



The Pension Story - Data-Driven Storytelling with Pension Data

Kay Schröder^{1,2}(✉) , Poornima Belavadi² , Martina Ziefle² ,
and André Calero Valdez^{2,3}

¹ Human Data Interaction Lab, Zuyd University of Applied Sciences,
Heerlen, The Netherlands

kay.schroder@zuyd.nl

² Human Computer Interaction Center, RWTH Aachen, Aachen, Germany

³ Institute for Multimedia and Interactive Systems, University of Lübeck,
Lübeck, Germany

Abstract. Due to global socio-economic changes, the European pension systems require several reforms that call for more active roles from the citizens. Past research has shown that traditional pension communication is often not read and understood by the majority of the population. Furthermore, the general interest of the people to learn about pension information is low. As a consequence, the accessibility of pension information poses a significant challenge. To address this challenge, we try to find out if data visualization can help in the perception of the complexity of pension data, and if a narrative can facilitate the understanding within a particular context in this research study. A data-driven storytelling application was built aiming to bridge the knowledge gap about the pension data among the citizens. In this paper, we describe the visualization and narrative structure development process with domain experts. We tested the application individually customized to ten test subjects and found out that the developed data story enhances the understanding, user satisfaction, and accessibility of this information.

Keywords: Information visualization · Storytelling · Pension data

1 Introduction

A changing labor market, increased life expectancy, and the increasingly aging population in Europe require fundamental pension reforms [14]. In the Netherlands, the government set the course for changing the Dutch pension system in 2016. The revision of the system and further development of the pension sector could significantly impact the various stakeholders over the next ten years. Therefore, it is essential to communicate about the development of the pension sector to all of the different stakeholders. However, communicating efficiently through the available communication channels is one of the biggest challenges faced by the pension sector [16].

So far, the pension sector has been using the traditional communication channels, e.g., post mail, to communicate information to their clients. However, these conventional communication channels no longer suffice. Although the communication style has changed from a physical letter to a digital e-mail combined with a personalized online environment in recent years, it appears that written information (including the uniform pension overview that everyone receives annually) and annual reports are often not read or understood by people. There are two main reasons for this: first, the interest to deal with it directly is low for many people because the payout event is far in the future [22, 24]. Second, understanding financial data and its context is challenging for many people [4, 5, 12, 23]. The underlying reason for this may be that the information provided consists mainly of text and numbers [18]. With the reform of the current pension system, new ways of communication will be possible.

In this study, we focus on the second aspect: *understanding*, by the aid of visualizations we propose to improve the understanding of pension information. Visualization has been getting more attention within the pension communication sector in the last years [6, 21]. As it is known that our brain can process and remember visual information much faster than text and numbers. In addition, we investigate whether adding narrative structures can enhance the visualizations to further aide the process of understanding the underlying data in context [8, 9].

In this paper, we describe the process, findings, and the resulting data story of the participatory design process that we applied to develop the data story with domain experts. We conclude the finding of our qualitative evaluation study that we conducted with ten participants testing the resulting individualized pension stories. We found out that all test subjects have very little or no knowledge of their pensions and pensions in general. Moreover, questions related to interaction and behaviour indicate that their general interest in learning about pension is low. After the stimuli (a data story from approximately 1 min), nearly all subjects were able to explain how the pension system works in general and how their pension fund is generated over years. Furthermore, their follow-up questions indicate that their general interest in learning about pension increased. Additionally, we also tested visualization literacy and financial literacy. We could state that all test persons passed the visualization literacy questions successfully, from which we conclude that all of them understand the visualization method. Surprisingly, one of three test persons could not answer all financial literacy questions correctly, irrespective of the pension knowledge questions correctly reproduced in the last step, which was surprising as it was expected that the questions on pension knowledge and financial literacy questions were closely related.

2 Related Work

While there are several studies conducted to facilitate understanding of pension data for domain experts in the context of financial data visualization, the use of data visualization to reach a broader audience regarding pension information is still not well understood.

