Visualization Principles for facilitating Strategy Development Process in the Organization

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Abstract. Visualization is essential to facilitate human cognitive activities especially to handle information complexities. There is a huge effort to develop various kind of visualization tools in order to facilitate human cognitive activities in the organization. One of the major activity in the organization is the strategy development process (SDP). This activity often involves complex cognitive activities (CCA) and always happen in the collaborative settingns in the organization. Therefore, it is essential for visualization to facilitate SDP from Collaborative-CCA perspectives. In order to do that, this paper intend to highlight three visualization principles that able to facilitate SDP in the organization. Using the systemic view as a fundamental, the visualization principles are; (i) higher level visual structure, (ii) lower level visual structure, and (iii) the interconnection between higher and lower level visual structure. Consequently, by applying focus group observation, this paper demonstrates the usefulness of the visualization principles in facilitating SDP. Finally, this research will further evaluate and consult current visualization techniques, methods and tools in facilitating SDP.

Keywords: visualization, knowledge visualization, Strategy, Strategy Development Process, Complex Cognitive Activities, Collaboration,

1. Introduction

Knowledge Visualization (KV) has been widely used to facilitate the cognitive process in an organization. From basic presentations aids like Power Points, Prezi and Keynote to more sophisticated tools like Decision Support System, Knowledge Management, Business Intelligent and currently Big Data – visualization has been used to facilitate cognitive process. This is because, visualisation provides ways to ease the understanding of complex knowledge and improving managerial judgement by transforming complex text into visual representation form. According to [1], the importance of visual representation to support decision making has been emphasized and explored by many researchers [1, 2, 3]. Align with visualization advancement, we can see the trend of visualization use has been expanding rapidly to support specific and special application like strategy planning in the organization. So far, we can see the visualization paradigm shift towards creating an effective, rightful and valuable solution for the users is parallel to the increasing complexities and massiveness of information in the organization [4]. It is clearly that understanding the human perceivedness and organizational context of use are essential for current visualization needs. Because through these understanding, it can help generate a more useful, relevant and comprehensive visualization solution for strategy development process.

Therefore, this paper is focusing on visualization for strategy planning in the organization. In brief, As CCA, Strategy Development Process (SDP) has higher level of cognitive complexities and when doing strategy planning collaboratively, it increases the difficulties to communicate among the group members and pose numerous cognitive overload, emotional and social challenges. Therefore, in facilitating strategy planning, it is essential for visualization to tackle the CCA and collaborative challenge as well (Collaborative-CCA).

2 Working Background

Knowledge visualization (KV) was introduced in 2004 and has been well accepted since then. Burkhard & Eppler [5] define KV as "*the use of visual representations to improve the transfer and creation of knowledge between at least two persons*". Through an understanding of users, knowledge transfer and perception should be better, more efficient, and generate further aggregate knowledge. With a focus on business and management, KV designates all graphic means that can be used to construct and convey complex insights, experiences, attitudes, values, expectations, perspectives, opinions and predictions to enable someone to re-construct, remember and apply these insights correctly. KV aims at understanding the functions, augmenting knowledge creation, and identifying the cognitive and organization needs of users from the perspective of cognitive, perception and social communication, and as such can supply some insights for us to determine how to design visualizations.

Meanwhile, strategy is a designation of method, action or plan to achieve a desired future such as long-term business goal or the solution for any problem. In pursuit of that, strategy development process is the course of action to plan and design the method, action or plan and making decision on allocating its resources to pursue the strategy. Usually, the outcomes is the strategy planning that use as a mechanism to control and guide the strategy development that widely used by military, companies, government sectors and communities. According to [2,6], SDP can be overwhelming challenge because it compounds with time pressures, uncertainty, constant distraction and internal tensions. From visualization perspectives, SDP is mainly dealing with information complexities and uncertainties. Thus, SDP is a Complex Cognitive Activities (CCA) that requires interaction between various parts of tasks, actions and events for solving a higher level of cognitive activities [7]. In contrast with basic cognition, CCA is a higher cognitive process that involved more that storing and encoding memories as it must come with the ability to presuppose the availability of knowledge and put it to use. [8] recognized CCA as the processes that lead to understanding and the ability to transform and use knowledge in the appropriate context settings. Since CCA often involves a higher level of thinking and knowledge, the process of strategy planning tends to answer the questions of 'how' and 'why' (higher level knowledge). The questions of how and why require an understanding of the lower level of knowledge (remembering, understanding and knowing) before a user can make an analysis and a synthesis in response to higher levels of knowledge [9] in which the visualization need to support the reasoning in this kind of cognitive process. By focusing to SDP from CCA perspective, we concentrate to facilitate the uncertainties of information and higher level of cognitive complexities.

