SUPPORTING THE DECISION ON DASHBOARD DESIGN CHARTS

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Abstract - Different decisions types need differentiation of information presentation; management requires adequate tools for the decision-making process. Business value insights are improved with better information visualization, therefore improving decision making. In this study, it presented a theoretical review based on three main areas: management, reporting, and visualization. Upon this theory review, we identify the primary dimension. Those dimensions are used to embody decisions that maybe incorporate in a decision tree. This decision tree may be helpful in the choice of adequate data visualization form managerial dashboards. For future works, we suggest conducting an empirical work that uses this decision tree to understand the impacts on its usage on management context better.

Keywords - Data visualization, Dashboard Design, Chart Design.

I. INTRODUCTION

Different decisions types need differentiation of information presentation; management requires adequate tools for the decision-making process. Business value is leveraged by an improved information visualization enabling, at the same time, decision-making process. Enhancing hundreds of thousands of "small" decisions adds up to sizeable annual value for the business. We must consider that there are several types of decisions: Unstructured, Structured, Semi-structured [[18]][[35]][[36]][[38]]. In unstructured choices, the decision-maker must provide judgment, evaluation, and insight to solve the problem. While structured decisions are repetitive and routine, involving procedures to handle the process, so managers do not have to deal with each situation as if it was as new. In semi-structured, only part of the problem has a clear-cut answer provided by the accepted procedure. Typically, Senior Managers Make many unstructured decisions. Middle Managers Make more structured decisions than a senior manager, but these may include unstructured components. Operational managers take more structured decisions than all the other managers. Several tasks are critical in the process of decision making: intelligence, design, choice, and implementation. Intelligence consists of Discovering, identifying, and understanding the problems occurring in the organization. The design Identifies and explores solutions to the problem. Choice corresponds to ponder and choose among solution alternatives. The implementation consists of Making chosen alternative work and continuing to monitor how well the solution is working. Apart from the various studies on data visualization, the authors found that executive management dashboards needed a broader tool to help data scientists on the visualization challenges.

This primary study objective is to propose a conceptual framework for decision making of the adequate data visualization presentation in dashboards. To achieve this objective, we conducted a literature overview on which we proposed a decision tree for data visualization. This study contributes to a decision tree to help the decision design of dashboards for organizational contexts. The construction of this decision tree is based upon various theories, such as management theory, design, and data presentation.

This paper is structured in four sections, starting with a theoretical background on management. It is followed by the identification of central reports presentation problems. The next section (third) is presented a review on visualization and given some recommendations. In the last section, we propose a decision tree for helping in the information report for management dashboards.

II. THEORETICAL BACKGROUND

Information systems can support some of the roles played by managers. According to the Classical model of management functions, there are five functions: planning, organizing, coordinating, deciding, and controlling [[13]][[39]]. More contemporary behavioral models, the Actual managers'behaviour appear to be less systematic, and more informal, more reactive when compared with the classical model. According to Mintzberg [[26]], there are 10 Managerial Roles grouped into three types of roles: Interpersonal roles, Informational roles, and Decisional roles. Interpersonal roles include Figurehead, Leader, and Liaison. Informational roles may be Nerve center, Disseminator, or Spokesperson. Decisional roles comprehend entrepreneur roles, disturbance handler, resource allocator, and negotiator [[15]][[26]][[44]].

In real-world decision making, there are also several problems. There are three main reasons explaining why investments in ITdo not always have positive results: Information quality, Management filters, and Organizational inertia and politics. In fact, High-

quality decisions require high-quality information [[2]][[8]]. Management filters result from the fact that managers have selective attention and have a variety of biases which discard information that does not conform to prior conceptions. Finally, Strong forces within organizations resist making decisions calling for major change creating Organizational inertia and politics [[7]][[34]]. High-Velocity Automated Decision Making made possible through computer algorithms, precisely defining steps for a highly structured decision. However, Humans is often taken out of the decision. For example, High-speed computer trading programs. Trades are executed in 30 milliseconds [[6]][[32]][[33]], requiring safeguards to ensure proper operation and regulation.

2.1. Business intelligence

Business Intelligence includes Infrastructure for collecting, storing, analysing data produced by the business, including Databases, data warehouses, and data marts. Business analytics is often included in the context of Business Intelligence [[3]][[4][4]][[14]][45]. To clarify, some authors use de expression Business Intelligence and analytics [[5]]. It includes tools and techniques for analysing data, OLAP, statistics, models, and data mining. Often, six elements are considered in the business intelligence environment: Data from the business environment. Business intelligence infrastructure, Business analytics toolset, Managerial users and methods, Delivery platform, and User interface. In the context of the Delivery platform, it is possible to specify MIS, DSS, ESS. The user interface includes Data visualization tools, among other aspects.

