



Network for Studies on Pensions, Aging and Retirement

Show Me My Future: Data-Driven Storytelling and Pension Communication

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Abstract

In light of current pension reforms driven by the rise in life expectancy, aging populations, and changing labor markets (Merton, 2014), communication about those reforms and communication to get people activated is crucial. In the Netherlands, communicating efficiently via the existing communication channels is one of the biggest challenges for the pension sector (Prast et al., 2012), as current reforms can have severe consequences for different groups of stakeholders. Written communication (such as the yearly pension overview sent by post or email) is often not read or understood by their recipients (Elling & Lentz, 2018; Montae, 2012; Pander Maat & Lentz, 2013), possibly because this type of communication consists of words and numbers, which is especially unappealing to people who are used to visual communication. Our brain is faster in processing visual information, and we are also better at remembering information transferred in visuals as opposed to text (Potter et al., 2014). Besides this, the content structure of information could be improved by making use of storytelling (Sax, 2006). In this paper, we first discuss the status quo of pension communication in the Netherlands. We then summarize literature from the fields of marketing, economics, and finance on the effects of visuals and storytelling, draw from the field of human data interaction to showcase a series of applications of visualization and data-driven storytelling in the pension communication field, and develop implications for managers and scientists wanting to work on visualizations and storytelling.

Samenvatting

De hervormingen van pensioenstelsels als gevolg van stijgende levensverwachting, vergrijzing en veranderende arbeidsmarkten (Merton, 2014) betekenen ook dat het des te belangrijker wordt om duidelijk te communiceren en mensen te activeren. In Nederland is efficiënt communiceren via bestaande communicatiekanalen een van de grootste uitdagingen voor de pensioensector (Prast et al., 2012), terwijl huidige hervormingen grote gevolgen kunnen hebben voor verschillende groepen stakeholders. Schriftelijke communicatie (zoals het jaarlijkse pensioenoverzicht dat per post of e-mail wordt verzonden) wordt door veel mensen niet gelezen of begrepen (Elling & Lentz, 2018; Montae, 2012; Pander Maat & Lentz, 2013), mogelijk omdat dit soort communicatie uit woorden en cijfers bestaat, wat vooral onaantrekkelijk is voor mensen die gewend zijn aan visuele communicatie. Ons brein is sneller in het verwerken van visuele informatie en we zijn ook beter in het onthouden van informatie die in beelden wordt overgedragen in tegenstelling tot tekst (Potter et al., 2014). Daarnaast zou de inhoudsstructuur van informatie verbeterd kunnen worden door gebruik te maken van storytelling (Sax, 2006). In dit artikel bespreken we eerst de huidige status van pensioencommunicatie in Nederland. Daarna vatten we literatuur samen op het gebied van marketing, economie en finance samen over de effecten van visuals en storytelling, putten uit het veld van menselijke gegevensinteractie om een reeks toepassingen van visualisatie en datagestuurde storytelling op het gebied van pensioencommunicatie te demonstreren, en ontwikkelen we implicaties voor managers en wetenschappers die willen werken aan visualisaties en storytelling.

1. Introduction

Most people find making decisions for the distant future, including for after retirement, to be complex and difficult. However, this subject is gaining central focus throughout different societies. Populations in large parts of the world are aging, labor markets are changing, and therefore, many pension systems have been or are being reformed to keep pace with these developments. It is crucial to support individuals in making optimal decisions in this changing landscape through various interventions (e.g., nudging; Eberhardt et al., 2021). In face of this development, communicating effectively via existing communication channels is one of the biggest challenges for the pension sector (Debets et al, 2018; Prast et al., 2012; Thorp et al., 2020).

Written communication such as the yearly pension overview that is sent by post or email is often not read or, when read, not understood (Elling & Lentz, 2018; Montae, 2012; Pander Maat & Lentz, 2013), possibly because this type of communication is transported through letters and numbers. Such communication is especially unappealing to the eyes of people who are used to visual communication. Our brains are wired to much faster processing of visual information, and we are also better at remembering such information as opposed to text (Potter et al., 2014). The content structure of information might also be improved by adding another layer to strictly visual information, namely storytelling (Sax, 2006).

We conceptualize three main goals of effective pension communication. First, pension information needs to be engaging and interesting enough so that people read it. Second, the information needs to be understandable. Third, the information needs to convey that individuals feel empowered to make choices. We use these three goals in the remainder of the paper to structure the literature review and case studies.

In the remainder of this paper, (1) we summarize literature from the fields of marketing, behavioral economics, and human data interaction on the effects of visuals and storytelling; (2) we propose a design space and showcase several applications of visualization and data-driven storytelling in the pension communication field; and (3) we develop some implications for practice and theory on visualizations and storytelling.

2. Background

In this section we describe the evolution of the legislation governing pension communication in the Netherlands and the main goals thereof. We then outline whether pension communication has met these goals and which factors need to be considered for successful pension communication. We refer back to literature in finance, marketing, economics, and visualization.

2.1 A recap of the evolution of means and goals of pension communication in the Netherlands

As digitalization became widespread and with a changing pension system, the ways and means of pension communication in the Netherlands changed as well. The Pension Act of 2005 required pension funds to annually provide individuals from 2008 onwards with retirement income projections. The Social and Economic Council had recommended this Uniform Pension Overview (UPO), so that individuals had the information they needed to assess whether they would receive an adequate pension. The UPO presented the projection almost as a given fact, without communicating the risks and uncertainties around pension forecasts. This same law stipulated that the pension industry needed to set up a pension register so that individuals would have information on their combined rights stemming from their first- and second-pillar pensions. The goal was to raise pension awareness, measured by whether people (1) know that they will receive a pension income, (2) know whether their pension income will be sufficient, (3) know how to fill potential income gaps at retirement, and (4) can decide to act if needed. However, the mandated pension communication was unsuccessful in reaching its main goal: pension awareness did not improve in the 2009–2011 period (Wijzer in geldzaken, 2014), and Dutch pension awareness was low compared to other countries (Towers Watson, 2012).