In the organization, [10] has observed that SDP always happen in the collaborative settings. Apparently, the meetings, discussions and brainstorming are among the familiar settings to plan the strategy in the organization. This is because, to develop the comprehensive strategy, it is not feasible to tackle by single people, the organization needs the view and opinion from experts and skilful managers from various domain. Based on [11], collaborative enhances the traditional interaction by bringing together many experts so that each can contribute toward the common goal of the understanding of the object, phenomenon, or data under investigation. In this condition, experts and decision makers are among the most potential collaborators to handle the increasingly large, complex and various domain and fields that are involved in the SDP [12]. Thus, by having multiple collaborators is what transforms the cognitive process and give rise to its challenges.

The crucial challenges of SDP learned from [13] highlighted the lack of facilitation for the convergence (synthesis) during Collaborative-CCA. To handle convergence challenge, [14] suggested the approach of summarization and abstraction. Summarization can be achieved by capturing the essence of information with fewer information elements and representing it with fewer information elements. Through summarization methods, we will select only unique information, then merge similar contributions to keep only the essential, and finally select an instance of similar pieces of information to represent multiple instances. Abstracting information can be performed by creating higher level concepts that encompass relevant information from the original set. The purpose of abstraction is to make the content more cognitively manageable by allowing people to pay attention to relevant information and to ignore other details. Abstraction can be done by generalizing a set of similar objects regarded to be a specific generic type / object. It can also be attained by aggregating the relationships between objects in a hierarchical manner. Both of abstraction and summarization approach can help to eliminate redundancy, similarity and overlap during the convergence of cognitive.

When dealing with visualizations, abstraction and summarization techniques can be automatic and carried out by users. As of yet, there is little research about summarization and abstraction techniques in complex visualizations, and as such, these techniques will need to be developed and tested. In order to support summarization and abstraction for visual structure synthesizing, the research considers three kernel theories as the foundation. Each of the theories will be described in the next paragraph: i) General System Theory, ii) Overview concept, ii) Cycle of expectation formation.

i) Overview Concept

The concept of summarization and abstraction is closely related to understand the interconnection and provide the big picture in the sense of holism. Hence, from the visualization-computational based perspective (for instance – IV, KV, Visual Analytics, Data Visualization), an overview concept is the key element that should consider the systemic view for big data interfaces. Overview is the key element in the classical visual information-seeking mantra - O*verview first, zoom and filter then details on demand* by Schneiderman [15]. However, the context of meaning for overview is incomplete for the systemic point of view. According to [16], the meanings and uses of the notion of overview from an information visualization research mainly discuss a technical sense of systemic, in which an overview is a display that shrinks an information space and shows information about it at a coarse level of granularity. Although this mantra suggests the importance of a user's initial high-level view of the data in framing further analysis, it seems to capture only the modest parts of overview. In particular, the emphasis on getting an overview first and preferably pre-attentively is at odds with descriptions of overviewing as actively created throughout a task. By having the synthesis through summarization and abstraction means the users should be able to understand the reality and overall situation. They should be clear of the main driver, capable of identifying the key points and see the interconnections between various perspectives, understand the interconnection between various elements and finally, give them readiness to handle any emergence of ideas, information or tasks during Collaborative-CCA. Therefore, we attempt to extend the technical function of an overview to suffice the demonstration of the systemic view. Thus, we extend an overview concept towards the systemic view.