2.1 Visualizing Pension Fund Data

An overarching research question in the financial sector is how can visualizations help the experts in the field to work efficiently with complex financial information. To answer the question from the visualization research point of view, we first distinguish between the two objective: *Visually analyze pension data* for domain experts, e.g., for portfolio managers and *presentation of the analysed data* to the stakeholders or citizens like clients from pension funds or connected organizations. While both the contexts aim at domain experts with specific domain knowledge, they give an overview of possible design-space considerations.

Aiming at presenting annual report data, Rodriguez et al. [17] propose multiple variations of area, bar and line charts and more specific combinations like fold-over stacks, directional waterfall or position folded bar charts. Most of the examples aiming on comparison tasks or visualizing temporal changes and therefore mostly used a spatial encoding. Schroeder et al. [19] proposed a combination of bubble chart and bee-swarm plot to help asset managers identify potential financial risks in pension portfolios through regular computer displays or mixed reality devices. Lugmayr et al. [11] proposed to use virtual reality technologies to put investment data into context. However, the expected audience in this case had a high financial and domain literacy and were able to extract the right information from the proposed information systems.

2.2 Visualizing Pension Information

One of the rare examples of how financial information could be visualized to enhance understanding and decision making was given by Cox et al. [6]. The authors use infographics to visualise key mutual fund disclosures and study if the infographics effect the investment decisions of novice, intermediate and expert investors. They use infographics to highlight the risks and the rates of choosing a particular mutual fund and assist the investors in choosing and comparing them with others. They report that the infographics did help in improving the decisions made by the novice investors who represent a large population of people who find financial decision making difficult in the real world. Although not much effect was seen among the intermediate and the expert investors' decisions. Another example proposed to use metaphors in combination with pension data to facilitate understanding and engagement from citizens by Schroeder et al. [20]. Although the paper uses narrative structure to help in explaining the dutch pension systems to users, the quantitative context was primarily explained in textual form. The metaphors helped user to link the abstract context to his individual experience, however, it does not directly facilitate the understanding of the abstract concept itself.

3 Method

In this section, we describe the design process that was followed to bring forward the final visual story on pension funds. In addition we also discuss the user

study design plan to investigate if the generated visual stories improved the understanding on pension funds among the users.

3.1 Domain Problem Characterization

The development of the narrative structure took place in a participatory design process. Together with domain experts from the pension sector we conducted a mixed research group workshop to explore viable design and storytelling options under consideration of prior domain knowledge. The group consists out of two academic researchers with background in information visualization & HCI and five domain experts (a market researcher, three pension communication professionals and a pension expert).



Fig. 1. The individual steps of the data story, starting with the monthly spending towards building a total pension pot and finally getting a fixed amount per month (text in figure in Dutch keeping the language of the target users in mind).

3.2 Narrative Structure

The domain experts with in-depth pension communication knowledge, work for one of the worldwide biggest pension funds which has more than 3 million members from a wide range of demographic backgrounds, provided a comprehensive perspective on the Dutch pension market. As outcome of this workshop we collected best practices from the domain experts regarding the data story structure, content and ordering. Furthermore we also discussed potential pitfalls, lessons

learned, and promising future approaches in designing dynamic data visualization/storytelling based on their internal market research projects from the previous years. The findings of the practitioners were consistent with the proposed strategy that we found in the recent studies [7, 14, 15]. The story development followed a participatory design process with iterative validation steps, which involved domain experts as well as end users to ensure the validity of the narrative choices, the approach was similar to that followed by [25].

3.3 Visualization Design

One of the goals in the workshop was to understand the communication measures that were currently being practiced by the pension sector through which they conveyed important information about the pension funds to their clients. The pension information was communicated to the clients annually by post mail and owing to the introduction of efficient digital communication channels, communication in the pension sector has also witnessed the shift towards digital communication means. Acknowledging this shift, we developed a web application in JavaScript using the libraries D3js [2], animeJS [1] and JQuery [3] as a basic model of pension communication, to communicate the basic information about the pension like: how is the pension fund generated, what is the employer's in one's pension fund, how is the interest generated on the fund etc., A brief overview of this is shown in Fig. 1.