Business Intelligence and Analytics Capabilities [[19]][[40]][[43]] have a Goal to deliver accurate real-time information to decision-makers. In this context, the main analytic functionalities of BI systems are:

- production reports,
- customer-parameterized reports,
- dashboards/scorecards,
- ad hoc query/search/report creation,
- drill down and forecasts,
- scenarios,
- models.

To improve the decision process, databases may be used. However, it needed to use more sophisticated tools like Online Using to analytical processing (OLAP), Multidimensional Model, Data Mining, or Big Data [[4]][[11]][[12]].

Predictive analytics uses a variety of data, techniques to predict future trends and behaviour patterns, like Statistical analysis, Data mining, Historical data, and Assumptions. Incorporated into numerous BI applications for sales, marketing, finance, fraud detection, healthcare, Credit scoring, or Predicting responses to direct marketing campaigns [[21]]. Big Data Analytics is also becoming a reality. It includes a massive dataset collected from social media, online and in-store customer data, and so on help create real-time, personalized shopping experiences for major online retailers. It may be related to Smart cities, where Public records, Sensors, and location data from smartphones may give the Ability to evaluate the effect of one service change on the system.

Operational intelligence is a specific area in the business intelligence related to Business activity monitoring, collection, and use of data generated by sensors. It also allows the development of the Internet of Things, by Creating vast streams of data from web activities, sensors, and other devices. Software for operational intelligence and analytics enable companies to analyse their big data. Also, location analytics gives the ability to gain business insight from the location (geographic) component of data. Here the following elements are especially relevant: mobile phones, sensors, scanning devices, and map data. Geographic information systems (GIS) link location-related data to maps. For example: For helping local governments calculate response times to disasters [[20]]. There are several Management Strategies for Developing BI and BA Capabilities: One-stop integrated solution.

Moreover,multiple best-of-breed solutions. In One-stop integrated solution, Hardware firms sell software that runs optimally on their hardware. It Makes firm dependent on a single vendor. Multiple best-of-breed solutions allow Greater flexibility and independence but Potential difficulties in integration and Must deal with numerous vendors. All BI and BA systems bring high switching costs (Phan & Vogel, 2010).

Decision-support systems are Support for semi-structured decisions. They use mathematical or analytical models, Allow varied types of analysis, like “What-if” analysis, Sensitivity analysis, Backward sensitivity analysis, or Multidimensional analysis / OLAP (e.g., pivot tables). Executive Support Systems (ESS) and management support systems (MSS) are decision support tools for senior management. They help executives focus on relevant performance information. Balanced scorecard method measures outcomes on various dimensions (Financial, Business Process, Customer, Learning, and growth). For measuring each dimension, it is essential to identify Key performance indicators (KPIs) [[22]][[23]][[24]]. Business performance management (BPM) translates a firm’s strategies (e.g., differentiation, low-cost producer, the scope of operation) into operational targets. KPIs developed to measure progress toward goals. Data for ESS includes Internal data from enterprise applications and External data such as financial market databases and is analyzed through Drill-down capabilities. GDSS (Group Decision Support Systems) is an Interactive system to facilitate the solution of unstructured problems by a group including Specialized tools to support Virtual collaboration

rooms [[27]][[28]][[29]][[31]]. Those tools may include software to collect, rank, edit participant ideas, and responses. It may also promote a collaborative atmosphere, anonymity.

2.2. Some reports have problems

Tufte [[41]] classifies Napoleon's March to Moscow, a drawing made by Charles Joseph Minard in 1869, as one of the most effective graphic illustrations ever created. This presentation communicates a rich and flowing story. The chart, which portrays the dead of Napoleon's army during its 1812 invasion of Russia, begins on the left-hand side with 442 thousand men in Napoleonic campaign to Moscow. The black line, which moves in the opposite direction, signifies its retreat and the terrible fatalities.

It is essential to Tell a Story using data [[37]]. Are there other ways to tell a great story through data? This is not possible because often reports have problems. They do not have a story. They have Weak visual quality, Shadows, and 3D sometimes are noise. The Colour schema and Character fonts are not the most suitable, and they do not have more adequate graphs.

