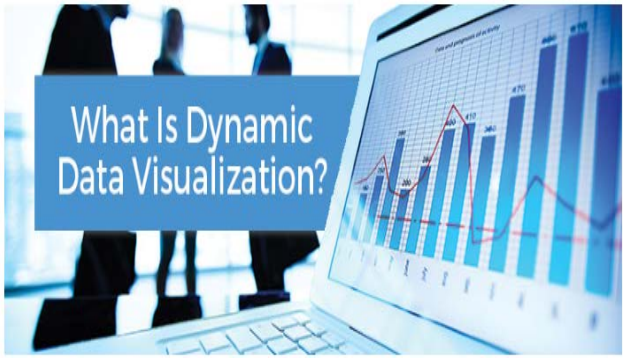
Symbol placement. A key business mapping feature supporting data visualizations is the use of symbols, which can vary in image, size and color. Whether customized or selected from any given number of canned options, symbols define the market highlights and major opportunities across a business map, from customers and hotspots to storefronts and affluent areas of interest.

Territory mapping[figure-4]. With business mapping software, marketing and sales territories can be organized by state, county, or ZIP code. Easily create and maintain these data visualizations of sales territories that drive accountability into your organization. Business mapping data visualizations of sales territories enable accurate and fast sales data aggregation which quickly communicate results and generate strategic and tactical discussion that inform sales planning.

Figure-4: Territory Mapping

VI. DYNAMIC DATA VISUALIZATION AND IMPROVEMENT IN BUSINESS COMMUNICATION

When graphs and charts contain interactive options, more in–depth details and cross–referenced information, data visualization becomes dynamic as shown by figure-5.



Three categories of Dynamic Data Visualization

1.Interactivity

With a customer statement, the facts of a given customer's transactions with a business are essentially etched in stone. When a statement is enhanced with interactive, online features and made accessible on a secure, encrypted, password–protected server, the customer now has a dynamic range of options. Through online visualization prompts, a customer can monitor charts on a day–by–day or week–by–week basis and filter information to suit their needs. Other types of information that a user can access through online filters include the following:

- **Transaction data:** If a customer needs information on a particular transaction, the info can be accessed by clicking the link of said transaction, which can usually be searched by time and date of occurrence.

- **Spending totals:** If a customer is trying to tabulate how much was spent on dining out versus eating in during a two or four–week period, the info can be culled by narrowing down spending records to the timeframe in question.

In addition to making it easier to track finances, interactive visualization makes it easier to gain answers to long–confusing mysteries regarding charges or bank statements. If a customer prefers charts over graphs or vice versa, visualizations can be set according to preference.

2.Extensive Databases

There are some cases in which a customer needs access to more than just the prior 12 months worth of transaction records. With an extended database, transactional archives going back since the start of an account can be provided in year–by–year document files. This can come in very useful if a customer is subject to an audit by the IRS. An extensive database can also come in handy for account holders who simply wish to reevaluate spending trends over the preceding five or ten years.

3.Multiple Content Sources

Not all account holders place their eggs in one basket. Many customers would like the option to view all accounts or systems in one place for cross–referencing purposes. With multiple–source options, customers can analyze info in any given number of ways, including the following:

- **Compare different areas of spending:** If a customer needs to compare his annual basic living expenses to the amount he's spent during twice–yearly trips overseas, he could access one account through another and view the data side by side.

- **Contrast charges and returns:** Alternately, an account holder could contrast the amount of credit debt she's amassed over the last four quarters with her income tax returns.

With multiple–source options, a customer can access all types of data in one place for easy problem solving. The combination of interactive features, extensive databases and multiple sources provides customers with a dynamic set of tools for an overall more satisfying experience.

VII. BENEFITS OF DATA VISUALIZATION

Heightened Brand Exposure

A press release that incorporates well-designed data visuals is likely to stand out from the piles of material that journalists and PR execs are swamped with on a daily basis. This is very beneficial when distributing a press release, because the visuals increase the likelihood of it getting chosen over the PR materials of competing entities.

Stronger Impressions on Consumers

Visualization graphics help audiences gain a quick understanding of the crucial math involved in a given set of data. Providing that the visuals are laid out clearly, a consumer could gain insights that would otherwise be missed, and in turn use that information to make more informed decisions going forward. The emphasis here is on "well–designed" and "clearly laid out," because images that lack those qualities could have the reverse effect and end up confusing, misleading or even alienating viewers.

In short, a visual needs to have three key qualities in order to succeed with viewers:

- **Eye–catching design:** Whether it's a chart, graph or something else, the image must stand out on a page or Windows browser with its uniqueness.
- **Informative contents:** Regardless of how succinctly the info is conveyed, it must provide viewers with useful, digestible info.
- **Factual accuracy:** The information must be truthful and not cherry–picked or speculative.

