Understanding Big Picture and Its Challenges: Experts and Decision Makers Perspectives.

Suraya Ya'acob
Public Service Department of Malaysia
surayayaacob@gmail.com

Nazlena Mohamad Ali, Norshita Mat Nayan
Institut of Visual Informatics
Universiti Kebangsaan Malaysia,
43600 Bangi,
Selangor, Malaysia
nazlena@ivi.ukm.my, norshita@ivi.ukm.my

Abstract.

The big picture of an organization plays an important role in providing insight into the decision making process. Thus, the objectives of this paper are to investigate how experts and decision makers obtain the features of the big picture, and then identify related challenges (problems and issues). Data analysis and interpretation show that experts and decision makers gain the big picture through a process of collaboration. Basically there are four main sequences in the collaboration process of constructing the big picture. These are: (i) understanding the big picture requirements, (ii) extracting content from the tools, (iii) collaborating on pieces of information and (iv) using the collaborative information for decision making. In addition, the challenges of attaining the big picture were identified and then clustered into the 3 main components from the perspective of knowledge visualization (KV) on user perception, namely cognition, perception and communication. Data was collected using semi structured interviews following qualitative methods. The sketching technique was used in the one-to-one interviews to represent mental models which are important for later use in the design stage.

Keywords: Big Picture, Knowledge Visualization, Cognition and Perception

1. Introduction

The visions and the outcomes of an organization are closely related to the decision making processes. As organizational decision making is increasingly complex and dynamic, the collaboration of decision makers and experts becomes an even more critical component for the quality of decision making in management [3].

Lamont explained that the big picture of an organization should provide insight and be the main drivers in decision-making[10] and [11] added that successfully coping with the big picture challenge positively reflects the process of knowledge

integration between experts and decision makers, thus enhancing the quality of decision making. Through ten years of collaborative knowledge study, [24] has identified the big picture as one of the key problems in the process of expert/manager knowledge communication as shown in Fig. 1.

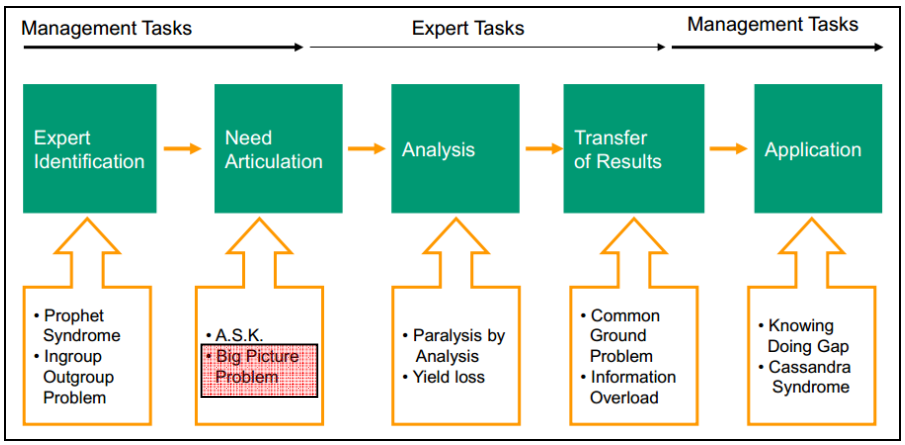

Fig. 1. Key Problems in the Process of Expert/Manager Knowledge Communication [24]

This research investigates big picture problems from the perspective of knowledge communication with computer support, specifically using visualization. The big picture has been described in terms of identifying its main drivers and the interconnections between various perspectives while paying sufficient attention to its relevant details [5].

Investigation into real organization practices has identified that Knowledge Management (KM) and Business Intelligence (BI) support decision makers to gain the big picture in an organization but unfortunately, 50%-70% of KM initiatives fail to fulfill the organization's needs [26] and 30% of BI applications fail to meet business requirements [21].

From the information and interface design perspectives, currently BI technologies and KM initiatives use the concept of Information Visualization (IV) to present information. Through the IV concept, the information will be mapped to a visual coding in terms of architecture, design and interaction. Thus visual techniques and mechanisms such as heat maps, bubble charts, fish eye views and timelines are widely used today as big picture tools [25]. This is because visual representations can utilize the natural capability of experts and decision makers who are better at pattern recognition compared to reading text to obtain the big picture. Further investigations through literature reviews and market studies reveal a gap in the use of visual representations to support organisations. Tergan & Grimm clarify that IV is focussed on coding textual to visual representations and should be synergized with the perceptive capacity of experts and decision makers [15].