After the global financial crisis of 2007 and 2008 and the ensuing changes in the pension system, a new Pensions Communication Act was passed in 2015. The law reflected the variety of information needs that come with the increased variability of pension income introduced in the Dutch pension system. It placed more emphasis on the individual and reduced the focus on behavioral change. The definition of being fully “pension aware” now included that people know (1) how much pension they can expect, (2) whether that amount is sufficient, and (3) the risks of their pension plan. In line with the incremental switch from a Defined Benefit system (DB) towards a Defined Contribution (DC) system and the shift of responsibility from the pension fund to the individual fund member, pension communication also needed to inform

people about possible choices. The law also acted upon the trend of digitalization, with increased online information and communication. Pension funds could now send the UPO on paper, electronically, or both. Online, information is provided in three layers, with each layer providing more detailed but less individualized information. The riskier nature of the second pillar pension would be shown by providing three projections of retirement income: a realistic, an optimistic, and a pessimistic version.

From the way pension communication legislation evolved, we conclude the following. First, there is increasing attention to personalizing pension communication (Eberhardt et al., 2016). Pension funds need to consider the differing preferences and knowledge of individuals, and to provide different layers of information (Pension 1–2–3). They need to ensure that their members understand the information provided to them and that the information is relevant to them. Second, considering the higher risk in the second pillar pension due to system reforms, pension funds need to communicate that risk. Third, pension communication needs to include choice options. Fourth, the means of communication have gradually shifted away from paper-based to online communication. Most people use the internet, apps, and mobile devices daily for work and leisure, with younger people being referred to as “digital natives”. While the latter might not learn differently from digital illiterates (Bennett, Maton & Kervin, 2008; Margaryan, Littlejohn & Vojt, 2010), digitalization opens up opportunities for pension communication with respect to means and content: contrary to a static letter, individuals can engage with interactive tools.

2.2 Effect of pension communication on interest in pensions, pension knowledge, and active decision-making according to literature in marketing, economics, and finance

In this subsection we use marketing, economics, and finance literature to look at the impact of pension communication, and what factors help achieve the three goals of pension communication laid out in Section 1.

Low interest in pension matters can have many reasons. First, people may simply be indifferent as they cannot make any choice. A shift to DC pension plans may help overcome this hurdle. However, even then, people may still actively avoid information, as discussed in detail in Golman, Hagmann, and Loewenstein (2017). Next to strategic reasons, people also avoid information when they think it will hurt them in the short term. In the case of pension communication, they might avoid reading their pension overview because they expect a financial loss or an income gap at retirement (i.e., they are averse to risk, loss, or disappointment). They might also

avoid information because they are anxious about the risks and uncertainties around retirement,. Another reason for information avoidance might be that the information is difficult to understand and that a lot of energy is needed to remain attentive to it.

While pension communication cannot fully overcome these barriers, pension providers can improve the information by making it more relevant to the individual, simplifying it to enhance understanding, and communicating the risks in a transparent way. Another reason why a person may have little in pensions is bias. Individuals focus on here and now, while retirement is distant for most people. Therefore, the relevance of pension communication is perceived to be low. Hershfield et al. (2011) propose to let people interact with their age-rendered pictures (i.e., their future selves), making their future selves more concrete through the interaction. They show that people who interact with their future selves are more likely to forego immediate rewards and to allocate more money toward their future selves. Sims et al. (2020) extend these findings, showing that students who see their future selves display higher confidence in their financial literacy, and have greater interest in long-term financial planning workshops than their peers who only see their current selves. Next to personalization and using self-identification to make information more relevant to pension fund members, timing is also important. For example, Blakstad, Brüggem, and Post (2017) find that the life event of "starting a new job" activated 25% of study participants to register for the portal or change their pension contributions.

More recent studies have also looked into financial rewards or gamification to increase people's interest in pension communication. Bauer, Eberhardt, and Smeets (2022) find that providing financial incentives in the form of a voucher lottery leads to increase of the likelihood that pension fund members will look at pension information by up to 86%. A literature review on the impact of gamification on e-learning shows that gamification elements such as points, leaderboards, and badges increase a student's motivation and learning outcomes (Saleem, Noori & Ozdamli, 2022). However, the question remains whether extrinsic motivation can crowd out the intrinsic motivation to interact with pension information on an online basis.

The second goal of pension communication, that of providing information that people understand and that increases their pension literacy, has been studied more intensively in the field of financial literacy. Fernandes, Lynch, and Netemeyer (2014) find that only 0.1% of the variation in financial behavior can be explained by financial education interventions. A more recent meta-study, however, shows that financial education programs increase financial literacy and consequently also improve financial behavior (Kaiser et al., 2020). In the more specific pension communication field, Bateman et al. (2016) show in an experiment that retirement savers

use investment disclosure statements in unexpected ways: 35% of individual choices could not be explained by any of the five information items. In an online experiment, Bateman and Eberhardt (forthcoming) tested how different versions of a single-page fact sheet on retirement income products affect product knowledge, perceptions, and choice. They found that participants who see the text-only fact sheet scored higher on product knowledge than participants who see fact sheets with graphs, tables, and/or a salient risk rating. Nevertheless, product risk perceptions follow the visual saliency of the risk rating, and they affect product choice more than product knowledge. In the Netherlands, Debets et al. (2020) find that the UPO may have a slightly positive effect on pension knowledge, but with the caveat that this finding is not robust. Bauer, Eberhardt, and Smeets (2022) find that pension fund members who look at pension information online do not do better in a subsequent pension quiz. The effect of the current methods of pension communication on pension knowledge is thus small at most.