ii) General System Theory

Since the inevitable of the systemic view in the current visualization-computational base is rooted from the theory of analytical reductionism. It states that the system is a 'sum of its parts' and the account system can be broken down into different individual accounts. That theory is applicable for a complicated system but clearly a mismatch for complex matters. Therefore, it is important to implement the theory that can provide the overview in the sense of systemic. The systemic concept has been mentioned by Aristotle 2000 years ago when he explained the significant holism is something over and above its parts and not just the sum of them all [17]. According to [18], the concept of system thinking is rooted from the General System Theory (GST). GST had been introduced by Von Bertalanffy in the 1930s and under system science, GST evolved to System Thinking around 1950 to the current date. Within that, Checkland, Ackoff and Senge are among the key persons that contributed to the significance of GST in handling complex challenges, especially for the organization and management perspectives.

GST approaches the problem like a supply chain. Rather that reacting to individual parts that arise, GST will understand the underlying interconnection between various elements within a system – looks for patterns over time and seek for the root case. One of the famous metaphors to describe GST is an Iceberg Model [19]. There are four levels of GST from the Iceberg Model, namely: i). Events as the reaction on what just happened, ii). Pattern and trends to anticipate what trends been there over time, iii). Underlying structure is the design that influenced the pattern to understand the interconnection between parts and iv). Mental model as the platform to transform the assumptions, beliefs and values that people hold about the system as illustrated in **Fig.1.**

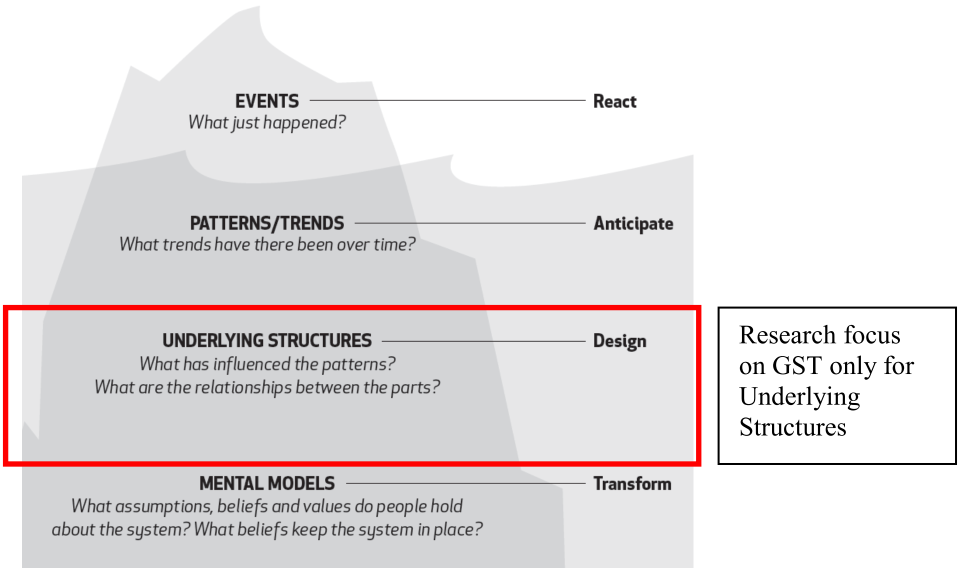

Fig. 1 Iceberg Model as Metaphor for General System Thinking (source: [19])

Because of the large extent of the GST level to be examined, we propose to concentrate the systemic view for visual representation on level three – underlying structures. Our study seeks an importance of the underlying structure of the Iceberg metaphor to clarify the interconnectedness between elements of information to represent system as a whole. Based on [18, 20], the research is aware that presenting visualization for the systemic view must at least contain the interconnection between elements and also between the higher levels of information (for instance: abstraction, key points and perspectives) and lower level information (details). So far, literature review in the visualization-computational field finds that the visual representation design focus is sufficient in presenting data part by part for lower level details. Therefore, to achieve a higher level of information, we argue to have higher level structure to complement a lower level of object data in forming the cycle of expectation.

