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GIVING THE BOSS THE BIG PICTURE: DEMONSTRATING CONVERGENCE VISUALIZATION DESIGN PRINCIPLES USING BUSINESS INTELLIGENCE AND ANALYTICS TOOLS

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ABSTRACT

Business Intelligence and Analytics (BIA) tools have been widely commercialized to ease the process of retrieving, analyzing and presenting the information. Some of the major BIA tools' applicants are the experts and decision makers whoare known as the higher level management in an organization. They use BIA tools to derive for better business decisions. However, the management's activities involve Complex Cognitive Activities (CCA) such as decision making, analysis, forecasting, strategizing and sense making. These activities require higher level thinking in which the management team needs to analyze and synthesize the information. While there are various kinds of visualization within BIA tools having been developed to present the information, there is a lack of initiatives to facilitate higher level thinking effectively. One of the lacking initiatives is about visualizing the interconnectedness within information complexities in a way that can help experts and decision makers gain insight from the overall situation (the big picture). Therefore, this paper intends to demonstrate convergence visualization design principles that are able to complement current BIA tools in order to provide the big picture for higher level thinking.

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Based on the flow concept, the demonstration structured multiple visual elements to become a flow of sequential phases of a sponsorship process as the higher level of visual structure. Then the complementary between higher and lower level visual structure facilitates the exploration of overview and in-depth information for the higher level thinking process.

Keywords: the big picture, interconnectedness, analysis, higher level thinking, complex cognitive activities, visualization, visual structure and overview.

1. INTRODUCTION

In the organization, [1] observed the needs to gain the big picture for more effective business decision. They explained that the big picture should provide insight and be the main drivers in decision-making and [2] added that successfully coping with the big picture challenge positively reflects the process of complex cognitive activities (CCA) between experts and decision makers, thus enhancing the quality of business decision. On the other hand, the analytic has been studied extensively on a technological perspective. For instance, business intelligence and big data address the immense of data hence the concept of capture, store, manage and analyze has been major interesting research to address [3]. However, far too little attention has been paid to the same capacity of brain and limited human cognitive to perceive and process the complexity of huge amount of information and data. As a result, it increases the difficulty to gain the big picture from users and organization perspectives [4].

In the context of visualization-computational based, according to [2] data and information are encoded and stored internally (e.g, as magnetic patterns on a hard disk platter) and are not directly accessible to users. The only access is through the visual representation at the interface. Therefore, the design of visual representation for analytical interface fundamentally influences how experts and decision makers perceive and process the information. While there are various kinds of visualization within big data having been developed to present the information, there is a lack of initiatives to facilitate the users for effective higher level thinking. One of the lacking initiatives is about visualizing the interconnectedness within information complexities in a way that can help experts and decision makers as the bosses in the organization to gain insight from the overall situation and yet, at the same time, are able to derive and relate to any particular details. Eppler and Mengis [2, 3] have enlightened the interconnectedness issue as a ‘lack of the big picture’. Therefore, this paper intends to demonstrate visualization design principles that are able to complement current BIA tools in order to support interconnectedness for higher level thinking. By proposing the systemic view as a fundamental, this paper intends to help the experts and decision makers as the bosses to

see the interconnectedness within data/information complexities. For the purpose of demonstration, this paper focuseson the scholarship monitoring and analyzing data/information context of use

2. WORKING BACKGROUND

Visualization-computational based is a rapidly advancing field of study both in terms of academic research and practical applications. The field of visualization is interdisciplinary, one that incorporates scientific, technological and cognitive aspects. Visualizations focus on amplifying human cognition [5-7] and more recently, they have been used as a communication mediator to build common understanding, insight, and decision-making within organizational environments [8-10]. After more than 30 years of advancement, visualizations have become very important, almost indispensable, and are used in many application domains [11-12] and currently significant for analytical purposes. Information Visualization – IV is an umbrella term for any visualization-computational based spread as an alternative solution for information overload. Data Visualization (DV), Knowledge Visualization (KV) and Visual Analytics (VA) are among the domains within IV coverage as a multidisciplinary approach for data mining, data management, data fusion, statistics and cognition science to automate analysis, represent aggregated information and facilitate formulation for expert analysts. Hence, visualization has been commercially used to represent, analyze and predict information in various domains of application. Today, organizations are the prime domain of visualization and widely uses it to facilitate decision making, analysing, forecasting, strategizing and sense making – which are in a larger extent called Complex Cognitive Activities (CCA) [13-14].