Aside from an informational brochure, Lusardi et al. (2017) test more innovative methods to increase financial literacy, namely a visual interactive tool, a written narrative, and a video narrative. They do so since most people are connected to the internet, which makes online communication scalable, easily accessible, and potentially less time-consuming than other literacy interventions. While all treatments led to higher self-efficacy, the video narrative increased financial literacy and confidence in knowledge the most. The visual tool did not affect financial literacy, but it increased confidence in knowledge.

Another example of an interactive tool is the distribution builder proposed by Goldstein, Johnson, and Sharpe (2008). This builder is intended to help people communicate their risk preferences. With the builder, people visualize their desired investment return distribution, given specific budget restraints. According to the authors, this should make preference statements more informed. Camilleri, Cam, and Hoffmann (2019) used graphs showing the distribution builder to visualize the risk-return distribution of investment options in an incentivized multi-period experiment. Participants who saw graphs that were updated every period, or defaulted to a period-specific option, made choices consistent with life cycle theory. Visualizing risk-return trade-offs in this way thus seems to inform participants correctly, so that they can make appropriate choices.

The third goal of pension communication is to engage fund members when they have an income gap. Evidence of the effect of pension communication on decisions is mixed. Doll et al. (2018), in a German experiment, examine the introduction of annual letters that inform about expected public pension payments. They find that

the information led on average to increased tax-deductible private retirement savings as well as labor earnings. In the Netherlands, literature on the effect of communication on actions is scarce. Debets et al. (2020) find a robust impact of pension literacy on conscious retirement decision-making, but not on recall of having received the UPO. Bauer, Eberhardt, and Smeets (2022) find that looking at pension information online does not increase the likelihood of reporting more savings. This is in line with the results reported by *Wijzer in geldzaken* (2020), showing that most people stay inactive during life events, even though they understand that life events and actions affect their later retirement income.

Overall, pension communication in its current state is often unsuccessful in engaging fund members, increasing their knowledge, and activating them if applicable. This problem not only affects the pension sector but every field where information reaches a certain degree of domain-specific complexity. Therefore, it is not surprising that those domains act more extensively, i.e. using visual means, to help individuals understand domain-specific data related to health (Strikwerda et al., 2021; Weyers et al., 2021), legal, and pension information (Schroeder et al., 2020; Schroeder, Ajdadilish and Calero Valdez, 2020; Schroeder et al., 2022a; Schroeder et al., 2022b; Schroeder et al., 2022c).

There is evidence that visualization, interactive tools, and storytelling can improve the understanding of complex phenomena, as these methods make information more attainable and interesting for individuals. While little research has yet been conducted on financial data visualization in general, we see a growing use in recent years of visualization for pension information (e.g., Cox, 2020; Lanotte, 2021; Schroeder et al., 2020; Schroeder, Ajdadilish, and Calero Valdez, 2020; Schroeder et al., 2022a; Schroeder et al., 2022b; Schroeder et al., 2022c; Van Hekken, 2019).

To shed light on what a "visual" future of pension communication might look like, we discuss a human data interaction perspective in the following chapter, along with some visual illustrations of application cases.

3. How human data interaction can improve pension communication

We now turn to the literature on visualization to conceptualize how visualization methods can help reach the goals of pension communication. These are: 1) evoking the interest of people, 2) increasing their pension-related knowledge, and 3) eventually activating them. First, we present an overview of fundamental concepts of human data interaction, focusing on information visualization. In this section, we overview information visualization research in the context of financial and, especially, pension data.

3.1 The value of information visualization

The research area of information visualization explores, both theoretically and practically, how the visual representation of complex phenomena can enhance and support human cognition. Complex phenomena in this context could be quantitative, i.e. numerical data (e.g., financial), or qualitative, i.e. non-numerical data, such as text or geographic information. This research discipline has a strong interdisciplinary character, as it emerges from the intersection of design, human-computer interaction (HCI), computer science, and psychology (Card, Mackinlay, & Shneiderman, 1999). Within this domain, much empirical research has been done to better understand how efficient visualization systems can be designed and related effects can be measured.

Understanding how the human perceptual and cognitive system interacts with data-driven systems is essential in this process (Ware, 2019). To understand data through visual means, a remarkable basic model of thinking is the idea of channels and marks (Munzner, 2014). This idea describes the translation of data or abstract information into visual elements called channels and marks, where marks represent what is presented, and channels reflect the individual data-based properties. Examples include how much something is or which qualitative properties something has. As a consequence, a design space of multiple possible channels and marks exists. Evaluating those individual visual primitives (e.g., an area representing a number) in a specific context enables determining their effectiveness within a specific task (Mackinlay, 1986).

The implications of individual channel encodings within the context discussed here have been studied extensively. Early (Cleveland et al., 1984) as well as recent studies (Harrison et al., 2014; Heer and Bostock, 2010) have shown that a spatial position is the most effective way to map information within a two-dimensional space if the related task is aimed at reading or comparing individual attributes. However,

as to financial or, more specifically, pension information, multiple dimensions and various influencing factors exist. This therefore calls for careful justification of the visualization design process and the resulting encoding methods, and evaluation of the resulting artifact. For a visualization design to be efficient, it needs to help a user carry out a specific task (e.g., understanding and engagement with financial data), supported by visual means and interaction. Regarding pension data, several aspects need to be considered: the use of data visualization within the pension domain is new and, within this specific context, still not well understood. Especially if we look at the visual encoding of financial data towards a broader audience, that might include complex concepts, such as uncertainties or individual choices that will arise as a consequence of the pension reform (Westerhout, 2020).