iii) Forming the Cycle of Expectation

For higher level thinking (analysis, synthesis and create), [19] describes the process as how people interpret the visualization as 'the cycle of forming expectation'. Basically, to interpret visualization, the process is between making hypotheses at a higher level structure and later confirming the hypotheses.The confirmation can be done through checking the relevant details at a lower level. Object data will recur iteratively until the users are satisfied and get the full understanding of the problem or the phenomena. From the cycle of formation, [20] emphasizes the importance of a higher level of visual structure to fill the gap in understanding how people communicate and reason with visual information, especially for complex cognitive processes. Meanwhile, IV from the overview concern basically operates at a lower level of abstraction and focuses mainly on raw data and information. A study from [15] mentioned that overview basically operated at a lower level of abstraction and focus mainly on the raw data/information. Therefore, to achieve a higher level of abstraction, [19,20] suggest to have higher level structure of IV to complement the lower level of object data in forming the cycle of expectation. They argue that the encoding of visualization structure which is similar to how human structure information in their cognitive thinking would be useful in understanding the complex cognitive processes.

3 Visualization Principles for Facilitating SDP.

Based on the convergence challenge and approaches described in section 2 and suggestion by [10], the research propose the systemic concept as a visualization principles basis for SDP facilitation. Since visualization is capable to explicitly present the underlying structures between the information parts, it will help to show and draw the visual representation structure in order to synthesize the information complexities during SDP. This will help to clarify the interconnection and provide the big picture of the SDP context of use. Basically, this visualization principles have been theorized by extending the overview concept towards the systemic view. Then using GST, the research proposed the systemic view by embedding the underlying structure (layer 3 of the iceberg) to underpin the concept of the synthesis visual structure. Moreover, the cycle of formation will help to strengthen the needs for higher level and lower level of multi-view visual structure as to support synthesis for higher level thinking. The visual structure synthesizing claims three elements within this principle; i) higher level visual structure, ii) lower level visual structure, and iii) the interconnection between higher and lower level visual structure.

3.1 Higher Level Visual Structure

In terms of the higher levels, [20, 21] have argued that the encoding of the visualization structure should be similar to how people structure information and this would be useful in helping them carry out complex activities. In addition, they highlight the use of metaphors to frame higher level visual structures and, by doing so, allow the abstract overviews. It is important that the overviews will allow users to make hypotheses about the information space at a higher level and enable them to confirm (or reject) these hypotheses at a lower level. Thus, it is clearly understood that the context of use for the macro level is essential as the rationales for this part (steps 1-3 from the context of use). As many cycles would need to be carried out, the structure need to be fluid, and fluidity of visualizations may not be easy to have when metaphors alone are used. There is a need to go beyond the metaphors. This is because, the importance of the metaphor has been highlighted as higher level visual structures to allow for the abstraction overviews for the visual representation. We argue that lack of metaphor alone as higher level visual structures to handle complexities and provide a systemic structure. Thus, we propose multiple-view properties as a synthesis visual structure to complement the concept of higher level information with the lower details to generate the systemic view of visual representation design. In order to create multiple-view properties of the visual structure, the context of use from the perspective details is also important to indicate the elements needed in the multiple-view properties. Thus, we suggest step 4 of the tasks-processes, step 5 of function and step 6 of knowledge needed is important to rationalize multiple-view properties for the higher level visual structure. The combination of these will help to form a more comprehensive visual structure as to guide the higher level of abstraction during the collaborative-CCA process.

3.2 Lower Level Visual Structure

Much of the literature has focused on the lower level representations. Thus, the research can easily choose, apply and combine the current visual structure as the lower level to present and guide the detailed information. The selection of these can be rationalized from the context of use on the detail parts in which are step 4, 5 and 6. According to [22], to reduce and manage the cognitive load, the overwhelming of the details can be clustered and categorized according to the key components. The selection of the key components can be according to the priority business and activity goal in the context of use – either based from function, tasks or knowledge in the context of use.

