Information visualization as an interactive business intelligence tool for improved management and self-assessment of financial brokers in private banking

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ABSTRACT

Tack vare den ständigt ökande lagringskapaciteten så strävar idag många organisationer efter att samla på sig så mycket data som möjligt om sin verksamhet. Denna data kan sedan aggregeras och visualiseras för att förbättra företagets strategi, vilket kallas Business Intelligence (BI). Idag känner en del verksamheter inte till den sanna potentialen av informationsvisualisering inom BI, däribland äldre banker.

Denna rapport är en experimentell, design-orientoerd forskningsstudie med syftet att utforska möjligheterna och utmaningarna med att designa en informationsvisualisering för att förbättra både management och själv-utvärdering av börsmäklare inom private banking, på en storskalig, svensk bank.

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ABSTRACT

With an increase in storage capacity, many organizations strive to collect as much data as possible. The data can then be aggregated and visualized in order to provide a strategic advantage, commonly referred to as Business Intelligence (BI). Several sectors are contemporarily unfamiliar with the full potential of BI visualizations, among them the financial sector.

In this report, an experimental design-oriented research study, set out to explore the affordances and challenges with designing an information visualization to improve both management and self-assessment of financial brokers in private banking at a large-scale bank.

To explore this area, a prototype was iteratively developed based on information gathered from interviews and evaluations on two private banking managers and a panel of UX professionals at the bank. The final prototype was then evaluated by the two managers and five of their financial brokers through a combination of a task analysis and semi-structured interviews. The results concluded that the proposed visualization improved several aspects for financial management including business overview and workload balancing. However, the proposed tool was not deemed useful in self-assessment terms as financial brokers’ performance is so largely dependent on the current market state.

ACM Classification Keywords
Information Visualization, Interaction, Business Intelligence, Business Process Management, Management, Private Banking, Transaction Data

1. INTRODUCTION

The past years’ rapid IT development has had a large impact on modern society. The amount of internet users is ever-increasing, and the data traffic is growing exponentially each year. Studies show that 90% of the world’s data was collected the previous 12 months alone as of 2016 [22]. In 2007, approximately 290 exabytes of data could be stored globally [21]. 11 years later, in 2018, approximately three times of that amount was generated each year [15]. A large amount of this data is collected by companies in order to gain a competitive advantage through data analysis. However, the gathered data is often far too extensive for the human cognition to parse directly. Instead, one can utilize the fact that humans perceive visual representations more efficiently than reading numbers or text. This form of data representation is referred to as information visualization.

One of the societal sectors which collect large amounts of data for performance analysis is the financial sector. Money and private economy is something that is highly regarded in modern society, and a good economy is something most people strive for. People who already have achieved this can purchase a banking service called private banking. This kind of service manages the high-net-worth individual’s assets to make them grow, and is partially done by allowing financial brokers to perform trades with the individual’s resources [32]. The trades are valuable both in terms of the bank’s reputation amongst their wealthiest customers, and the pure economical value itself. Because of this fact, the performance and management of the financial brokers are of great importance to the bank, hence much data is gathered for analysis. Traditionally this data is aggregated into static tables and charts. While this form of data representation does enable analysis to a certain extent, it might not be optimal for management and self-assessment of financial brokers. By developing an interactive information visualization one might be able to perform these kind of business processes in a more nuanced and effective manner.

1.1 Case Description

The business intelligence tool evaluated in this study was designed and developed for one of Sweden’s largest banks. The bank has had a yearly total operating income of tens of billions SEK the last five years, with around 40% of that generated from fee and commission income. A part
1.2 Research Question

This report is a design-oriented experimental research study which aimed to improve the management and self-assessment of financial brokers in private banking. This was done by developing an interactive prototype to assist both managers in their strategy and planning, and brokers in their self-assessment process. The prototype was designed iteratively, and finally evaluated by a set of expert users as well as a group of User Experience (UX) professionals. The study aimed to further the knowledge about how to efficiently and clearly visualize historic, financial transaction data interactively by creating a design artifact [18].

The research question was hence articulated:

What are the affordances and challenges with an information visualization for improvement of management and self-assessment of financial brokers in private banking?