A potential design space thus needs to be defined, developed, and evaluated. Before taking a closer look at individual examples in this field, we must first distinguish between two possible consumer intentions: 1) visually analyzing and/or exploring the data, and 2) presenting data for communication or reasoning purposes. Both appear similar at first glance, but on closer examination, they turn out to be fundamentally different approaches. While exploring data that aim at helping users to ask and answer the right questions (a common scenario for a domain expert), the presentation aims at communicating clearly defined facts (such as in an annual report). Depending on the intent of the user, different visual encodings and types of interaction might be necessary to archive an efficient human data interaction. Consequently, the user's intention needs to be considered when developing a system, as well as when evaluating novel or existing approaches. As both intentions are necessary in light of the new pension reform, a careful justification is needed to validate whether a method is suitable for both scenarios – which might be necessary in the years to come.

3.2 Information visualization and pension data

Visualization of financial data has a long-standing tradition, starting more than 200 years ago with the Scottish political economist William Playfair (Spence, 2006), and was initially developed to present findings to domain experts. Most of these methods were developed when visualization was still a handicraft and could only represent a limited amount of data, but they are still used today. A possible reason is that reading the charts became an integral part of every curriculum and was taught in schools. As a result, high visualization literacy for those methods exists within the financial domain and the general public, also relating to its application. Careful evaluation of related

effects on interpretation and decision-making is a more recent development and still relatively underexplored in the financial domain.

Dwyer et al. (2004) presented a 2.5D approach that utilized the third dimension to understand multiple dimensions in a temporal context. Looking at annual reports, a comprehensive design space has emerged in recent years. Rodriguez et al. (2016) present an overview of several combinations of further developed bar chart concepts such as fold-over stacks, directional waterfall, or position-folded bar charts, aimed at supporting specific tasks such as understanding quantitative changes over time or comparison tasks. However, the implications of these individual design choices on decision-making are not evaluated and validated.

Schroeder et al. (2020) went a step further, with their development and evaluation of a forced-based bee swarm plot within a comprehensive field study. They found out that the visualization and interaction approach can significantly enhance the decision-making of asset managers with pension data. Furthermore, they developed a novel way to manage pension data in mixed reality, using a Microsoft HoloLens. This involved utilization of the third dimension to encode the additional dimension of data quality to include reliability and uncertainty aspects in the visualization approach. However, the targeted audience for all of the above scenarios has a high level of domain literacy and, very likely, above-average visualization literacy. Looking at pension communication towards the general public, the field remains widely silent.

Hekken et al. (2019) made a first step toward understanding pensions through visual means by proposing the Dutch "pension metaphor." They assert that an incorrect view of pensions can be a mental model problem (as many people believe that their monthly payments are directly paid to pensioners) and try to fix this by mapping the concept of a navigation system. For instance, it connects "now" with the intended future while multiple incidents may occur on the way, such as a traffic jam leading to a delayed time of arrival of a navigation system. The work by Hekken et al. marks a relevant first step and shows that metaphors can help people better understand their pensions. However, to understand whether the proposed approach is optimal, or simply outperforms the text or a single image shown, calls for a comprehensive analysis of the design space in combination with empirical validation.

By suggesting the navigation system metaphor as a model image function, abundant attributes could be introduced to the concept, thereby distorting the newly created image. A navigation system involves choices to control the route and, for example, turning left or right, whereas the concept of uncertainties within pensions implies that something might happen throughout the course of accruing a pension,

without the consumer being able to exercise any control or having only limited control. Also, both options are communicated equally but might be perceived differently. Positive and negative outcomes are perceived differently, whereby negative information can distort the judgment of the expected positive outcome (Diamara, 2017; Kanouse, 1984).

Communicating information on the accrual of pensions is of vital importance to understand the concept of pensions. However, the metaphor primarily communicates possible consequences. Hekken et al. (2019) conclude that the majority of the Dutch population is not aware of the underlying processes. Therefore, it seems imperative to also pay more attention to the build-up phase within pension communication, whether visual or other.

Schroeder et al. (2022c) also developed and evaluated a metaphorical approach, with a stronger focus on understanding pensions as a whole, so that later pension payments are put into context. Here, they used a metaphor to communicate how monthly contributions by employer and employee, as well as the related investment amounts by the pension fund, lead to a growing savings pot that results in a monthly payment after retirement. The mental model in this case is related to the attributes of a tree that is watered (i.e., monthly payments) to grow over time and that later on bears fruit (i.e., monthly pension).

One of the rare examples of quantitative visualization within the field was proposed by Schroeder et al. (2022a). They utilized a dot-plot to combine quantitative visualization methods with storytelling and interaction to facilitate understanding within context. Finally, within the resulting interaction and design choices, visualization literacy (Börner et al., 2019; Locoro, 2021) must be considered carefully while the design space is evaluated. While past research focused on measuring financial literacy to determine whether the financial domain knowledge is sufficient to understand pensions, earlier research by Schroeder (2022a) also found that financial literacy does not need to correlate with pension literacy. This could be because the underlying metrics are quite old and might not cover the most elemental aspects of pension knowledge. Therefore, future researchers need to focus on more specific metrics, to validate that the intended target group has both the required pension as well as visualization literacy to understand the presented information in context. Both aspects need to be carefully aligned.