3.3 Interconnection Between Higher and Lower Level Visual Structure

According to [18, 20], contextual visual design must at least show the interconnection between higher levels of the information space (abstraction, key points, and perspectives) and lower levels (concrete details). It is important to handle the analytical and synthetical process and furthermore the divergence to the convergence phase. This is because the users develop abstractions of the higher levels by accessing and manipulating the lower level details. Therefore, the relationship between these lower and higher elements is important to facilitate the reasoning process. To support the process, the cycle of formation can strengthen the main relationship between the higher level and lower level of visual structures.

4 The demonstration of Visualization Principles for SDP.

The research has demonstrated and evaluated the visualization principles for SDP. Based on the needs to identify how visualization principles can effectively facilitate SDP, the unit of analysis for this research is the interactivity process between the user and visualization design. The demonstration and evaluation has been made through focus group obervation by applying case study in the natural and collaborative settings. Initially, the visualization principles design has translated into paper-based visual representation. The paper based instrument has been used because it is open ended, free and easy to use and, due to the unfinished look has encouraged the users to amend it during SDP. Therefore, from the observation, the research can see the potential of this instrument to facilitate the users to develop the strategy planning. The paper-based instruments will be put in front of the group to facilitate them during the experiment and the users were reminded to use the instrument as the guidelines, reference and central point of view during SDP. Three collaborative groups have been selected to perform SDP in the meeting settings as shown in **Fig. 2**. Each of the group consists 4-6 people. During the focus group, the group members need to collaborate during the SDP to achieve the goal. Within 120 minutes (2 hours), the group has been assigned to develop 3 strategy plan for inter-agencies collaboration in the public sector. Since the demonstration and evaluation is a case study basis, the focus group seems to be more flexible and open eded to adapt the real case neccessities. Due to the limited pages, this paper will focus only on the demonstration part and the evaluation findings will be presented in the future work.

Fig. 2 The settings for Paper-Based Instruments in the Strategy Development Process.

4.1. The usefulness of Visualization Principles for SDP

Generally, the demonstration found the usefulness of visualization principles as visual representation instrument to facilitate SDP during the focus group observation, in other words, it justified the usefulness of visual structure synthesizing to facilitate SDP. The visual representation instrument is useful as a main reference during the discussion among the group members. The group used the instrument to guide them to handle each of the task in achieving the activities' goal. The elements provided in the higher level visual structure (the paper in blue color) serve as the points to guide the process and trigger an ideation in the lower level visual structure (List-shortlist, journey mappings and free style sketching). They also can write, draw, delete, connect and mark any information in the lower level visual structure based on the need during the SDP. Hence, interactivity between all these information (content and context) are explicitly shown, pointed and remarked. These can influence the interactivity between the users and the instruments and the communication among themselves. One of the examples is when one of the participant communicated among the group members to convince the abstraction of the think-tank group as the second strategy by using the details and elaboration from the lower level instrument (visual mappings). To convince this point of abstraction, the content inside the instrument will evolve when other group members give feedbacks during the communications.

This process will iterate until the group is satistified to decide the think-tank group as one of the public service collaborative profesionalism strategies.

4.1. The Usefulness of Higher Level Visual Structure

From demonstration, the applicable design for the higher level visual structure has been transformed into a paper-based platform and highlighted using a blue color background paper. During the experiments, the research found 2 from 3 groups rarely put any content inside the higher level visual structure. Then after the experiments, the researcher had asked the group member about the function of the higher level visual structure (the diagram in the blue paper). The respondents from group 2 said that the higher level visual structure was useful because it eased their understanding about the process to be taken and the elements to consider during the experiment. Hence, they used it as the guidelines, while the content for details discussion about the understanding will be put in the lower level structure since it is a more proper place. The respondents from group 3 also agreed with the usefulness of the higher level visual structure as easy guidelines. Additionally, they mentioned the guidance on the basic elements let them have the similarity points of view to consider during the strategy development, especially for group 3 since each of the group members came from a different scheme of service in the public sector. They have different background, scope of works and interests that might lead them to have different points of consideration during the strategy development.