With the aim to provide the rightful way to represent information complexities for experts and decision makers in the organization, this research intends to complement the current BIA tools with visualization design principles effective for higher level thinking. This is because visualization is not only meant to reduce and control information.Instead, it must be able to facilitate, shape and alter the users' mental space and coordinate towards the higher level of information's understanding.Recent research [15] has developed the Convergence Visual Representation Design (Converge-VRD) to facilitate higher order thinking in the organization. There are three Converge-VRD as visualization principles highlighted in this research; (i) higher level visual structure, (ii) lower level visual structure, and (iii) the interconnection between higher and lower level visual structures. These principles apply systemic approach as a basis for visual representation structure. The concept of systemic is

closely related to understanding the interconnection and providing the big picture in the sense of holism and extension for an incomplete overview concept of IV [16]. The outcomes from this research show the effectiveness of Converge-VRD to facilitate, guide and bring clarity during analysis and synthesis processes. Among the key findings is the visualization is not only meant to represent the complexities of knowledge, but it must be able to represent the knowledge complexities in a way that can support the users' mental model. Thus, in providing this kind of role, the visualization must be designed to show and represent the interconnection between related information to form a coherent whole. By having those capabilities, the visualization is able to facilitate the cognitive in handling the information complexities towards knowledge construction.

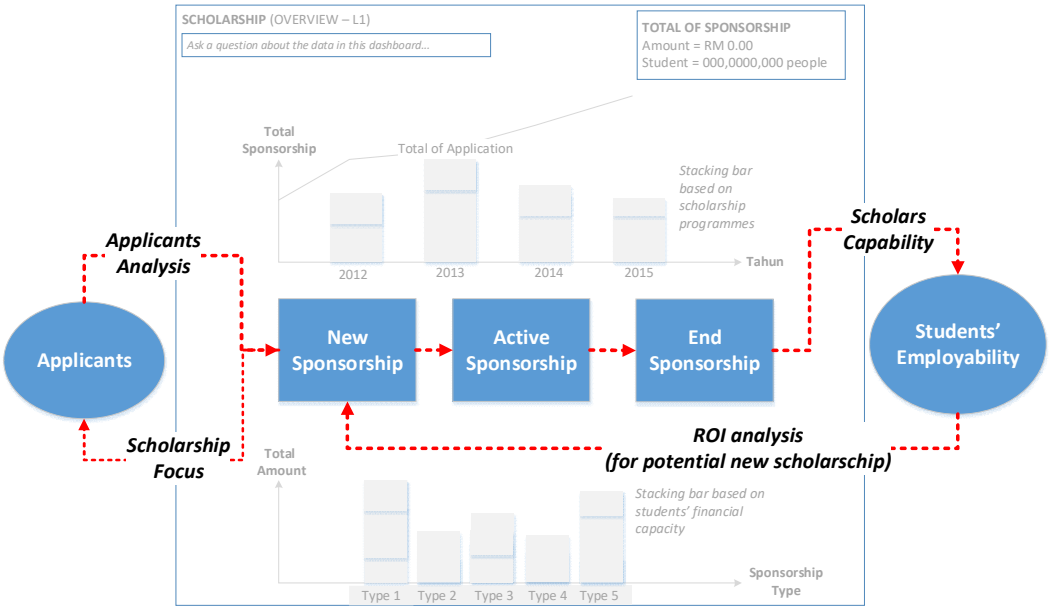
3. DEMONSTRATE 'THE BIG PICTURE'

Understanding of human-centered issues in the area of IV is starting to grow important. It needs the visualization to function at the micro levels by facilitating cognitive shift and visualization should adjust to the user's needs [17]. Nevertheless, it is such a waste to develop new techniques, mechanisms or algorithms to fulfill the specific user requirements since visualization has such a tremendous number of them in the IV, VA, KV and DV fields. A massive quantity of visualization tools, techniques and methods has been developed for BIA. Therefore, [18] recommends the combination of different visualization methods using one and/or different media in one interface as complementary visualization termed as 'multiple coordinated views'. This process of 'mix and match' is relevant to provide the dynamic of IV appliance towards user's requirements.The customized visualization has various types of visualization functions to facilitate the analytical process. Along with that, the compilation provides visualization that is fully documented, applied in real life management in organizational settings, fit to represent knowledge-intensive and complex issues and applicable by non-experts. For this particular demonstration, the research focused on the selection from Power BI Visual Custom (please refer to https://goo.gl/TyKX1C). The customized visualization from Power BI is organized systematically according to the category of advanced analytics, data visualization, gauges, info graphics, KPIs, Maps and Timelines.

