

Interactive Data Visualisation: Facilitate the Accountability Disclosure Through the Lens of Organisational Semiotics

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Abstract. UK charities suffer from insufficient accountability disclosure regarding different stakeholders, therefore failing to meet their various needs. For the purpose of facilitating an accountability disclosure of the charity reporting practice with interactive data visualisation, this paper, as an extension of the previous research from Liu and Tan [1], is to propose a framework leading the design of interactive data visualisation procedure on the scope of charity reporting practice. It firstly interprets the impact of ‘display and interaction’ of data visualisation on both semantic and pragmatic levels of data signification, based on the theory of semiosis triangle and semiotic ladder. It then develops a visualisation framework for dividing the information into different degrees of detail and linking each information points to a user’s intention. Finally, the developed framework will be applied to a visualisation prototype relating to Age UK.

Keywords: Interactive data visualisation · Organisational semiotics · Pragmatics and visualisation

1 Introduction

Data visualisation, a set of activities to present data or information with the aid of visual representatives, such as a table, map, diagram and chart, allows data to become sense-making in front of various readers [2]. Strecker [3] points out that data visualisation looms as a tool which offers opportunities to transform and display data and information, for the purpose of ‘capturing and addressing’ complexity of dataset. Segel and Heel [4] point out that an interactivity on data opposed to the traditional static visual display enables readers to filter information according to their reflective interpretation. With the development of cloud computing techniques and data intelligence, interactive data visualisation can be accessed through multi-devices, where the reader can customise content and layout of data dashboard in terms of ad-hoc information requests. To some extent, to compare with traditional ‘visual display’, the ‘interactive’ of data visualisation not only enables data to be sense-making, but also fulfils a wide range of information demands from different readers.

Referring to the definition from the Charity Act [5], charity can be defined as the organisation which is established for a charitable purpose and serve the social public with charitable activities. There are 165,231 registered charities in England and Wales, which earn the income of 69.49 billion pound in 2015 [6]. However, Charities have been suffering from low transparency because of insufficient disclosure, since the traditional charity annual report cannot fulfil the information needs from multiple stakeholders was spotted since 1990s [7, 8]. Connolly [9, 10] argues that because of the inadequate efficiency on the charity reporting practice, charities tend to be increasingly ‘business-like’ – over-emphasise the financial information, such as ‘annual income’, instead of describing the performance and impact of charitable activities. Influenced by the scandals that happened in the charities section around 2000s, some scholars further discuss that without efficient and understandable reporting practice, it is likely for the social public to gradually lose their ‘trust’ on charities [11]. Although a series of empirical studies proved that the reporting practice tends to be improved over a period years, since the pressure of regulation and public supervision, lack of awareness, skills and resources still prevent the information delivery of UK charities [8, 12, 13]. Hyndman and McConville [14] and Charity Commission [15] criticise that the transparency of charity operation would be constrained since the reporting practice cannot enable the social public to understand ‘where did a charity raise money’ and ‘how did they use money’.

For the purpose of facilitating the information delivery of charities and enhancing the transparency, the concept of accountability was proposed in the 1970s, which indicates ‘be awarded of its conducts and stakeholder’s information needs in terms of what has done, is doing and plans to do’ [7, 11, 16]. In contrast to the research above, this paper will improve the accountability disclosure in the charity reporting practice with the aid of technical support – interactive data visualisation, for the purpose of enhancing the performance of charity reporting practice in terms of understanding, accessibility and interactivity (Sect. 2). Organisational semiotics, a theory revealing the procedure where information transfers from one party to another on the context of business, will be applied to lead the design of interactive data visualisation (Sect. 3). Instead of purely exhibiting data into ‘fancy pictures’ [3], this paper will follow the principle of organisational semiotics, regarding data visualisation as a ‘procedure’ where data should be categorised and displayed in different layers in terms of ‘degree of detail’ (Sect. 4). Age UK, one of the leading charities, will be selected as a case study to demonstrate how the framework aided their business reporting in Sect. 5. In the final section, a brief summary and a few suggestions will be provided to guide the following studies to progress the research further.