Therefore the coding processes in computational environments through information architecture, design and interaction need to be enhanced to meet the

cognition, perception and communication needs of experts and decision makers. In order to do that, this research further explores the field of Knowledge Visualization (KV), focusing on fostering knowledge through cognition, perception and communication perspectives [2] and demonstrating how it fulfills the needs in the field of IV.

2. Background of Work

Knowledge Visualization (KV) is an umbrella term for any domain using visual artifacts in sequence to deliver knowledge [15]. Zhang describe KV as an evolution. It started in the 1980s with Scientific Computing Visualization and within two decades, Information Visualization (IV) spread as an alternative solution for information overload [17]. Fig. 2 shows the evolution of Knowledge Visualization.

KV was introduced in 2004 and has been well accepted since then. Through an understanding of users, knowledge transfer and perception should be better, more efficient and should generate more knowledge.

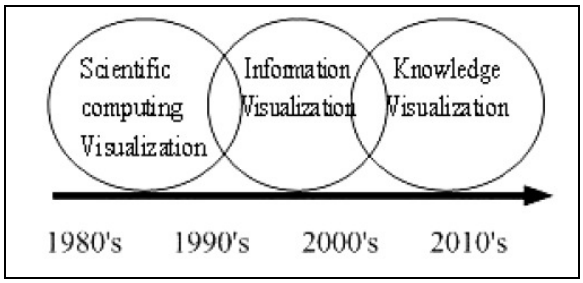

Fig. 2. Knowledge Visualization Evolution [17]

Specifically, Eppler defined KV as the use of visual representations to improve the transfer and creation of knowledge between at least two persons [13]. It is a new field in visualization with business and management as its core. It designates all graphic means that can be used to construct and convey complex insights. Beyond the mere transport of facts, KV aims to transfer insights, experiences, attitudes, values, expectations, perspectives, opinions and predictions, and this in a way that enables someone else to re-construct, remember and apply these insights correctly.

A related field and precursor to KV is information visualization (IV). IV is a rapidly advancing field of study both in terms of academic research and practical applications. [22] Defined IV as "the use of computer-supported, interactive, visual representations of abstract data to amplify cognition".

IV and KV are both exploiting our innate abilities to effectively process visual representations, but the way of using these abilities differs in both domains [15]. IV aims to explore large amounts of abstract (often numeric) data to derive new insights or simply make the stored data more accessible. KV, in contrast, aims to improve the transfer and creation of knowledge among people by giving them richer means of expressing what they know. While IV typically helps to improve information

retrieval, access and presentation of large data sets, particularly in the interaction of humans and computers, KV, on the other hand, primarily aims at understanding users and augmenting knowledge-intensive communication between individuals.

IV has reached high technological standards and offers a variety of useful applications in different working, learning and problem solving scenarios. Focusing on techniques and visualization tools has resulted in IV lacking an understanding of the users. While the technical issues have been the focus, the prerequisites of the user for dealing adequately with IV and making sense of visualizations have not gained much attention in the past. It is important to develop new technologies in alignment with the changing demands of the user, because the user is the one who has to interact with the tools. Thus, it is necessary to include the experience and know-how of more user-oriented sciences from KV perspectives into IV tools design. On the other hand, the study of KV has focused more on understanding the users but the shortcomings are related to the lack of representational facilities of the visualization tools. Therefore, more synergistic approaches are needed.

To synergize KV and IV in a coherent manner, this research intends to use the design approach based on the Knowledge Visualization Framework [13] as a foundation. There are four main components in the framework; these are function type, knowledge type, recipient type and visualization type. In the process of identifying a suitable visualization design, this framework includes the perspectives of both users and tools. The function type, knowledge type and recipient type perspectives weigh more on the users which leads to the perspective of KV while the visualization type focuses more on the tools, leading to IV perspective, as shown in Fig. 3.