However, to develop a more effective visualization for higher level thinking in the CCA, the selection and combination from custom visualization must be able to provide the big picture for experts and decision makers in the organization. In order to do that, this paper proposesthe selection and combination from custom visual to be designed according to Converge-VRDso that the visual layout and structure is capable of externalizing and showing the inter-related

elements' structure. In addition, Converge-VRD is able to organize many elements from various perspectives and these elements must come from context of the users. In order todesign the visualization based on Converge-VRD, it is firstly important to organize the users' context based on their requirements. Then analyze and categorize the requirements into details and overview insights. For this particular demonstration, the requirement analysis has identified 29 insights from the users. Within the insights, the interview with the top management highlighted their needs to gain an overview understanding for the sponsorship domain through its processes – the first phase is about new application. Once approved, it will become an active sponsorship phase and after graduating, the sponsorship process will be ended. They also highlighted the needs to ease the analysis of potential applicants at the beginning and impact of employability at the end of the sponsorship process. At the same time, the user also needs to understand the sponsorship trend and capacity over the years. Therefore, these 29 insights have been organized into four categories to become higher abstract level of: i) New Sponsorship, ii) Active Sponsorship, iii) End of Sponsorship and iv) Sponsorship and Capacity Trend.

Since Converge-VRD emphasized the importance to see and draw the interconnectedness between the related elements, the demonstration harmonized all the higher level visual structures using the flow concept as shown in Figure 1 to become the big picture. Using the concept flow, the demonstration combined the trends, flow and capacity of scholarship to provide the big picture for scholarship monitoring and analysis activities. Further than that, the demonstration also considered how the selection of the visual structure is capable of externalizing and showing the inter-related elements structure for the analysis and synthesis processes during CCA.



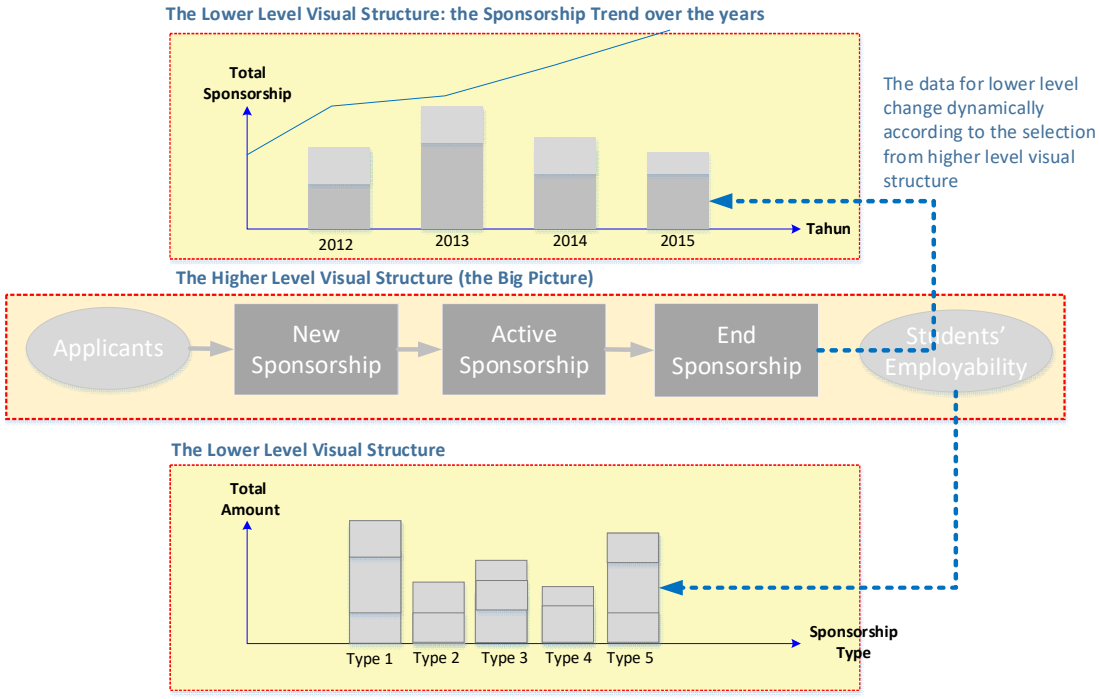
*Certain elements intentionally left in grey colour to highlight element 2

Fig.1. The flow of Sponsorship Process.