We visually encode the quantitative financial information representing the customer's salary share, his/her employer's share as blue dots and the additional interest gained is represented yellow dots. The number of dots were chosen to depict each party's approximate share to the customer's pension fund. We use animations to highlight the three parts of the pension fund and to show the accumulation of the fund over years until retirement. To facilitate the understanding, the animation logic was built closer to the user's mental model, the movement of dots from left mapped the idea of user giving the money to pension fund, and the movement of the dots to the right mapped to the idea of receiving the pension money. The addition of the interest amount was shown as dots stacking from the top. The animation ends with the final view of monthly annuity that the customer would get from the pension fund after his retirement.

4 User Study

We conducted a user study with 10 participants to evaluate the subjective and objective effects of the visualization. The procedure is illustrated in Fig. 2.

4.1 Participants

Participants ($n = 10$) were recruited from a pool of clients from one of the world's biggest pension providers. Formerly the clients had agreed to participate in market and research studies. After the experiment, each participant received

a leisure voucher from the local tourist association as compensation for participation. All the participants are currently employed and between 38 and 55 years of age. Four of them were female and six were male. A convenient sampling approach was applied to choose the participants and they voluntarily agreed to join the study. 9 out of 10 participants were working full-time (36 h/week), and one participant was working part-time (28,8 h/week). One participant had dyslexia. Three participants used mobile phones, the rest tablets or regular computers. One participant withdrew from the experiment due to health reasons.

4.2 Procedure

Based on the personal information of the test subjects (birthday, pension start year, salary grade and temporal extent of the employment relationship) a custom-made data story was developed. We tried to avoid the feelings or prejudices provoked by apparent deviations between the presented pension scenario and the individual scenario, which influence the results. In the first step, users were introduced to the procedure and background of the experiment and consent that the session can be recorded to transcribe the answers accurately. In every interview at least 2 researchers were present, one conducting the interview with the camera switched on and the other documenting and following all events in writing with the camera and microphone switched off. Table 1 shows a sample of the questions asked in the user study.

Before presenting the data story, a pre-experiment survey was conducted where participants were informed about the conditions and background of the experiment. We then asked the general demographic information of the participant to confirm the correctness of the background data so that the presented individualized story matched with the participant. The experiment was divided in 5 parts:

1) General Aspects. Participants were first asked about general conditions that could influence the results; we noted the devices that were used to see the story and added additional notes if necessary (e.g. dyslexia). Following, general knowledge about pensions and the pension provider were asked, and the related associations and possible emotions (e.g., fear) were noted. Additionally, participants were asked to summarize previous interactions with pension information resources (e.g., an online information system that overviews the individual pension) and the pension provider.

2) Knowledge Questions About Pensions. In the next step, we asked the participants to describe their understanding of how the pension allowance was made up in terms of accumulation and total savings.

3) Presenting the Pension Story. After a general introduction of the data story, we conducted a think-aloud protocol with the participants while there were looking at the storytelling application.