4. Pension communication applications of data-driven storytelling

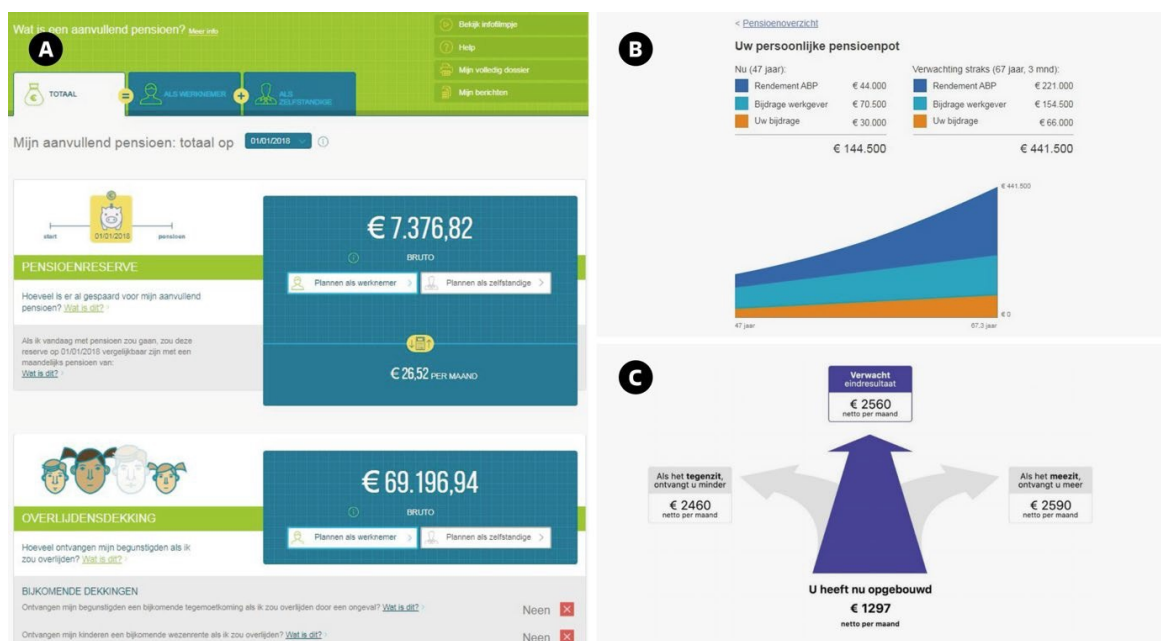
Next, we provide an overview of a potential visual design space for pension data-based information visualization. To better illustrate the individual dimensions, we discuss several concrete examples. First, we investigate the general approach to pension communication that is currently applied within Europe. It is built around widespread methods that open up digital access to customers based on existing content, and around standard visualization approaches with presumed high visualization literacy within the population. Second, we give an overview of concrete application cases that investigate novel approaches to visualized pension data in line with the latest data visualization insights.

Application case #1: The current status of pension communication

Many different tools are currently deployed to support prospective pension applicants in calculating their pensions. For instance, Nibud's *Pensioenschijf-van-vijf* tool calculates the pension amount that is required to cover the current living standard in old age. The Dutch government offers a tool (*mijnpensioenoverzicht*) that forecasts the expected pension outcome. Also, most pension funds provide calculation tools, such as *BrightPensioen*, that indicate expected pension benefits based on defined yearly or monthly contributions. However, what these tools have in common is that they require concrete and abstract numbers as input and provide as output, making it difficult for people in general, but particularly for less financially literate people, to draw conclusions and eventually take action regarding their pensions. A method that promises to be significantly more accessible and meaningful to most target groups, and thus to achieve the objective of engagement, involves pensions visualizations rather than abstract numbers as output.

The currently dominant approach that is geared towards increasing such engagement involves a text-based contextualization whereby a visualization is applied to illustrate heuristics (e.g., the prospective pension applicant's position in time within the pension saving period as illustrated in Figure 1a, or the cumulative savings as illustrated in Figure 1b). While high visualization literacy can be expected in the use of an area chart, the method primarily highlights the total area as a unit while the data itself is cumulative growth. In addition to the resulting possible misinterpretation of meaning content, several potential biases exist that can influence the interpretation of quantities (Correll, 2017; Newman, 2012). This applies especially in potential future scenarios where uncertainty plays a more prominent role.