According to Few [[11]][[12]],visual representation of the most relevant information needed to achieve one or more business objectives. Information presented in a consolidated and organized form on a single screen to be more easily monitored. This author identifies the most common pitfalls in dashboard design:

- exceeding the boundaries of a single screen
- supplying inadequate context for the data
- displaying excessive detail or precision
- expressing measures indirectly
- choosing inappropriate media of display
- introducing meaningless variety
- using poorly designed display media
- encoding quantitative data inaccurately
- arranging the data poorly
- ineffectively highlighting what is Important
- cluttering the screen with useless decoration
- misusing or overusing colour
- Designing an unappealing visual display

Ware [[42]][[43]] underlines the importance of visualization by explaining that the human eye and cognition naturally seek patterns. However, the information should be displayed in specific ways, as if the same information is presented in unexpected ways, people may not understand or oversee any pattern. The human mind is used to specific rules of the display, that when changed people do not comprehend it.

2.3. Memory

We have three levels of memory to make things actual: iconic, short-term memory, and long-term memory. Pre-cognitive attributes that help us to interpret some information but no other information. Exact quantitative perception: 2D length and positioning.

Not very precise quantitative perception: width, size, intensity, blur. We have Non-Quantitative Perception corresponding to Orientation, Form, Enclosure, Added Brands. In the XX century, the designer started to support their work in a set of principles: Gestalt Principles [[16]].

2.4. Colour and Character Fonts

In what concerns the art, it is essential to analyse what type of colours and how we organize them, and how we perceive them [[10]]. Colour may be sequential on a scale, from the darker to the lighter. We may create two divergent space. Colours may also be not organized in a logical order. Some rules may be followed to have a useful dashboard. First, do not have more than 3-5 colours in a unique look (think short-term memory). The eye can not differentiate more than five colours from the same hue. Try to have a semantic meaning for the colours used (Red = Bad, Green = Good). The character is also fundamental. Distinguishing Sans-Serif and serif fonts is important (Dix, 2009). The space used by an "i" e general smaller than the space used by "m." However, in monospace fonts, the space used by each character is the same. Some rules: Sans-Serif better for Digital Media in a professional context (E.g., Segoe, Calibri, Trebuchet). Serif fonts are better in printed texts. One can change the font-weight using three techniques: Change the size, Choice of different fonts with a greater weight of the same family and Use bold.). Choose at most 2-3 font types / sizes on a report page / control panel. Choose a lighter weight. Use a larger weight font from the same family for titles instead of (bold) Ex. Segoe UI Bold. According to Few [[11]],there are primary challenges: Placing a large volume of useful and often unrelated information in a limited space, be clear and Choosing the right information. Well-designed dashboards deliver information that:

- It is exceptionally well organized
- It is condensed, mainly in summaries and exceptions
- It is specific and customized to audience needs and goals
- Presented through concise means that communicate data and message clearly and directly.

III. DIMENSIONS

Adequate statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency. Graphical displays should show the data and make the viewer think about the substance rather than about graphic design, the methodology, the technology of graphic production or something else avoid distorting what the data has to say [45]. It is essential to present many numbers in a small space and make broad data sets coherent. The systems

should encourage the eye to compare different pieces of data and reveal the data at differentgranularity. From a comprehensive overview of the fine structure serve a purpose: description, exploration, tabulation, or decoration. It is also essential to be tightly integrated with the statistical and verbal descriptions of a data set [[41]].