2 Interactive Data Visualisation: Basic Concept and Principle

Information-overload intensifies the complexity of datasets, which causes the static data visualisation to no longer able to fulfil the diversified information demands from different stakeholders [17]. The function of ‘interaction’, where readers can customise the content and layout of dashboards, and interpret data from their ad-hoc perspective. The development of cloud computing enhances the interaction of data visualisation where readers can drill down the dataset into a detailed extension. In addition, the

presentation of data visualisation can be assessed by multi-devices, including PC, tablet and even smart phone [4]. Aligned with business intelligence, interactive data visualisation can address the complexity of dataset and answer the ad-hoc requests from different stakeholders [18], which will be utilised for assisting the accountability disclosure in charity reporting practice.

However, without a proper design and clear definition, data visualisation cannot automatically signify data and reveal the meaning and story behind it. Few [17] indicates that data visualisation is more than just simply displaying the raw data with visual representatives, but a certain procedure which enables data to be sense-making and to fulfil the information needs from various readers. Schoffelen et al. [19] emphasises that compared with displaying data in numeric format, the means of data visualisation to enhance the readability of dataset, where visual representatives attract people's attention with different colours and shapes, enabling sense-making in different layers of detail, and facilitating the reflecting interpretation with interactive functionalities. Ware [20] categorises two methods for visualising data, including 'bottom-up' which perceives the information through observing the patterns shown in the visualisation, and 'top-down' which checks over the data visualisation with pre-defined requests. Two approaches of designing data visualisation procedure is mentioned in Segel and Heer [4], 'author-driven' where the authors predefine the content, format and layout of information presentation and 'reader-driven' where the readers can explore the whole dataset based on the ad-hoc information needs. In 2015, stemmed by the theory of organisational semiotics, Liu and Tan [1] suggest to think of data visualisation as a procedure of 'abduction', where users can search for explanation, generate hypothesis, testify hypothesis, instruct their following behaviour based on the analysis result. This research focuses on display and interact with data which enables users to perform information processing capabilities.

This research puts a focus on the 'author-driven' approach to improve the inter-operation between authors and readers towards data visualisation. This approach advances the research outcome from Liu and Tan [1] in terms of building interactive capabilities around data while they are presented.

3 Organisational Semiotics to Data Visualisation

Semiotics is a study of sign which carries information from one party to another. Organisational semiotics shows that information delivery with an organisational and social system should not rely on technology alone and the impacts of procedure and interaction should not be neglected [21]. Liu and Tan [1] suggest under theory of organisational semiotics, data visualisation should be defined as a procedure which signifies data on both semantic and pragmatic levels, covering collecting data, transforming data, mapping visual representatives and displaying (interaction). Instead of discussing displaying visual representatives, this paper will discover how interactive data visualisation signifies data on the semantic level, and enables readers to address their ad-hoc requests and to interpret the author's intentions from different perspectives. Thus, in this section, two theories in organisational semiotics, Semiosis and Semiotic Ladder, will be discussed to inspire the following findings with theoretical supports.

3.1 Semiosis

Theory of semiosis was derived from the work of Peirce in the 1930s, which demonstrates the procedure of information delivery among different parties into a triangle framework [22]. Sign, plays the primary role in this framework which carries information through a physical token, such as written words, graphics and oral language. Object indicates the meaning and information which a sign indicates or links to. In order to link a sign to an object, every individual needs to go through the process of ‘interpret’, which is more than interpreting the information carried by sign, but also the author’s intentions and reflections/impacts on the reader’s behaviour. Therefore, both the quality of sign and principles of interpret would influence the information delivery and interpretation.

Data visualisation, as a procedure of information signification and interpretation, can also be demonstrated into the framework of semiosis (Table 1). Visual representatives can be regarded as signs which carries information. On the context of business, the financial or operational performance always counts as object which should be revealed to stakeholders. Different from the previous research which stress design of visual representatives and algorithm, this paper will focus more on the procedure of interactive data visualisation where not only the information would be revealed with the help of a visual representative, but readers will also be empowered to interact with data on the function of interaction.