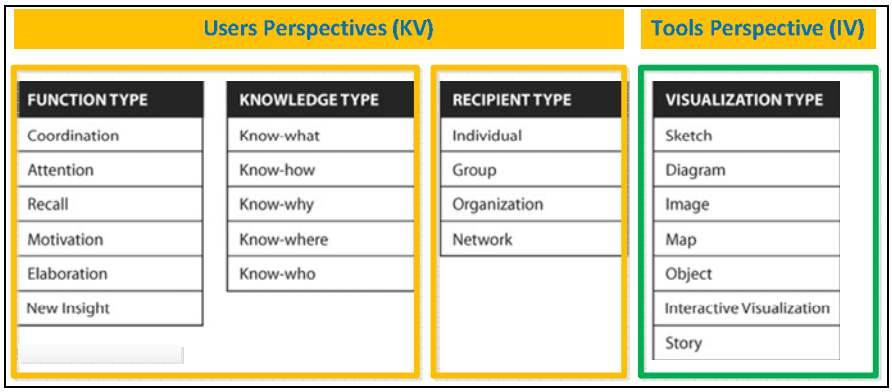

Fig. 3. Knowledge Visualization Framework [13]

However, this paper focuses on the recipient type perspective as in the KV concern, and in terms of knowledge, it only covers the perspective of context. As a preliminary study, the results will indicate the issues and challenges that arise from the users' perspectives (KV concept) in gaining the big picture. Explaining the function type and knowledge type perspectives will be done in another phase. Finally,

through a process of dynamic identification [16], the principles of design for visualization tools will be identified within a user's perspective.

3. The Experimental Procedures

As mentioned above, this study intends to identify the challenges in establishing the big picture and to get an understanding about the big picture from the recipient's perspective.

3.1 The Objectives

There are two objectives for the data collection. Firstly is to investigate how experts and decision makers gain the big picture. Secondly is to identify the challenges (problems and issues) related to the big picture from experts and decision makers perspective.

3.2 The Respondents

For this study, the selection of respondents as recipients is based on the concept of knowledge communication. Using this domain concept, Eppler carried out his research among specialists (experts in the field) and decision makers (managers, clients or top management) [24]. As this research is designed to investigate big picture problems that originate from the field of knowledge communication, it uses the same pattern of expert-decision makers to select the recipients. In this case, the ICT Department (experts in the ICT field) and the Chief Information Officer (CIO) Unit (decision makers) were selected. Five recipients were interviewed from the ICT Department and CIO Unit in the Treasury, Ministry of Finance Malaysia as they met the requirements of the research sample:

(i) The respondents were at the Professional/Executives/Grade A level. Experts and decision makers are mostly within this level and this eliminates the issue of different education and work background.
(ii) The respondents had more than five years working experience. The data collection needed to obtain the perspective of experts and decision makers and how they integrate knowledge to form the big picture. Respondents with this range of work experience are mostly experts who influence decision making and some of them had been promoted to the management team (decision makers).

3.3 The Task and Setting

Data was collected using semi structured interviews, following qualitative methods. Interestingly, the sketching technique, introduced by Bischof [3], was used to facilitate one-to-one interviews. The visual representations through sketches may

represent the respondents' mental models which are important for later use in the design stage. Besides, they support qualitative interviewing by providing an overarching structure which organizes information, coordinates the conversation and highlights key aspects. Before the interview, there was a session to introduce the objectives of the interview and to briefly explain the sketching concept that would be used during the interview. The interview was divided into three main components as shown below:

(i) Defining the Big Picture

The initial phase of the interview was to get a mutual understanding about the definition of the big picture. The respondents described the meaning of the big picture from their perspectives. Using big picture variables provided by [11], the interviewer included and explained additional facts. By building mutual understanding, indirectly the respondents will better understand the concept of the big picture that the study seeks to investigate.

(ii) Accessing the Job Scope

The respondents were then asked to list out their scope of work. From the list, the interviewer picked the most regular or unique job scope for further investigation.

(iii) Understanding the Big Picture from the Job Scope Perspective.

For the particular job scope selected, the respondents were asked to give a few examples of recurring problems. The interviewer then picked one of the problems as the new sketching subject. Respondents employed think-aloud through sketching techniques when describing the particular problem. All of the respondents were able to clearly describe the problem and fluently explained the main drivers, key points, information details and the relationships within the job scope.