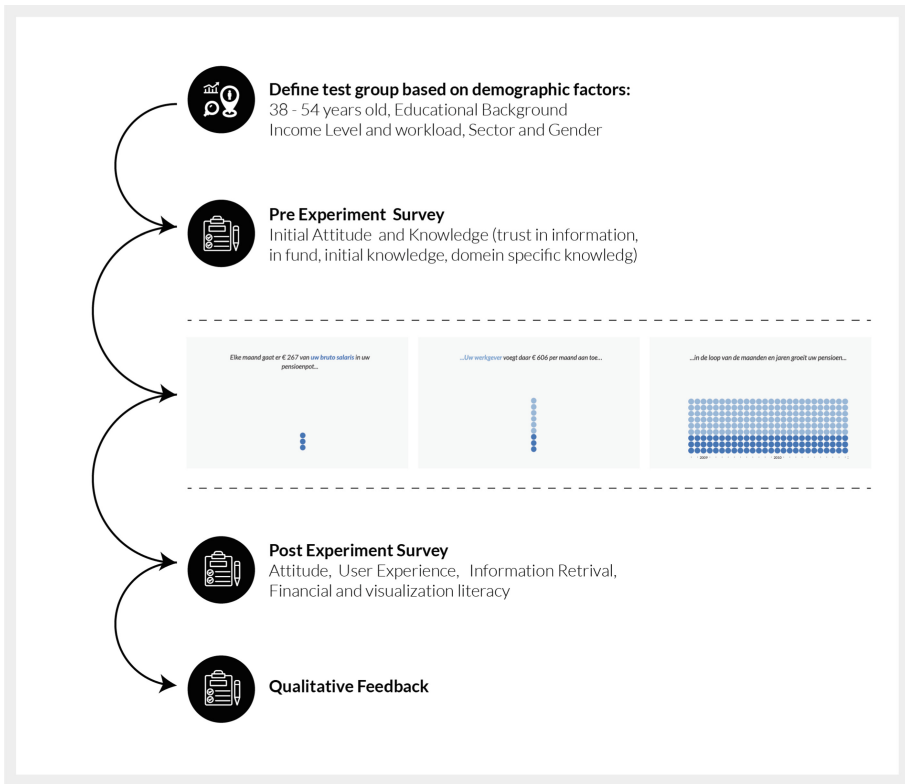


Fig. 2. Overview of the user study design conducted to study the effect of the pension fund visual story on understanding of the user.

4) Evaluating Perception, Knowledge Retrieval, and Conclusions.

After viewing the data story, we collected the initial feedback, the findings that the participants draw out of the data story, their perceived ease of use, and the level of conformity with their previous knowledge. Further, we collected subjective feedback and potentially triggered a follow-up question.

5) Measuring Financial and Visualization Literacy.

To understand if the test subjects were able to understand the visualization in general, we tested the visualization literacy [10] to validate if users understand the individual elements of the visualization as their overall meaning. Finally, we measured the financial literacy according the scale from [13] and concluded the interview with an open-ended feedback question.

5 Results

In this section, we summarize the findings from the qualitative user study. A total of 6 people were involved in the qualitative data collection. Between 2 and 3 researchers were present at each interview. At the end of the experiment, all results were discussed together and summarized based on a common consensus. To sum up, most test subjects knew little to nothing about annuities. Only a few of them indicated that they had contacted their pension fund in connection with life events such as a divorce or a house purchase. About half of the total number of participants had consulted the general information websites to get an overview of pension structure and background information. Therefore, it is not surprising that the majority had no or neutral associations with annuities and the pension fund in question.

5.1 Initial Knowledge

A low level of basic interest was reflected particularly clearly in the pension-related question block: General knowledge questions about the structure could not be answered completely correctly by any test participant. Only 4 of 9 subjects knew that there was also an employer component; the rest thought that only they paid money into their pension or had no idea. Two subjects were able to indicate the amount they pay per month to pension contributions. When asked, all subjects could imagine that the money was invested, but how and in what amount was unclear to all participants.

5.2 Knowledge Retrieval After Stimuli

After the participants were shown the animation, all participants were able to reproduce the structure of the pension fund generation process correctly. The employer's share was explicitly named by 7 participants. One person had problems reading the texts, which can be explained by the fact that they had problems reading the small letters as they viewed the data story on a mobile phone. Five participants responded clearly to the net pension. All participants found the animation easy to understand and the content clear. The pictures of the animation formed the foundation of the understanding of the content, while the texts supported the contextual understanding. Only two participants stated that they did not learn anything new. However, we found that these participants had answered the content questions incorrectly before the animation and correctly afterward, which indicates a variance between their perception and our observation. The compound interest effect was clear for 7 participants; two participants gave a correct answer immediately after the animation, but could not remember it later. This could possibly be due to the fact that the new question was not understood correctly. One participant saw the interest but did not want to believe that it belonged to the pension payment amount. The same respondent was initially strongly convinced that the interest was not part of their retirement savings. What is striking here is that even though they understood the information correctly, their initial opinion hardly changed.