Table 1. Explanation of semiosis [22]

| Roles | Explanation | Data visualisation |
|--------------|--|--|
| Sign | The physical carrier of information, or the raw material where the information comes from | Visual representatives: chart, diagram, table and map |
| Object | The meaning of sign, which will influence the receiver’s understanding and even behaviours | Financial and operational performance: cost-efficiency, customer satisfaction, market growth |
| Interpretant | A mechanism or a set of activities to process the raw material to the information which fits the demand of information users | Understand the definition of each variable in the visual presentation; Link different variables to the performance measurement; Capture the author’s intentions through reflecting ad-hoc requests |

In summary, the semiosis triangle demonstrates the procedure of information delivery as an information pathway going through three points, including sign, interpret and object. Moreover it leads this paper to focus on the procedure of interpretant, where the authors and readers can achieve communications in terms of information and intentions. In the following part the process of sense-making ‘interpretant’ will be discussed further, within the body of the semiotic ladder.

3.2 Perception Towards Information

Following the semiosis triangle from Peirce, Stamper [23] further interprets the procedure of ‘interpretant’ in semiotic ladder, for the purpose of identifying and removing the barrier of signifying different signs. The procedure of ‘interpretant’ covers more than just interpretation, but a set of activities, from perceiving the sign from a physical aspect to instructing the following behaviour. Inheriting the research from the traditional semiotics where divisions of syntactic, semantic and pragmatic to indicate grammar, meaning and usage of sign, semiotic ladder extends the basic levels of ‘physical world’ and ‘empiric’ to measure the quality and functions of sign, and the premium level of ‘social world’ to imply the influence of social context [21]. Table 2 provides all six levels and their detailed explanations.

Table 2. Explanations of semiotic ladder [22]

| Levels | Explanation |
|-------------------|--|
| Physical element | The durability and stability of sign |
| Empirical element | The reliability of channel used to deliver the sign |
| Syntactic element | Whether the language can be understood by both information senders and receivers |
| Semantic element | Whether the receiver can figure out the relationship between the sign and object |
| Pragmatic element | Whether the intention attached to the sign can be perceived |
| Social element | Whether the interpretation of sign can be linked to some certain social norms |

The functions of ‘sign’ are mainly related to the semantic, pragmatic and social levels. Following the study of Liu and Tan [1] where data visualisation should be regarded as a procedure to reveal the meaning of data and intentions from authors, this research will enhance the information further, to interpret the procedure of data visualisation on semantic and pragmatic levels, and develop a framework to enhance the communication in terms of the meaning of data and even information needs from readers. On the semantic level, compared with the traditional annual report of charities, data visualisation signifies data with visual representatives. On the pragmatic level, the function of ‘interactive’ allows readers to explore the data based on their information demands.

In charity reporting practice, although previous research points out that the traditional annual report cannot fulfil the information needs, they have never tried to solve the problem with technical solutions. In this research, interactive data visualisation will be utilised as a tool to enhance the performance of charity reporting and to enable the content to be understandable for all stakeholders. Also, it supports the communication between authors and readers on the level of pragmatic. On the one side, all report content will be divided into different levels in terms of the degree of detail and all information can be linked to the whole picture which demonstrates the overall

performance of charity operation. On the other side, readers can request a certain theme they are particularly interested in, instead of following the predefined routine. In the following section, a new-developed framework will be introduced for the purpose of leading the design of interactive data visualisation. On the semantic level, it enables data to be sense-making; on the pragmatic level, it allows readers to follow the author's routine and reflect their ad-hoc request at the same time.

4 The Visualisation Framework

Data visualisation is more than displaying raw data with visual representatives, but rather a procedure to enable data to be more sense-making and empower the reader to reflectively interpret data and author's intentions through the function of 'interaction'. Following the principles of organisational semiotics, a design of interactive data visualisation should sufficiently address issues from both semantic and pragmatic levels.

The visualisation framework is depicted in Fig. 1. This framework was inspired by a common challenge when a reporting system offers a presentation of data in a specific structure, in non-profit organisations [14]. Such challenge often affects users to easily discover business issues from the data. The framework intends to empower users to have sense making on the data through their pragmatic abilities.