4.2. The Usefulness of Lower Level Visual Structure

There are three types of diagrams that have been used as lower level visual structures for the experiment namely List-shortlist, Journey Mappings and Freestyle sketching. Firstly, list-shortlist contributes as an intermediate between the higher and lower level visual structure. The list as shown in (a) plays a role to support the divergence phase in identifying the possible strategies. Then, from the lists, the group must converge to choose three best strategy plans using the shortlist visual structure as shown in (b). We can see that the users quite hesitated about the convergence process and took long time to come out with the three selections. For this reason, it is important to further clarify the convergence from the lists into the shortlist of 3 strategy plans. Secondly, Journey Mappings has been used to elaborate and discussed for each of the strategy that has been develop during SDP. Each of the visual mapping hold the details discussion for each of the strategy plan. The experiments showed the usefulness of the lower level visual structure to hold the content of discussion. It is explicit about the points of discussion in which the users can see the evolvement of the constructive content throughout the discussion. From here, the users have the reference to refine, amend and rationalize the convergence for each of the strategies as an abstraction point. Thirdly, the research also provided freestyle sketching (blank paper without any structure) because SDP is context dependent, thus any emergence condition can occur during the process. The free style sketching is useful to cater this need. As an example, group 3 needed an additional blank paper to explain the details about the value of the strategy to the stakeholders and power redundancies among the agencies for the third strategy plan – the central knowledge base. The freestyle sketching helped the users to understand situation clearly.

Additionally, we want to clarify the importance for the cycle of formation during the collaborative CCA process especially between the lower level visual structure (in this case is the visual mappings) and its intermediate-higher level visual structure (in this case is the lists-shortlist). As mentioned above (in paragraph i), the intermediate higher levels structure used the list to diverge all the possibilities and then used the shortlist to converge into 3 strategy plans. For the lower level visual structure, each plan will be discussed and elaborated in detailed using visual mappings. The elaboration from the lower level visual structure was useful to rationalize the convergence for each of the strategy plans. The feedback looping process from lower level to the higher level and vice versa helped to refine, amend and rationalize the abstraction for each of the strategy plan. Furthermore, the highest level visual structure (the Kaplan Model House on the blue paper) helped to elaborate and describe the lowest level of visual mappings in a more centered and relevant point of view, which indirectly helped to refine the abstraction to be more relevant. From here, the research found the convergence-divergence process from top-down or right-left (higher level to the lower level) help to identify the possible abstraction. Then the feedback loop from bottom-up or left-right (lower level to the higher level) helps to refine, rationalize and confirm the abstraction.

4.3. The Usefulness of Open Ended Organizing and Structuring

The visual representation instrument is useful as contextual guidelines. The combination of multiple visual structures helped to coordinate, manage and organize the incoming of information content during the experiment. Through an open-ended and multiple feedback loops, users are free to amend and put new input in the instruments for every emerging information and idea, in addition to the instrument morphing itself to include new information. As a result, the users were able to construct and develop their knowledge according to the content construction in the instrument. At the end of the experiment, the visual structure has been filled in and well utilized. The visual structure arranged the information according to the tasks given, thus it helped to reduce the cognitive load by chunking the big amount of information into smaller portion and then structuring and organizing the information that helped to enhance the information processing. Further than that, an explicit visual structure was useful to hold the centralized memory during SDP. The users have one point of reference center to clarify and check the collective memories.

5. Conclusions and Future Works

Strategy Development Process is a complex cognitive activity that involves information complexities and required higher level thinking. Since SDP always take place in the collaborative settings in the organization, it has increase the complexity challenge and the convergence issue has become more significant since it involves distinguished background of the multiple collaborators that increase the cognitive processes. Therefore, this paper has concentrate and elaborate three visualization principles for Strategy Development Process and the demonstration of it. From the demonstration, the research found the usefulness of: i) higher level visual structure, ii) lower level visual structure and iii) the interconnection between higher level and lower level visual structure to facilitate SDP. Due to the limited pages in this paper, the evaluation results and findings from the demonstration will be presented in the future work. Through the observation during the demonstration, the results show the effectiveness of visualization principles to facilitate SDP. At the same time, the observation also gain deeper understanding about how these challenges has being taken in the real organization settings. Furthermore, using description and task settings from the real users' own job perspectives enrich and expand the description for each of the visualization principles.

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