Table 1. Table showing the sample of questions asked in the user study (translated from Dutch)

Personal questions
Can you introduce yourself?
What do you know about pension?
How do you think about retirement? What feeling does it evoke in you?
What are your views about ABP?
Have you contacted ABP or looked up ABP information? if yes, What for? What do you think about it?
Do you log in to myABP? What information did you look for?
Knowledge and questions about pension contributions
Which parties play a role in depositing the money for your retirement fund?
Do you pay for your retirement monthly? Do you know approximately how much you pay?
What happens to your deposit money? What role does ABP play in handling your deposit money?
In what ratio do each of the parties deposit money to your retirement fund (in percent)? How did you come up with the number? Where did you find the information?
After watching the Pension story
Can you tell what you saw here? What does it mean to you?
Was the animation easy to understand? What were the clear and unclear aspects of the animation
Does the information in this animation match what you already know about your retirement?
You now saw a picture about the ratio of deposits in your pension pot. Do you know what are the three parties involved? Does your answer about the ratio change?
If you look at the growth of your pension, when does your pension grow the most?
Does the animation appeal to you? Why?
Do you want to learn more about pension now?

5.3 Subjective Feedback

8 out of 9 participants found the form clear. Two participants said it could be a little more appealing. (“I am missing a bit of 2021 vibe”). As further suggestions for improvement, one stated that the color contrast between the blue tones could be more robust. A voice-over was also recommended in combination with the existing text. One participant found the animation unappealing and difficult to follow, the test person was the only one who did not have a device with sufficient display size (cell phone) and therefore had problems reading the content. The

emotional response to the story was neutral to motivating (1), satisfied (2) and hard to believe (1). 7 out of 9 participants wanted to know more about their pension funds after viewing the pension data story, more detailed information about investments was explicitly mentioned by 6 participants, one participant wanted to know how the monthly pension is calculated, another wanted to know what his pension fund would look like if he retired earlier.

5.4 Literacy

3 out of 9 participants were not able to answer all financial literacy questions correctly. The visualization literacy questions were nevertheless answered correctly by all the participants.

6 Discussion and Conclusion

One of the challenges being faced by the pension sector is to make their clients foresee the future and prepare for the time after retirement. Although most of the working population understand finances early on, they think about retirement and take interest in understanding the pension plans only in the later stages of life or at the times of major events (marriage or divorce) in their life as suggested by one of the participants in our study. Even then, majority of them struggle to understand how the pension is calculated and don't pay attention to or find it difficult to understand the information letters sent to them via post.

New methods should be devised to increase the interest among the people and build their engagement towards understanding the pension plans and help them make better decisions. We propose using visualizations to communicate with the clients. As the phrase goes "a picture can speak a thousand words", visual cues are perceived and understood better by people from different cultural and educational backgrounds. With the communication channel shifting towards digital modes, visual cues with animations can be used to create the interest, explain a complex idea to the people. In this paper, we use a basic visualization and animation to make the users understand how pension fund is created. We conducted a user study ($n = 10$) to test if the visual data story increased the understanding of the people in this regard. The results showed that, majority of the users were able to understand the structure of the pension fund, which they did not know before viewing the visualization.

One interesting aspect that caught our attention was that the initial bias of one user about interest amount not being part of the pension fund did not change despite him answering correctly in the post test that the interest was part of the pension fund, which makes us ask the question whether there is no correlation between understanding and bias. This could be further investigated with a bigger test group. In this paper, we have done a preliminary study to test if visualizations are effective in increasing user understanding. This could be elaborated in the future to have more metaphors and visual cues and test what visualizations are best suitable for this domain problem. More work has

to be done to evaluate the different possible narrative structures for the pension problem. This work shall be extended to test the role of interactions along with visualizations among different target user groups.