The Flow concept is able to facilitate the users to gain data easily and guide the 'know how' of the sponsorship process. The flow is a natural metaphor to indicate the continuity of the phases within a process. Since the elements of sponsorship have been arranged from: i) New sponsorship, followed by ii) Active Sponsorship and finally by iii) End of Sponsorship, it gives an overview through imitating the real and routine process of sponsorship. The flow concept is able to highlight, externalize and show the interconnection between the sequential process which can act as the guidelines for the 'know how' of the sponsorship process. By providing the big picture through the sponsorship process, it gives an easy understanding for information flow and exploration. The users can easily predict where to demand for detailed information from these higher levels of the sequential process. Furthermore, the sponsorship process has been extended to the pre and post of the real process. Since there is a need to understand the sponsorship trend and capacity over the years, it is important to highlight that the new sponsorship stage is closely related to the applicants' (students) data. This is because, the students will be able to identify the scholarship focus and new sponsorship will be considered from the applicants' analysis. Only the applicants that meet the sponsorship criteria based on the scholarship focus will be granted. At the end of the sponsorship, it is important to analyze the scholars' capability through the student's employability data. Then, from here, there is a need to analyze the Return of Investment (ROI) capacity to create a new potential scholarship. Therefore, the big picture has been extended by putting the data of

applicants, new sponsorship, active sponsorship, end sponsorship and student's employability in one flow.

To handle higher level thinking during complex cognitive activities, it needs to be an epistemic cycle where experts and decision makers would perform to check and reason from lower level details. To do this, they must understand and get some detailed explanation about their current overview and what they are going to dig for more.There are essential connection between higher and lower level details of a visual structure. Through lower level structure, the users are able to develop abstractions for higher levels by accessing and manipulating the lower level details. In other words, the relationship between these lower and higher elements is important to facilitate the cognitive during the reasoning process. For the lower level structure, this research use the concept of trend and capacity of the sponsorship over the years as shown in Figure 2. It provides the trend and capacity from the users' requirement category. The combination of a histogram, stacking bar and line chart was integrated to represent the sponsorship trend over the years. By having a combination of these three visualization types as one element of a visual structure, it embeds the element of simplicity because of its perceived common usage during the presentation and analysis process.



*Certain elements intentionally left in grey colour to highlight the organization of the visual structure

Fig.2. The interconnection between Higher Level and Lower Level Visual Structure

Furthermore, the combination indicates each of the users' insight in a way that complements each other and can be viewed as a timeline over the years. It provides a quick and comprehensive view for the monitoring process. Other than that, the histogram by year also acts as the visual metaphor of a timeline structure. This would allow for a more consistent and deeper understanding of a visual structure to centralize mental models over the years among the users. This timeline metaphor indicates it as the anchor structure for abstracting elements in the monitoring process. The discussions can go deep into certain elements, but the users could always find an adequate abstraction by referring back to the timeline metaphor. Consequently, the sponsorship trend is related to the sponsorship capacity. By usinga similar approach, the elements have three key components of visual custom: i) a histogram to represent the type of sponsorship, ii) a stacking bar to represent students' financial capacity (based on their financial and family background) and iii) the height of a bar to represent the total amount by each sponsorship. By using mouse over interaction, the users will be able to identify the financial capacity of the students (e.g. B40 for low income, M40 for middle income and H20 for high income) based on the year and sponsorship program.

4. CONCLUSION

We hope this demonstration can help the BIA tool developer, even the novice one, to provide the big picture for higher level thinking. The visualization types have been combined and organized to become an overview visual structure by following Converge-VRD design principles. Through the flow concept, the demonstration of sequential phases of i) new sponsorship, ii) active sponsorship and iii) end sponsorship have become one interconnection that provides the big picture for experts and decision makers. Since experts and decision makers are able to view the higher and lower level of information at the same time, they can view, relate and refer to the details during the reasoning for the higher level of abstraction. Furthermore, they should be able to understand the reality of and overall scholarship situation. The capabilities to identify the key points and see the interconnections between various perspectives give users preparation to handle any emergence of ideas, information or tasks during complex cognitive activities.

While the previous research on Converge-VRD focused to understand 'why' each of the design theories and principles is essential for higher order thinking context of use,then for this paper, the demonstration explored more about 'how elements' of Converge-VRD being practical for CCA – monitoring and analyzing scholarship activities inthe current visualization context. Furthermore, the demonstration activity provided the guidelines on how

to bring down the Converge-VRD design theories into design elements that are applicable to complement current BIA tools in the market,hence potentially complemented and improved current visualization techniques, methods and tools. Furthermore, this is what the future is looking for and we believe the expansion through this demonstration will help the developer to design more effective visualizations/dashboards for higher level thinking users.