4. Results

The results section has been divided according to the objectives of this user study. First, it presents how the big picture is constructed through knowledge integration and collaboration from multiple sources. Understanding the process contributes towards understanding the big picture concept. The second part describes the challenges, issues and problems faced by the experts and decision makers while gaining the big picture.

4.1 Construction of the big picture

To understand how these experts and decision makers construct the big picture, a list of the respondents' answers is given below:

- *Respondent 1 said it took him 8 years to gain the big picture of his organization. From time to time, he gained the knowledge through managing several of the company's projects. Each project gave him an insight from a different*

perspective. Nowadays, he can link them all and give weightage from every hand (key point).

- *Respondent 4 mentioned that she needed at least 3 months to understand the job scope, to read and digest the workflow process, to search and understand the policies, circulars and to ask people for help if she could not get the information from the documents.*
- *Respondent 5 said that the time taken depended on the complexity of the big picture and the incoming task. If it was simple, then the process of getting it done was less complex. But when it was complex, she needed to gain more knowledge through previous cases, through files and the internet, and by asking the people inside and outside the agency before producing solutions.*

From the list above, it appears that experts and decision makers gain the big picture through a process. A process, as defined by the business dictionary [26], is a sequence of interdependent and linked key points which at every stage, consumes one or more resources (explicit and tacit knowledge) to convert the incoming issues to quality solutions (outcomes).

Furthermore, experts and decision makers combine and relate multiple data, information and knowledge (tacit and explicit) using various types of tools. [9] define the combination and relation of more than one data source as a collaboration process. As a collaboration process, the big picture challenge is about seeing and explaining the multiple connections of an issue. Experts and decision makers have to juggle simultaneously a multitude of causes, (indirect) implications, and contextual factors. In this view, the challenge of creating the big picture is also related to the capacity of systemic thinking and relates to cognitive capacity. Basically there are four main sequences in the collaboration process in order to construct the big picture:

- Understand the big picture requirements
- Extract the content/material from the tools.
- Collaborate on the pieces of information.
- Use the collaborative information for the decision making.

4.2 Challenges in gaining the big picture

After understand that there are four main sequences in the collaboration process in order to construct the big picture, next step is to identify the challenges rely in each of the steps. There are basically four main challenges. The challenges have been group as (i) Pattern of the incoming issues, (ii) Level of abstraction and detail, (iii) Complexity and the key point changes and (iv) Tools usage.

The finding shows that there are wide gap and diversity of the requirements between experts and decision makers. Table 1 is the summary of the challenges for experts and decision makers while gaining the big picture.

Table 1. Challenges for Experts and Decision Makers in Formulating the Big Picture.

No.	Challenges	The Expert	The Decision Maker
i.	**Pattern of incoming issues**		
a.	Field of Expertise	Mostly related to the experts' related field (focus)	Mostly involves the whole/various field(s) of expertise
b.	Issues similarities	Mostly the incoming issue is similar to previous cases.	Mostly the incoming issue is unique. It requires new solutions, ideas, innovations, decision making and evaluation.
c.	The need for a big picture solution	Less important: To initially understand the job scope.	More important: Emphasizes the need to sustain the big picture throughout the collaboration process.
d.	The usage	As a reminder /reference through the collaboration process.	Emphasizes the need to sustain the big picture to handle complexities of the collaboration.
ii.	**The Level of Abstraction and Detail**		
a.	Coverage	Within limited (one) job scope or expertise	From various expert fields
iii.	**The Complexity and the Level of Key Point Changes**		
a.	Key points	Low changes for the key points	High changes for the key points
b.	Perspectives	Considers a specific perspective (One perspective holds one or more key points)	Considers various perspectives (Each perspective holds one or more key points).
c.	Complexity	Less Complex	More complex
iv.	**Tools Usage**		
a.	The same usage	• Standard Operating Procedure (SOP) • Desktop Files ("Fail Meja") • Flow Chart • Manual Work Procedure • Policies	• Circulars ("pekeliling") • System (specific for the task) • Email • Contract Document • Minutes of Meetings • Search Engine/Internet

No.	Challenges	The Expert	The Decision Maker
b.	Different for explicit tools	• Checklist • Work Procedure Kit • Video Tutorial • Demo – latest technology Portal • Simulations	• Related Systems/Applications • Table of Content (TOC) • Previous files • Formal letters • Site Map • BI Dashboard
c.	Different for tacit tools	• Skills Experience – benefit of salary increment if in the related specific field • Ask people (boss, subordinate, colleague) • Training	• Working Experience - advantage for higher position if there has been involvement in the various fields • Ask people – internal/external (organisation) • Expert views/ opinion/paperwork • Observation

5. Discussion

From the data collection analysis and interpretation, it was found that the data collection fulfilled the purposes: the two main objectives were clearly addressed.