References

1. AnimeJS - a javascript animation library. <https://animejs.com/>. Accessed 29 Dec 2021
2. D3js - Data Driven Documents. <http://www.d3js.org>. Accessed 29 Dec 2021
3. JQuery - a javascript library. <https://jquery.com/>. Accessed 29 Dec 2021
4. Bernheim, D.: Do households appreciate their financial vulnerabilities? An analysis of actions, perceptions, and public policy. *Tax Policy Econ. Growth* **3**, 11–13 (1995)
5. Bernheim, D.: Financial illiteracy, education and retirement saving. *Living with Defined Contribution Pensions*, vol. 3868 (1998)
6. Cox, R., De Goeij, P.: Infographics and financial decisions. *Netspar Industry Paper Series* (2020)
7. Dinkova, M.: Brace yourselves, pension is coming: consumption, financial literacy and tailored pension communication. Ph.D. thesis, Utrecht University (2019)
8. Elling, S., Lentz, L.: Tien jaar upo.: een terugblik en vooruitblik op inhoud, doelen en effectiviteit. *Netspar Design Paper* (102), 1–42 (2018)
9. Lentz, L., Pander Maat, H.: De gebruiksvriendelijkheid van het uniform pensioen-overzicht. *Netspar Occasional Papers* (2013)
10. Locoro, A., Fisher, W.P., Mari, L.: Visual information literacy: definition, construct modeling and assessment. *IEEE Access* **9**, 71053–71071 (2021)
11. Lugmayr, A., Lim, Y.J., Hollick, J., Khoo, J., Chan, F.: Financial data visualization in 3D on immersive virtual reality displays. In: Mehandjiev, N., Saadouni, B. (eds.) *FinanceCom 2018. LNBIP*, vol. 345, pp. 118–130. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-19037-8_8
12. Lusardi, A., Mitchell, O.S.: Financial literacy and retirement preparedness: evidence and implications for financial education. *Bus. Econ.* **42**(1), 35–44 (2007)
13. Lusardi, A., Mitchell, O.S.: Financial literacy around the world: an overview. *J. Pension Econ. Finance* **10**(4), 497–508 (2011)
14. Merton, R.C.: The crisis in retirement planning. *Harv. Bus. Rev.* **92**(7/8), 43–50 (2014)
15. Myriam, L., Devolder, P.: Pension communication: digitalization and real power on people's behavior
16. Prast, H., Teppa, F., Smits, A.: Is information overrated? Evidence from the pension domain (2012)
17. Rodriguez, J., Kaczmarek, P.: *Visualizing Financial Data*. Wiley, Hoboken (2016)
18. Schroeder, K., Ajdadilish, B., Calero-Valdez, A.: Towards bridging the gap between privacy terms and humans through information visualization. *PinG Privacy in Germany* (2021). <https://doi.org/10.37307/j.2196-9817.2020.01.17>
19. Schroeder, K., Ajdadilish, B., Henkel, A.P., Calero Valdez, A.: Evaluation of a financial portfolio visualization using computer displays and mixed reality devices with domain experts. In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pp. 1–9 (2020), <https://doi.org/10.1145/3313831.3376556>

20. Schroeder, K., Kohl, S., de Jongh, F., Putzu, M., Ziefle, M., Calero-Valdez, A.: Rethinking pension communication - the role of metaphors in information visualization. In: Duffy, V.G. (ed.) *International Conference on Human-Computer Interaction*, vol. 13320, pp. 416–429. Springer, Cham (2022)
21. Strikwerda, J., Holleman, B., Hoeken, H.: Supporting pension participants. *Netspar Industry Paper Series* (2021)
22. Van Els, P.J., Van den End, W., Van Rooij, M.C., et al.: Pensions and public opinion: a survey among Dutch households. *De Econom.* **152**(1), 101–116 (2004)
23. Van Rooij, M.C., Kool, C.J., Prast, H.M.: Risk-return preferences in the pension domain: are people able to choose? *J. Public Econ.* **91**(3–4), 701–722 (2007)
24. Van Rooij, M.C., Lusardi, A., Alessie, R.J.: Financial literacy, retirement planning and household wealth. *Econ. J.* **122**(560), 449–478 (2012)
25. Weijers, M., Bastiaenen, C., Feron, F., Schröder, K., et al.: Designing a personalized health dashboard: interdisciplinary and participatory approach. *JMIR Format. Res.* **5**(2), e24061 (2021). <https://doi.org/10.2196/24061>