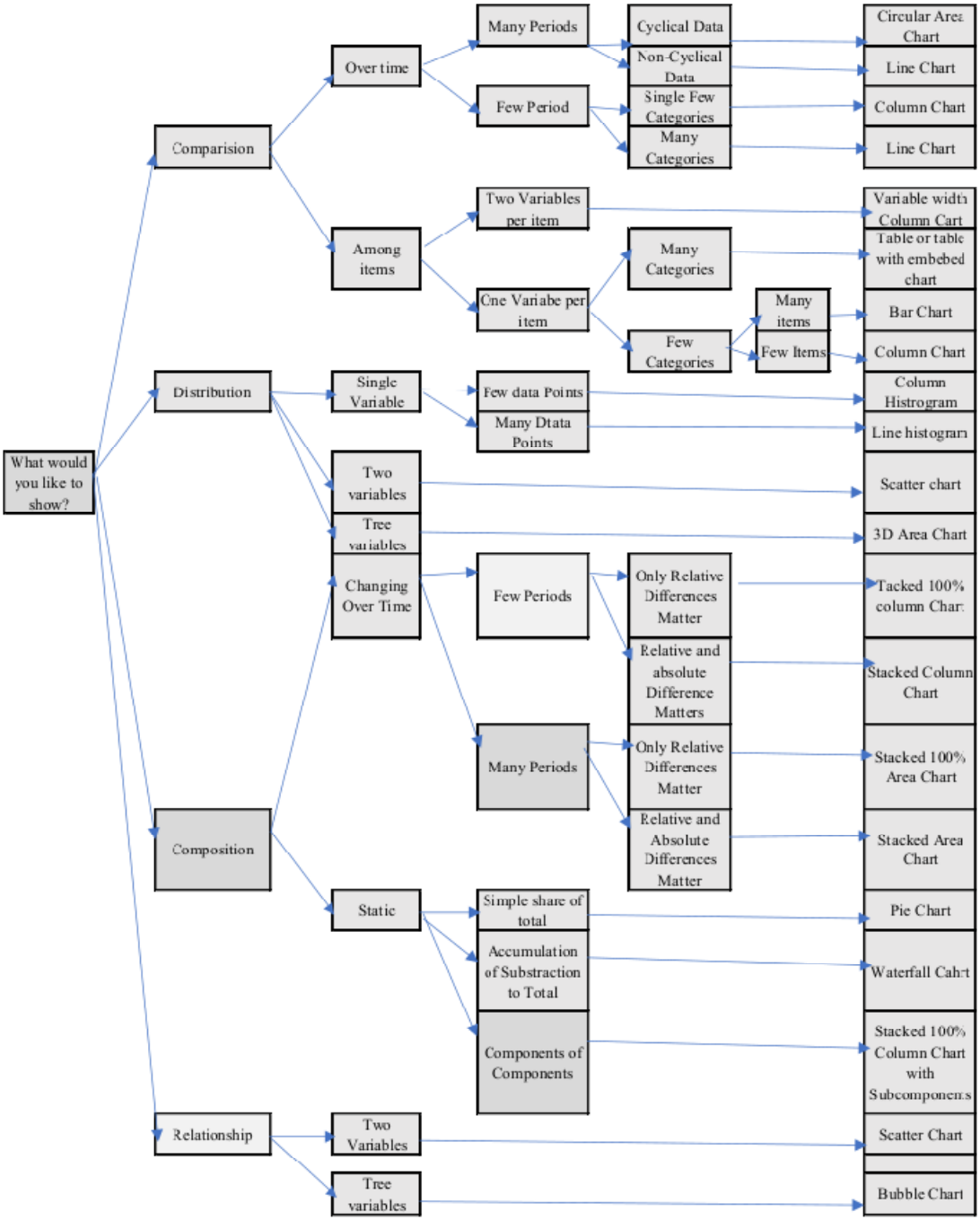


Fig.1. Dashboard design charts decision tree

First, it is essential to clarify the purpose and identify the audience. Based on this, generically, the purpose of a specified data bay be to show comparison, relationship, composition, or distribution (Abela, 2008). Then, it is essential to identifying the number of variables and time representation [[17]].

IV. PROPOSAL OF A DECISION TREE MODEL O DECISION FOR THE TYPE OF GRAPH

The following figure presents the decision tree for helping visualization decision in management context. In this decision tree, the user may select the appropriate chart. He may identify the purpose of the chart (comparison, distribution, composition or relationship), identify over time (may periods, few

periods), the number of variables may be one, two or more variables.

V. PRELIMINARY EVALUATION

In order to perform a preliminary evaluation, we performed a study using students that in the context of a course must create a dashboard using PowerBI [[25]]. Some of the teams were encouraged to follow this process. The other teams did not use the tool. They only followed a list of best practices presented in a class. Results show that those students that used this tool were more confident that those that only followed best practices presented. Students suggest that this approach should be extended to the process of production of the dashboard. In fact, during classes was told that creating a dashboard is telling a story. So, it would be interesting to have a tool to help in dashboard design using a storytelling methodology.

VI. CONCLUSIONS

In this study, it presented a theoretical review based on three main areas: management, reporting, and visualization. Upon this theory review, we present a decision tree for helping in the choice of charts. In this decision tree, the user may select the appropriate chart. He may identify the purpose of the chart (comparison, distribution, composition or relationship), identify over time (may periods, few periods), the number of variables may be one, two or more variables. Those charts must also be incorporated into a dashboard in order to support managerial decisions.

For future works, we suggest conducting an empirical work that uses this decision tree to understand the impacts on its usage on management context better. On the other hand, it is also relevant to create a tool that supports the process of creating the dashboard by grouping charts. This tool may be supported in the "storytelling" approach.

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