The first objective was to investigate how the experts and decision makers discern the big picture. This has been clearly answered through the interview's content extraction and analysis. Experts and decision makers gain the big picture through the collaborative process and the requirements of the incoming issue determine the complexity of the process. It also impacts the extraction of information from the tools in terms of usage, depth and coverage. A primary finding is that the process of gaining the big picture depicts the mental model and cognitive processes highlighted in Bloom's Taxonomy.

The second objective was to identify the challenges related to determining the big picture from the perspective of experts and decision makers. After discussions with experts and decision makers, the challenges have been identified not only from the problems or issues arising but also from the needs and requirements mentioned by them. The list of challenges has been clustered into three main components, namely cognition, perception and communication as highlighted in KV perspectives on user perception [1]. Table 2 presents a summary of the challenges, grouped according to the cognition, perception and communication components.

Table 2. Summary of Big Picture Challenges

Cognition	Perception	Communication
Complexity of level of requirements • Experts: Less complex • DMs : More complex	Experts and DMs mostly use the same tools but with different coverage.	Manual searching process from sources is very time and energy consuming.
Unsure which information to delete as the working memory can only hold seven plus minus two components at one time. So users tend to hold as much as possible and this contributes to a higher cognitive load	**The different field coverage** • Experts: Related to their field of expertise (focus) • DMs: Involves the whole/various field(s) of expertise	**The need for the big picture** • Experts: For early tasks • DMs: Sustains the big picture to handle the complexities of the collaboration.
No supporting tools while doing the analysis. The analysis happens in the user's head	**Level of information abstraction** • Experts: more detailed (vertical) • DMs: more abstract (horizontal)	Difficulty in communicating complex working ideas (knowledge sharing)
Cognitive background through experience helps decision makers construct the big picture easily	**Perspectives considered** • Experts: Specific • DMs: Various **Issues Similarities** • Experts: Similar • DMs: Unique	
The need for structure and organization of the information for better understanding.	**Level of Key Points changes** • Experts: Low changes • DMs: High changes Not well guided to access the relevant information. Uncertainty regarding related information may lead to missing, forgetting or losing valuable information	

* DMs = Decision Makers

6. Conclusion

Based on the Design Principles for Visual Communication [20] and identification process [16], the next stage is to elaborate on and identify the design principles that will help experts and decision makers get the big picture. In order to meet the experts and decision makers' requirements in getting the big picture, the visual perception from the perspective of experts and decision makers (users) should be synergized with the visual coding perspective, thus the concept of IV should be mapped on to the concept of KV.

Regarding the information and interface design concepts, the mapping process is based on the basic components of IV and KV. Thus, three main components from KV (user) perspectives namely cognition, perception and communication will be synergized with the information architecture, design and interactive components from IV (visual coding) perspectives as shown in Table 3.

Table 3. Main Components for KV and IV

User Perceive (KV perspectives - human)	**Visual Coding (IV perspectives - technical)**
Cognition	Information Architecture
Perception	Design
Communication	Interactive

From the interpretations of the data collected, the challenges in gaining the big picture from the perspective of experts and decision makers (users) have been identified and clustered according to the three main KV components as mentioned above. Further, the forthcoming plan is to identify suitable IV components in order to fulfill the requirements of experts and decision makers.

Firstly, the navigation, structure, organization, management, relationship and strategy used in the information architecture components should reduce the cognitive load of experts and decision makers relevant to user cognition challenges and conditions. Secondly, the context and task variables for the information and visual design must suit the perception of experts and decision makers. Thirdly, the interactive mechanism, pre-structuring mental model and technology interactivity should resolve the communication issues of experts and decision makers.