Figure 1. Application case #1: The current status of pension communication

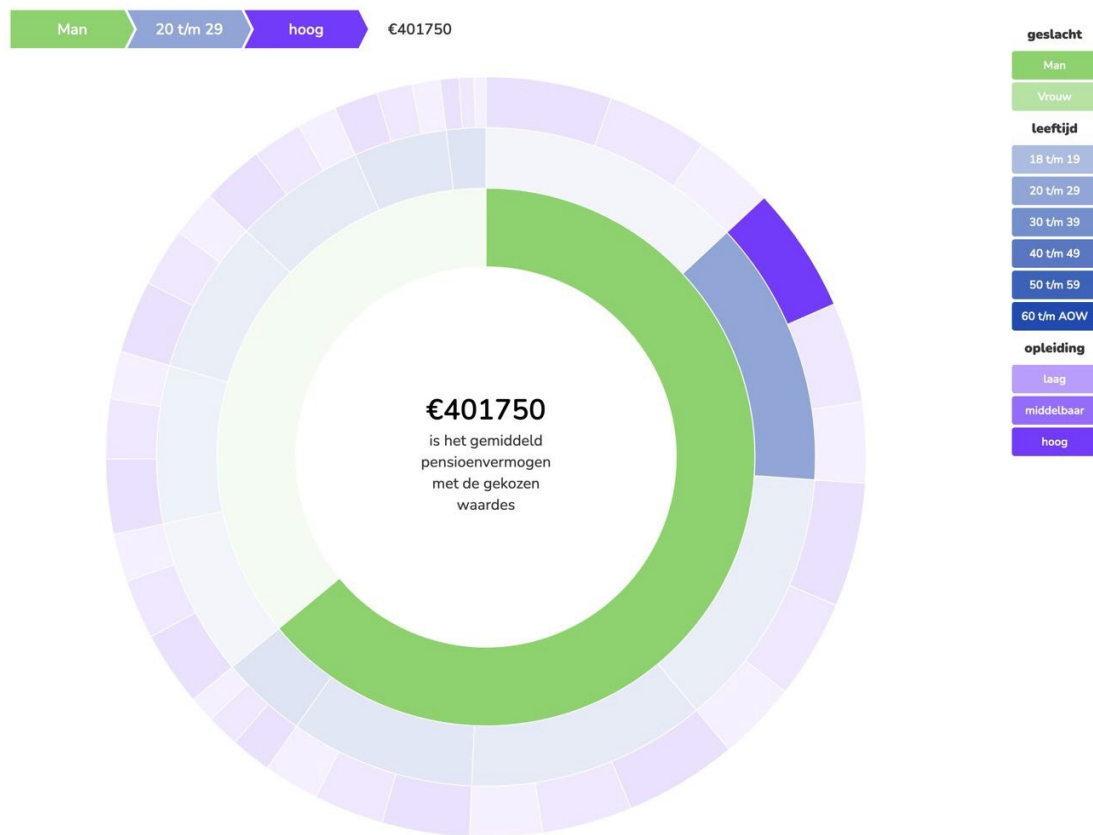


A new method occasionally used in the field is the pension metaphor (see Figure 1c). This was developed to increase the effectiveness of pension communication through a "navigation metaphor," utilizing arrows to illustrate projected future retirement income levels. The empirical study by Hekken et al. (2019) indicates that this metaphor outperforms purely visual and purely textual representations in terms of communication.

The approach unites two main purposes. First, the intent is to demonstrate to prospective pension applicants that pension savings can be accumulated in a variety of ways rather than solely by following the one golden path. Second, the visualization is meant to highlight the importance of starting to save on time (i.e., at an early age) for retirement. The visualization aims to achieve this purpose by showing a projection of savings over time, in different situations. The tool thus combines the different calculation tools discussed above in a single visualization. The purpose of the tool is not to serve as an end in itself, but rather as a means by which prospective pension applicants can be engaged and make better-informed decisions, thus to appeal to and trigger their thinking processes and to facilitate their engagement with additional sources and professional pension service providers.

While such approach marks a first step towards innovation to visualize pension information, as it shows that visualization methods can significantly enhance the understanding of pension information, the implementation itself still has some drawbacks. In particular, it lacks a critical and comprehensive analysis of the whole design space to assess whether the visualization method (and beyond this, the

Figure 2. Application case #2: Gamification elements in pension communication



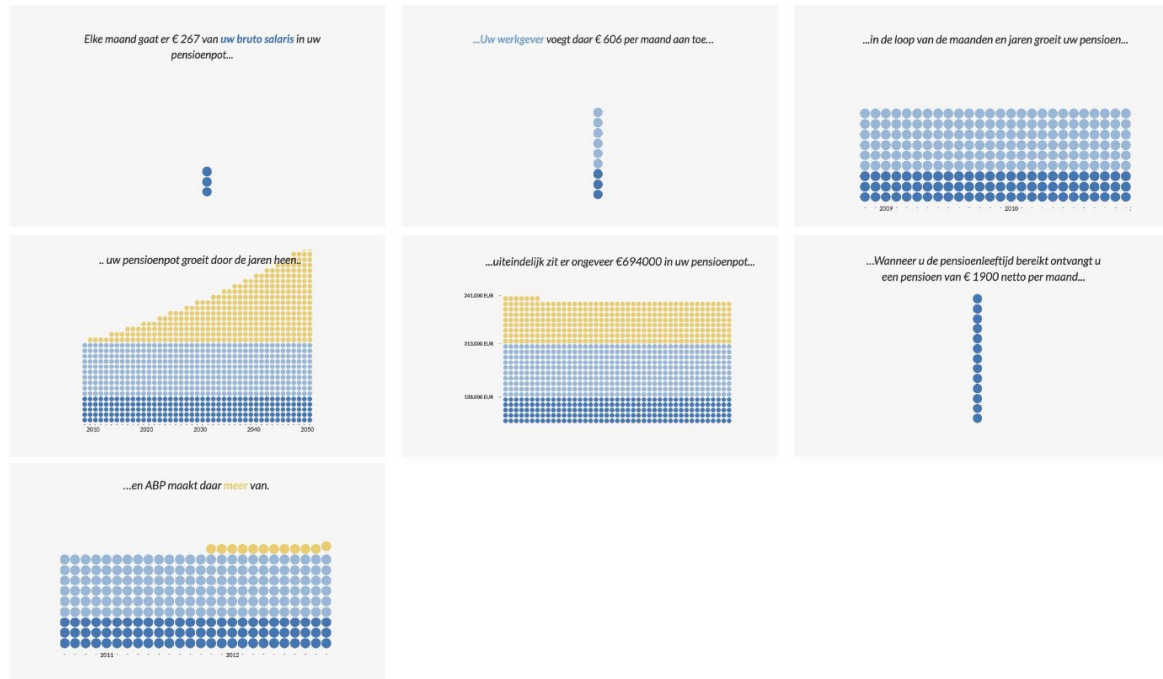
interaction method) is the most effective one within the given design space, and how other concepts, that are more complex than the projected incomes, can be presented.

Application case #2: Rethinking interaction with gamification to help increase engagement

Currently, when designing communication on pensions, professionals tend to use easy-to-understand words. Still, the topic of pension arouses little excitement in many prospective pension applicants. As a result, they do not engage with it. To encourage people and engage them more, integration of a gamification element bears promise.