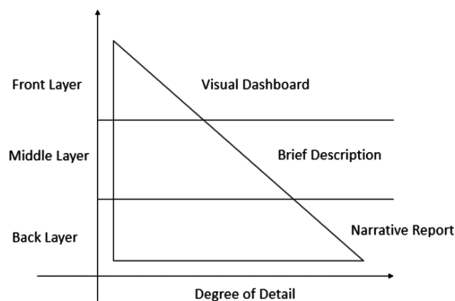


Fig. 1. Framework of visualisation pyramid

On the semantic level, it divides the procedure into three layers in terms of the degree of detail, where authors can present all information from a low to a high degree of detail. Visual dashboard at the front layer is an interactive user interface which presents information to allow users quickly generating facts and views based on meaningful signs through colour, size and shapes of visual representations [20]. On the pragmatic level, interactive visualisation empowers all readers to address their different information requests based on their preference. Other than capturing the pattern of dataset from the dashboard, readers can drill down certain information themes they are particularly interested in and look for further explanations.

5 Age UK: A Case Study and Prototype of Interactive Data Visualisation

This study has chosen Age UK, a leading charity providing services to senior citizens, as a case study. With a reference to Hyndman and McConville [14] and Connolly and Hyndman [12], two themes from Age UK's annual report, such as income and expenditure, are considered to be mostly interested by the readers (Table 3).

Based on such requirements, this study employed the visualisation framework to design an information structure (Fig. 2) which transformed the reporting practices. It feeds the data into the defined business views and governs interactive behaviour for reflective interpretations. For example, a user (i.e. reader) can compare income with expenditure on the top level dashboard, and then look into the cost structure within the theme of expenditure, in order to find out which type of charitable activities Age UK spent money on. Furthermore, the user can choose to view more narrative contents of performance which describe how Age UK invested money to help beneficiaries in terms of their welfare.

Compared with the traditional annual report, the prototype of interactive data visualisation can be utilised as a complimentary tool of charity reporting practice in Age UK. Firstly, instead of showing all contents in one report, this prototype is more flexible for readers to choose the information their interested in and get insight of the overall performance. Secondly, readers are able to drill down the information points they are interested in to a desired level of detail, rather than reading through all contents, which can fulfil their ad-hoc requests in an efficient way.

Table 3. Information categories (charity report)

| Theme | Reader's requests | Relevant contents |
|-------------|--|--|
| Income | How did Age UK raise money in 2015? | Five main sources of income Cost of raising money Detail description: narrative description, news, stories, photos |
| Expenditure | How did Age UK spend money in 2015? How did Age UK serve the social public in 2015? | Five main charitable activities Cost of each main charitable activity and percentage of total cost Performance measurement: case studies and beneficiary stories |

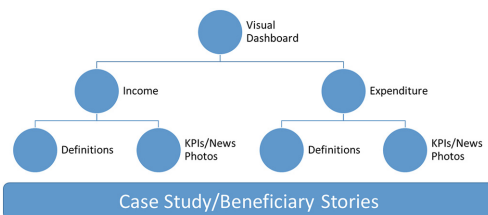


Fig. 2. Information structure for visualisation



Fig. 3. The dashboard for revealing information (https://public.tableau.com/profile/qi.li#!/vizhome/Book1_8896/AgeUKDashboard)

Figure 3 exhibits all three layers of information points based on the information structure. Themes, setting and visual dashboard, present the front layer of information, which delivers a ‘big picture’ of financial status. On the middle layer, Definition(s), KPIs and News, provides the complimentary information, which helps readers to understand the concepts and relevant indicators. On the back layer, case studies with extensive information of beneficiary stories, can be accessed through hyperlink, which can trace back to the website and demonstrate the most detailed information in a particular expenditure category that the reader is specifically interested in.

6 Conclusion and Future Work

This paper identifies the research gap where UK charities always suffer from insufficient accountability disclosure since the traditional charity reporting method cannot enable all stakeholders to understand the report content and provide little flexibility for them to address their ad-hoc requests. Instructed by the theory of organisational semiotics, this paper developed the visualisation framework which implemented the pragmatic ability in making sense of the data via the interactive data visualization tool. This framework was experimented on the Age UK. This tool enables every single information point to be link in a holistic viewpoint of the business. The functions of the interaction meet the uses’ specific information demands and view the content from different perspectives.