1.3 Delimitations

The goal of the study was to solve certain management problems for a specific target group; expert users within the field of finance. The terminology and information types in the prototype was presumed to be familiar to the intended users. This is the only user group which has assessed the prototype. The prototype caught attention from other divisions within the bank and will be used by more departments, but it was solely designed for, and evaluated by, the active trading department. Even though similar visualizations might have a value in management in other fields, financial broker performance is the only area on which conclusions can be drawn.

The study did not have a primary aim to assess or compare existing management methodologies used at the department, instead it had the goal to deliver a tool to simplify data analysis processes that are currently tedious. However, some comments on the existing tools have to be made for a nuanced discussion of this goal.

2. BACKGROUND

This chapter will first present previous work on Business Intelligence and Business Process Management and its current state in the financial sector. This is followed by established theory regarding information visualization.

2.1 Business Intelligence and Business Process Management

Business Intelligence (BI) is a generic term for the strategies and technologies used by enterprises for data analysis of business information [13]. Business intelligence technologies often consist of either information visualization, machine learning, or a combination of both [11]. Their most common goal is to provide historical, current and predictive views of business operations and business strategy. The technologies have the ability to manage large quantities of data, help identify and develop new strategic business strategies. Functions of Business Intelligence typically include data mining, business performance management, predictive analysis and online analytical processing [38]. BI tools are preferably represented as information-dense visualizations with filtering (querying) functionalities, rather than having multiple visualization complete each other [11][13].

Business Process Management (BPM) is part of Business Intelligence, and is a discipline in operations management in which people use various methods to discover, model, analyze, measure, improve or optimize business processes [25]. Furthermore, the BPM Institute has defined the field as: “...the definition, improvement and management of a firm’s end-to-end enterprise business processes in order to achieve three outcomes crucial to a performance-based, customer-driven firm: 1) clarity on strategic direction, 2) alignment of the firm’s resources, and 3) increased discipline in daily operations” [16].

Process visualization is one of the core elements within BPM projects, and is often achieved by visually depicting how businesses conduct their operations [12]. Visualizations of business processes has increased in importance
and popularity in the 21st century [4]. The lack of interaction and navigation in BPM tools have been criticized in previous studies. This fact was also formulated in an expert interview as a part of the study Major Issues in Business Process Management: An Expert Perspective; “Some companies, they print out ‘wall-papers’. they are sitting in the middle of the room with glasses and take a look at the comprehension of business processes” [3].

BI and BPM tools have been stated to have a potential to largely improve management and control in the contemporary banking industry. The technology plays an important role in structuring data for optimal analysis, which is valuable as many banks face problems due to their large extent of unstructured data [37]. BI tools also aid providing a more complex view of the business than the easily accessible older methodologies commonly used, such as spreadsheet analysis, through historical context and quicker overview and filtering of the data. Many banks have licences to the large, established BI engines such as QlikView, but the engines are rarely used to their full potential as big data analytics is a fairly new field on business analysis [40][42].

2.2 Information Visualization

This section establishes the definition and design principles of information visualization, and the theory and design related guidelines on data variables.

2.2.1 Definition and Design Principles

In the paper Visualization for Human Perception, Stephen Few defines visualization as “the graphical display of abstract information for improved data analysis and communication”. Whereas tables of data can be efficient in providing information for some tasks, such as looking up the exact value in a certain coordinated cell, information visualization enables the user to draw more complex conclusions from the dataset through patterns, trends and exceptions [19][20]. This is due to humans’ cognitive ability of perceiving physical attributes, such as shapes, sizes and colors, better than abstract ones, such as numbers [41]. Despite this, it is not always enough that the dataset is transformed to a graphical representation. In order not to compress the dataset in the transformation, every numerical data point should be accessible in the visualization, which risks leading to a myriad of graphical representations of the data points. From a usability perspective, a too large quantity of information presented at the same time is confusing and repelling to the user [41]. This is the cause for Ben Shneiderman’s mantra on information visualization; “Overview first, zoom and filter, then details on demand”. The mantra is accomplished by presenting the information in layers instead of all at once. First the user is presented a compressed overview of the dataset. The user then gets the possibility to sort out information of their wish by filtering and/or zooming the overview. Lastly, the user should be able to reach the smaller parts of the chosen subsection of the dataset, such as metadata, through yet another interaction [39].