At the same time, the image doesn't need to be especially fancy to convey its intended purpose. Often times, the simplest designs are most successful at putting the message across to viewers. A design could be memorable for its creativity, but fail to provide the necessary information and thus lack the "data" in data visualization.

VIII. THE PROBLEMS WITH VISUALIZATION

Unfortunately, there are a few current and forthcoming problems with the concept of data visualization:

1. **The oversimplification of data.** One of the biggest draws of visualization is its ability to take big swaths of data and simplify them to more basic, understandable terms. However, it's easy to go too far with this; trying to take millions of data points and confine their conclusions to a handful of pictoral representations could lead to unfounded conclusions, or completely neglect certain significant modifiers that could completely change the assumptions you walk away with. As an example not relegated to the world of data, consider basic real-world tests, such as alcohol intoxication tests, which try to reduce complex systems to simple "yes" or "no" results—as Monder Law Group points out, these tests can be unreliable and flat-out inaccurate.

2. **The human limitations of algorithms.** This is the biggestpotential problem, and also the most complicated. Any algorithm used to reduce data to visual illustrations is based on human inputs, and human inputs can be fundamentally flawed. For example, a human developing an algorithm may highlight different pieces of data that are "most" important to consider, and throw out other pieces entirely; this doesn't account for all companies or all situations, especially if there are data outliers or unique situations that demand an alternative approach. The problem is compounded by the fact that most data visualization systems are rolled out on a national scale; they evolve to become one-size-fits-all algorithms, and fail to address the specific needs of individuals.

3. **Overreliance on visuals.** This is more of a problem with consumers than it is with developers, but it undermines the potential impact of visualization in

general. When users start relying on visuals to interpret data, which they can use at-a-glance, they could easily start over-relying on this mode of input. For example, they may take their conclusions as absolute truth, never digging deeper into the data sets responsible for producing those visuals. The general conclusions you draw from this may be generally applicable, but they won't tell you everything about your audiences or campaigns.

4. **The inevitability of visualization.** Already, there are dozens of tools available to help us understand complex data sets with visual diagrams, charts, and illustrations, and data visualization is too popular to ever go away. We're on a fast course to visualization taking over in multiple areas, and there's no real going back at this point. To some, this may not seem like a problem, but consider some of the effects—companies racing to develop visualization products, and consumers only seeking products that offer visualization. These effects may feed into user overreliance on visuals, and compound the limitations of human errors in algorithm development (since companies will want to go to market as soon as possible).

IX. CONCLUSION

Data visualization technology provides a high-tech means for preparing the necessary information that enables sound business choices. It helps executives see the big picture all at once from trends and numbers to hot spots and trouble areas. This allows people in different capacities of decision making to mutually identify the most likely routes for success, and to pinpoint the most efficient means for taking ideas forward.

In this paper we have covered the concepts like introduction to data visualization, its types, data visualization and decision making, advanced data visualization,business mapping and decision making, benefits and challenges of data visualization to provide an in-depth knowledge on data visualization to researchers to go the next step.

X. REFERENCES

[1] https://www.widerfunnel.com/data-visualization-

[2]https://www.boostlabs.com/data-driven-decision-making/

[3]http://www.crgroup.com/wp-content/uploads/data-visualization-eBook.pdf

[4]http://www.visualworkforce.com/blog/4-ways-data-[5]visualization-can-improve-your-decision-making-kx5ly

[6]Arockia Panimalar.S et. al., " Data Visualization Tools and Techniques For Datasets In Big Data ", International Research Journal of Engineering and Technology , Volume: 04 Issue: 08 , Aug - 2017

[7]Ekaterina Olshannikova, Aleksandr Ometov, Yevgeni Koucheryavy and Thomas Olsson"Visualizing Big Data with Augmented and virtual reality: challenges and research agenda"Journal of Big Data (2015) 2:22.

[8]Shixia Liu, Weiwei Cui, YingcaiWu, Mengchen Liu "A survey on information visualization: recent advances and Challenges" Springer- 2014.

[9]S. Syed Fiaz, N. Asha, D. Sumathi, A.S. Syed Navaz "Data Visualization: Enhancing Big Data More Adaptable and Valuable " International Journal of Applied Engineering Research ISSN 0973- 4562 Volume 11, Number 4 (2016) pp 2801-2804.

[10]http://www2.cs.uh.edu/~gnawali/courses/cosc6397-f13/intro-visualization.pdf

[11]https://www.researchtoaction.org/wp-content/uploads/2014/02/Introduction-to-Data-Visualisation.pdf