7. References

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

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

[3] Bischof, N., Comi, A., & Eppler, M. J. :Knowledge Visualization in Qualitative Methods - Or How Can I See What I Say?. IEEE International Conference Information Visualization, 15, 371–376 (2011)

[4] Dillon, K. M., Talbot, P. J., & Hillis, W. D. :Knowledge Visualization: Redesigning the Human-Computer Interface. Technology Review Journal 13(1), 37–55 (2005)

[5] Mengis, J., Eppler, M. J. : Seeing versus Arguing. The Moderating Role of Collaborative Visualization in Team Knowledge Integration. In Journal of Universal Knowledge Management, 1 (3), 151-162 (2006).

[6] Eppler, M. J., Hoffmann, F., & Bresciani, S. :New Business Models Through Collaborative Idea Generation. In International Journal of Innovation Management, 15(06), 1323–1341 (2011)

[7] Eppler, M. J., Mengis, J., & Bresciani, S. :Seven Types of Visual Ambiguity: On the Merits and Risks of Multiple Interpretations of Collaborative Visualizations. IEEE International Conference of Information Visualization, 12, 391-396 (2008)

[8] Bresciani, S., Blackwell, A. F., Eppler, M. :A Collaborative Dimensions Framework: Understanding the mediating role of conceptual visualizations in collaborative knowledge work. In IEEE *Hawaii International Conference on System Sciences, 41,* 364-364 (2008)

[9] Kolfschoten, G. L., & Brazier, F.:Cognitive Load in Collaboration-Convergence. *Hawaii International Conference on System Sciences*, 45, 129–138 (2012)

[10] Liu, Z., & Stasko, J. T.:Mental models, visual reasoning and interaction in information visualization: a top-down perspective. *IEEE Transactions On Visualization and Computer Graphics*, *16*(6), 999–1008 (2010)

[11] Mengis, J., & Eppler, M. J.:Understanding and Managing Conversations from a Knowledge Perspective: An Analysis of the Roles and Rules of Face-to-face Conversations in Organizations. In Organization Studies, *29*(10), 1287–1313 (2007)

[12] Miller, G. A.:The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological review*, *101*(2), 343–52 (1994)

[13] Burkhard, R. A.: Towards a framework and a model for knowledge visualization: synergies between information and knowledge visualization. In Knowledge and Information visualization, 238-255, Springer Heidelberg (2005).

[14] Sweller, J. Van Merrienboer J. J.: Cognitive Load Theory and Complex Learning: Recent Developments and future directions. Educational Psychology Review, 17(2), 147–177 (2005)

[15] Tergan, K., Grimm, M.: The Impact of Dimensionality and Color Coding of Information Visualizations on Knowledge Acquisition. In Knowledge and Information Visualization. LNCS, vol 3426, (pp.167-182). Springer, Heidelberg (2005)

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

[17] Zhang, J., Zhong, D., Zhang, J.: Knowledge Visualization; an effective way to improve learning. IEEE Education Technology and Computer Science ETCS 2010 Second International Workshop, 1, 598-601 (2010)

[18] Dillenbourg, P., & Betrancourt, M.: Collaboration Load. In Elsevier J. Elen and R.E Clark (Eds) Dealing with Complexity in Learning Environments, 142–163 (2006)

[19] Akrani, G.: Decision Making Process In Management - Problem Solving. *Study Notes in Education and Management* (2010)

[20] Agrawala, M., Li, W. and Berthouzoz, F.: Design Principles for Visual Communication. Communications of the ACM 54(4), 60-69 (2011)

[21] John, H., Sallam, R. L., L. Richardson, J. Magic Quadrat for business intelligence platforms. In Gartner for Business Leaders, Feb (2012).

[22] Card, S. K., Mackinlay, J. D., Schneiderman, B., Information Visualization: Using Vision To Think. Morgan Kaufmann, San Francisco (1999)

[23] Schwartz, D. G.: Encyclopedia of Knowledge Management. IGI Global (2005)

[24] 10 years of Knowledge-Communication.Org; Results, Insights and Perspectives, http://issuu.com/mcminstitute/docs

[25] Resources of Information Visualization, http://www.infovis.org/

[26] Beyond the Podium: Delivering Training and Performance to a Digital World. http://www.jbp.com.

[27] Business dictionary, http://www.businessdictionary.com/