Figure 2 visualizes data taken from Statistics Netherlands, including average accrued pension (gross per year), household wealth by age, and education level of the main breadwinner. This application case features a sunburst diagram, as this best links input choices with the corresponding result. This D3 visualization runs through a step-by-step procedure covering 1) gender, 2) starting age of saving, and 3) educational level, to arrive at the result of the average expected pension. The visualization

Figure 3. Application case #3: A narrative element in pension communication



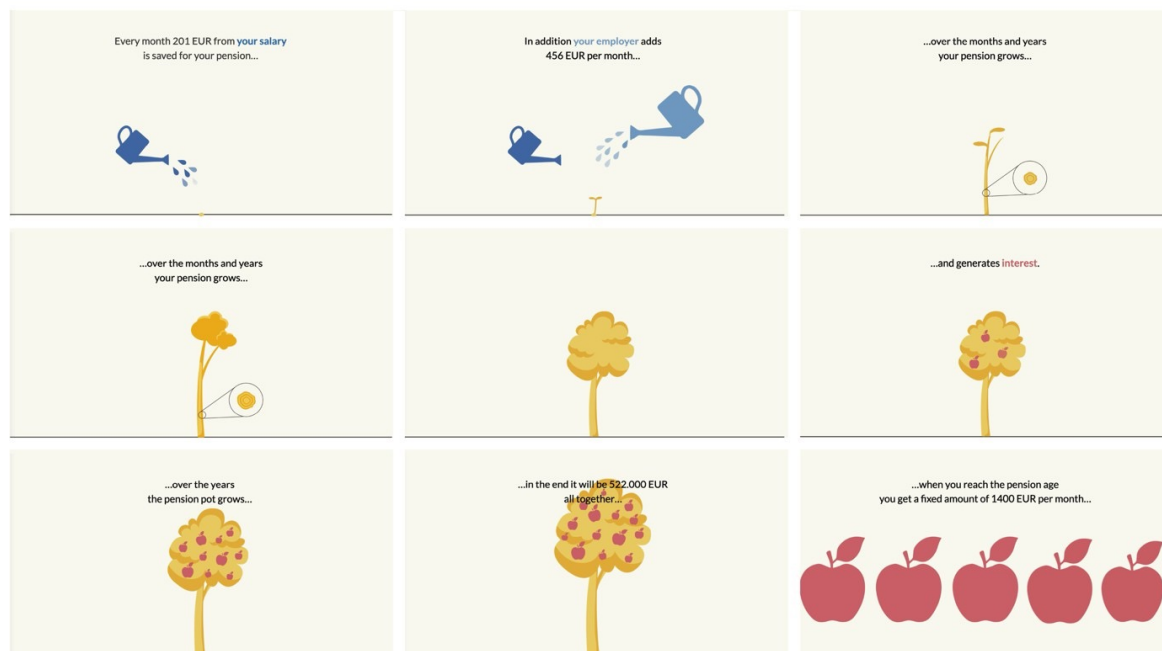
is supported by colors to better represent the split of categories. The intent of the visualization is to show the differences between the level of assets that are available to people in different age categories. Employing gamification elements, this feature is meant to encourage prospective pension applicants, especially younger people, to raise their awareness of different pension options. This visualization is furthermore to be integrated into a website, where prospective pension applicants may gather complementary information on the topic of pensions and thus encourage action.

Application case #3: A narrative element in pension communication

Moving beyond the gamification aspect, application case #3 aims to facilitate understanding of the pension saving process. This is illustrated in Figure 3. Using a tailor-made data story that considers income group and involves efficient narrative structuring, the visualization tells a simple story with a clear explanatory element that is especially catered to prospective pension applicants who have not yet fully grasped the pension concept. With simple visual language that is supported by descriptive text elements, a narrative of the pension concept is created. Colors are used to highlight the contributions by employer and employee, respectively, and the growth element of the pension contributions over time.

Figure 4. Application case #4: Using metaphors to help people understand the pension saving process

The Pension Metaphor Storyboard



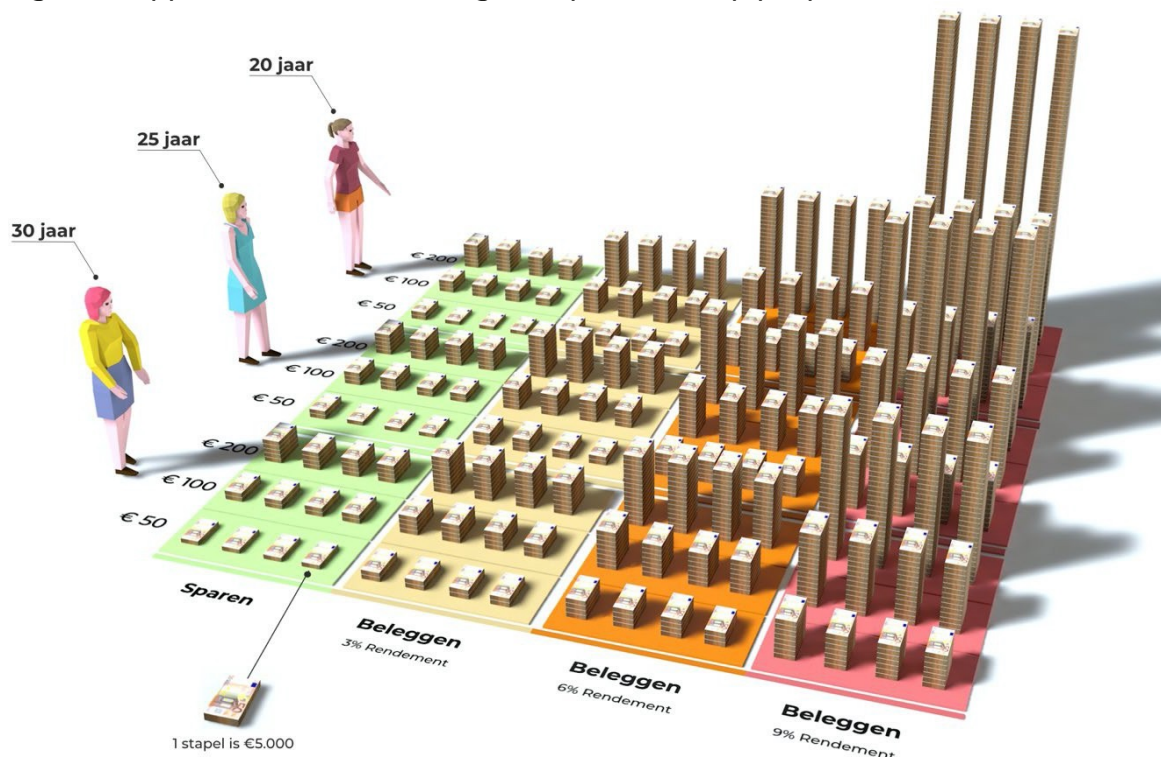
Application case #4: Using metaphors to help people understand the pension saving process