In addition, there are a few points where the following studies could be discussed further. Firstly, other than information of income and expenditure, more content can be fulfilled through the framework of visualisation pyramid. Especially, the study from Hyndman and McConville [14], where the information reflecting performance of charitable activities can be addressed by data visualisation, which helps identify the ‘high-profile’ charity in terms of their performance. Secondly, this paper interprets the procedure of data visualisation on both semantic and pragmatic levels. Referring to

the framework of the semiotic ladder, further research is suggested to focus on the level of the ‘social world’ of interactive data visualisation, where the meanings of data (semantic level) and intentions (pragmatic level) might influence the following behaviour of readers.

References

1. Liu, K., Tan, C.: Semiotics in visualisation. In: Proceedings of the 16th International Conference on Enterprise Information Systems, pp. 5–7. Lisbon, Portugal (2014)
2. Lindquist, E.: *Surveying the World of Visualization*. Australian National University, Canberra (2011)
3. Strecker, J.: Data Visualization in Review: Summary. IDRC (2012). <https://idl-bnc.idrc.ca/dspace/bitstream/10625/49286/1/IDL-49286.pdf>. Accessed 2 Feb 2016
4. Segel, E., Heer, J.: Narrative visualization: telling stories with data. *Visual. Comput. Graph.* **16**(6), 1139–1148 (2010)
5. Ellington, E.H., Guillaume, B., Austin, C.: Using multiple imputation to estimate missing data in meta-regression. *Methods Ecol. Evol.* **6**(2), 153–163 (2015)
6. Charity Commission: Charity Overview. Charity Commission (2015). <http://apps.charitycommission.gov.uk/showcharity/registerofcharities/SectorData/SectorOverview.aspx>. Accessed 5 Jan 2016
7. Hyndman, N.: Contributors to charities - a comparison of their information needs and the perceptions of such by the providers of information. *Financ. Acc. Manag.* **7**, 69–82 (1991)
8. Hyndman, N.: Charity accounting - an empirical study of the information needs of contributors to UK fund raising charities. *Financ. Acc. Manag.* **6**(4), 295–307 (1990)
9. Connolly, C., Dhanani, A., Hyndman, N.: The accountability mechanisms and needs of external charity stakeholders. In: ACCA (2013)
10. Connolly, C., Dhanani, A.: Accounting narratives: the reporting practices of British charities. *J. Public Non Profit Serv.* **32**, 73–97 (2006)
11. Dhanani, A.: Accountability of UK charities. *Public Money Manag.* **29**, 183–190 (2009)
12. Connolly, C., Hyndman, N., McConville, D.: UK charity accounting: an exercise in widening stakeholder engagement. *Brit. Acc. Rev.* **45**, 58–69 (2013)
13. Dhanani, A., Connolly, C.: Non-governmental organizational accountability: talking the talk and walking the walk? *J. Bus. Ethics* **129**, 613–637 (2015)
14. Hyndman, N., McConville, D.: Transparency in reporting on charities’ efficiency: a framework for analysis. *Nonprofit Volunt. Sect. Q.* (2015). doi:10.1177/0899764015603205
15. Charity Commission: Transparency and Accountability. UK Government (2004). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/284721/rs8text.pdf. Accessed 5 Feb 2016
16. Stewart, J.: The role of information in public accountability. *Issues Public Sect. Account.* **17**, 13–34 (1984)
17. Few, S.: *Now You See It: Simple Visualization Techniques for Quantitative Analysis*. Analytics Press, Berkeley (2009)
18. Rouhani, S., Asgari, S., Mirhosseini, S.V.: Review study: business intelligence concepts and approaches. *Am. J. Sci. Res.* **50**, 62–75 (2012)
19. Schoffelen, J., Claes, S., Huybrechts, L.: Visualising things: perspectives on how to make things public through visualisation. *CoDesign* **0882**, 1–14 (2015)

20. Ware, C.: Information Visualization: Perception for Design. Academic Press, San Diego (2004)
21. Stamper, R.K.: Information, Organisation and Technology: Studies in Organisational Semiotics. Springer, Boston (2001)
22. Liu, K., Li, W.: Organisational Semiotics for Business Informatics. Taylor and Francis, UK (2014)
23. Stamper, R.K.: Semiotic Theory of Information and Information Systems (1996). <https://assets.cs.ncl.ac.uk/seminars/101.pdf>. Accessed 2 Feb 2016