5. REFERENCES

[1] S. Ya'acob, N.M. Ali and N. M. Nayan. Understanding big picture and its challenges: experts and decision makers perspectives. In International Visual Informatics Conference Springer, Cham**. (2013)** pp. 311-322.

[2] J. Mengis. Integrating Knowledge through Communication-the Case of Experts and Decision Makers. Proceedings of the International Conference on Organizational Knowledge, Learning and Capabilities (OKLC). **(2007)** 44, 699–720.

[3] B. Sitohang, "Big Data is a Big Challenges," in The 4th International Conference on Electrical Engineering and Informatics**(2013)**

[4] M. J. Eppler. 10 years of Knowledge-Communication. Results, Insights and Perspectives, http://issuu.com/mcminstitute/docs [24 July 2017]

[5] B. Shneiderman. The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. Visual Languages Proceedings IEEE Symposium **(1996)** pp. 336-343.

[6] S. Noah, S. Yaakob and S. Shahar. Application of information visualization techniques in representing patients' temporal personal history data. Visual Informatics: Bridging Research and Practice**(2009)**. pp.168-179.

[7] C. D. Hundhausen. Evaluating Visualization Environments: Cognitive, Social, and Cultural Perspectives. In Handbook of Human Centric Visualization. Huang, W. (Ed.). Springer New York **(2014)**. pp. 115-145.

[8] R. A. Burkhard and J. Eppler. Knowledge Visualization towards a New Discipline and its Fields of Application. USI Research Note 2. **(2004)**

[9] S. Bresciani and M.J Eppler. Choosing Knowledge Visualizations to Augment Cognition: The Managers' View. IEEE International Conference Information Visualization **(2010).** Vol 14, 355–360.

[10] S. Bertschi. Knowledge Visualization and Business Analysis: Meaning as Media. IEEE International Conference Information Visualization **(2009)** Vol 13: pp 480–485

[11] L. Masud, F. Valsecchi, P. Ciuccarelli, D. Ricci, and G. Caviglia. From Data to Knowledge-Visualizations as Transformation Processes Within the Data-Information-

Knowledge Continuum. IEEE 14th International Conference of Information Visualization (IV),**(2010)** pp 445-449.

[12] R. Meyer. Knowledge Visualization. Trends in Media Informatics Advanced Seminar on Information Visualization 23 **(2009)**

[13] K. Sedig and P. Parsons, P. Interaction Design for Complex Cognitive Activities with Visual Representations: A Pattern-Based Approach. AIS Transactions on Human-Computer Interaction5(2): pp 84–133 **(2013)**

[14] S. Ya'acob, N.M. Ali and N. M. Nayan. Handling emergence of dynamic visual representation design for complex activities in the collaboration. Jurnal Teknologi, 78(9-3) pp 1-11. **(2016)**

[15] J. Johnson. Embracing design in complexity. In Embracing Complexity in Design. Alexiou, K. & Johnson, J. (Eds.). pp. 193–203, Routledge. (2010)

[16] S. Ya'acob, N.M. Ali, and N.M. Nayan, Systemic Visual Structures: Design Solution for Complexities of Big Data Interfaces. In International Visual Informatics Conference. Springer **(2015)** pp. 25-37.

[17] K. Sedig, P. Parsons, and A. Babanski, "Towards a Characterization of Interactivity in Visual Analytics," J. Multimed. Process. Technol., Vol 3, No 1, pp. 12–28 **(2012)**

[18] G. Andrienko and N. Andrienko. Coordinated multiple views: a critical view." In Coordinated and Multiple Views in Exploratory Visualization, 2007. CMV'07. Fifth International Conference on, pp. 72-74. IEEE, **(2007)**

[19] C. Ziemkiewicz and R. Kosara. Embedding Information Visualization Within Visual Representation. in Advances in Information and Intelligent Systems Studies in Computation Intelligence 251. Ras, Z, W. and Ribarsky, W (eds.). 307-326, Springer Heidelberg **(2009)**

[20] C. Ziemkiewicz and R. Kosara. 2010. Implied Dynamics in Information Visualization. ACM Proceedings of the International Conference on Advanced Visual Interfaces, pp 215-222 **(2010)**

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