The fourth application case, represented in Figure 4, facilitates understanding by building on the narrative element from application 3 and combining it with a metaphor that is consistent with the pension concept. Step by step, a narrative is presented that employs the analogy of planting and watering a seed that grows with the owner's help (i.e., pension contributions) until it involves into a fully grown tree that can weather any storm (i.e., the accumulated pension potentially covers living costs). Over the years, the tree grows bigger and bigger, accumulating interest in the form of apples which together make up the ultimate pension. The narrative is explained by means of icons only. Text elements are kept to a minimum and only act as auxiliary elements to explain the pension concept.

Application case #5: Using metaphors to help people understand choices

The final visualization, in Figure 5, combines elements of several above-discussed application cases. Unlike case #4, it is not directed at explaining the process of pension saving. Instead, it goes a step further and attempts to visualize the implications of different choices that people make concerning their pension. This

Figure 5. Application case #5: Using metaphors to help people understand choices



aspect is of particular relevance for contexts in which people can influence their pension. Applying a metaphor-based, data-driven storytelling approach, it is built around visualizing financial independence. The underlying rationale is to cognitively engage prospective pension applicants in the early phase of their life to consider the requirements for financial independence at retirement age. The design facilitates financial planning for the future self and, based on a set of input variables, provides an indication of the number of years it will take to become financially independent. Linking to one's future self has been shown to influence a people to make decisions concerning saving earlier in life (e.g., Ersner-Hershfield et al., 2009) and could also provide a promising avenue in this context.

The design of application case #5 is built around engaging prospective pension applicants with their pension at an earlier age. The visualization aims to provide a wake-up call that counters the widespread phenomenon of procrastination when it comes to pension considerations (Beshears et al., 2013). The underlying basis for calculation is the Robeco investment tool, based on the starting age of investing, the monthly deposit, and the desired return rate. These are then all added to the data-sheet per age, per monthly contribution, and per calculated return.

The visualization tool has been integrated in the Cinema4D software tool. This software program enables the presentation of bar charts in three-dimensional space.

The resulting visualization displays three virtual persons of different ages (in this example 20, 25, and 30 years). For each person, three variations of monthly pension contributions are visualized (in this example 50, 100, and 200 euros per month). This design facilitates understanding the implications for retirement. Financial consequences are displayed in three-dimensional space, where one stack represents 5,000 euros. Especially the design element that compares to other situations is much more pronounced than in two-dimensional charts. As input for the design of the various risk-return characteristics, a commonly accepted color-coding scheme is relied upon: 0% return (not investing, green), 3% return (low risk, yellow), 6% return (average risk, orange), and 9% return (higher risk, red). The design provides a clear structure and emphasizes readability. Through its clear narrative and metaphor, paired with a game-like character, its novel perspective is expected to encourage people to prepare for their retirement.

5. Implications

This design paper addresses a key aspect of the current reforms of the Dutch pension system that focuses on pension participant activation, namely pension communication. Communication of the way the pension system functions and of the implications of the choices made by pension participants is of elementary importance, particularly for participants with low levels of education and low financial (or pension-related) literacy. A pervasive obstacle in pension communication is that traditional written documents are often disregarded and perceived as complex and difficult to understand. The human brain is much better equipped to process and remember visual rather than textual information (Potter et al., 2014). However, visual representation alone is not a panacea, and a crucial element within the field of data visualization is the integration of storytelling to support conveying of the message (Sax, 2006). The interested reader will find a conclusive overview of international engaging pension communication strategies is offered in the work by Brügger, Ponds, Augustus, Barrett, and Teichmann (2022).

So far, surprisingly little research has explored the use of data visualization, storytelling, and interactive design for pension communication. Still, there is a growing trend in utilizing visualization for pension information purposes (Cox, 2020; Lanotte, 2021; Schroeder et al., 2020; Schroeder, Ajdadilish and Caldero Valdez, 2020; Schroeder et al., 2022a; Schroeder et al., 2022b; Schroeder et al., 2022c; Van Hekken, 2019), and data from commercial DC pension scheme providers on, for example, augmented reality offer new possibilities for research (e.g., FT, 2019; New York Times, 2019). We have delineated the challenges of current pension communication and have developed and presented concrete alternative application cases that address some of today's shortcomings. From a data visualization perspective, there is ample room for improvement of communication with narrative elements that use appropriate metaphors to help pension participants to better understand the pension process and the implications of their choices. We want to encourage the entire pension community, including Netspar, to conduct empirical research that tests the effectiveness of such pension communication visualizations in real life.

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