Despite this, following Shneiderman’s mantra is not enough for providing an efficient visualization. It is also of great importance to choose an appropriate visualization design in order to create an efficient and powerful visualization. Each dataset and desired conclusion requires different types of visualizations to maximize perception efficiency [41]. In her book Design for Information, Isabel Meirelles divides information visualization into six different structures, dependent on the chosen dataset; hierarchical, relational, temporal, spatial, spatio-temporal and textual structures [33].

As business intelligence technologies’ most common goal is to provide data in some kind of time related form (historical, current and/or predictive), the temporal structures of information visualization is the most frequently used in the field [38]. The temporal structures aim to display the performance of one or several indicators over a period of time. In its simplest, quickest graspable forms temporal structures take the shape of line graphs or bar charts [33].

2.2.1 Variables

The variation of visualizations in each category of structures is due to several reasons. The visualization should strive to fit the target user group in terms of design and usability [1]. Equally as important is the fact that the visualization should display the right amount and types of variables that are necessary to draw the desired conclusions. Essentially, there are three basic types of variables in information visualization; nominal, ordinal and quantitative variables [24]. A nominal variable is often defined as an unordered set. Nominal variables are sometimes also called categorical variables, as they are not part of a span - for instance titles or names. An ordinal variable, on the other hand, is defined as a tuple (an ordered set) with a fixed amount of elements, for example a rating system: 1, 2, 3, 4, 5. Lastly there are quantitative variables, which are a numerical range with an infinite amount of elements [7]. Furthermore, some of these variables can be altered through transformations, which sometimes can be convenient in information visualization. For instance, a quantitative variable can be transformed into an ordinal one by dividing the quantitative into ranges; 0, 60 minutes short, medium, long. This transformation is called “classing” as it categorizes the range into different subclasses. The transformation creates an accessible summary of the data, but
it also compresses the information about the location in the range [23].

In information visualization, different types of variables are optimally displayed as different kinds of retinal variables. The term retinal variables, also called visual variables, was coined by Jacques Bertin in his book Semiology of Graphics in 1967. Bertin’s original set of retinal variables were position, size, shape, value, color hue, orientation and texture [5][10]. Generally, visualizations tend to display its quantitative variables through positions or sizes, while projecting its nominal variables as the categorical retinal values, such as shapes or colors. Even if it is sometimes possible to map the variables in another way, such as mapping quantitative variables on a gradient of two colors, but it is not recommended as it often makes the visualization less clear [24][36].

The set of retinal variables has been expanded by other researchers since Bertin’s 1967 composition, amongst them Alan MacEachren, who introduced transparency and resolution to the set [30]. He did this as he was exploring and defining “uncertainty visualization” - a topic that aims to handle and display the uncertainty of some information visualization systems. Visualization research has often overlooked the errors and uncertainty which accompany the scientific process and describe key characteristics used to fully understand the data [8]. Most visualizations seem to lack indications of the uncertainty factor, which can lead to misinterpretations and bad usability. This has made it essential to indicate the level of uncertainty on every data point that is uncertain in any way, like estimates or similar. The level of uncertainty is often regarded as either ordinal or quantitative, and is encouraged to be visualized through MacEachren’s retinal variables; transparency and/or resolution [26][27][28][31].

It becomes clear that the theory of information visualization is one of the key components of a successful BI tool. By creating an information-dense information visualization with good overview and filtering one could potentially aid banks to adopt BI methodology in management and self-enhancement of financial brokers.

3. METHOD

This chapter will present the development process of the prototype and the scientific methodology used in the study. The process can be viewed in Figure 1. Each arrow in this figure represents the design and development based on the result of the previous stage.

3.1 Iterative Design Process

The iterative development process and design decisions were based on a heuristic panel analysis, and multiple interviews with one of the target groups; the Head of Active Trading (henceforth named HoAT) and the Administration Manager of Stock Trading (AMoST). The choice to perform both a heuristic evaluation and user studies was due to the fact that the two have been proven to work superiorly in combination rather than competition, when evaluating usability [6][14].

The fact that the managers were clear during the interviews that they had a good view of what would be useful to the brokers and not, a decision of not involving the brokers until the final evaluation was made. Instead, multiple questions about the brokers’ interests were asked to the managers during the interviews.

When performing qualitative research semi- and unstructured interviews are the most widely used methods [17]. As the purpose of the interviews was to evaluate certain aspects while still allowing the participant to speak freely about them, all interviews had a semi-structured character. According to Steinar Kvale, a successful interviewer is knowledgeable, sensitive, open and structured [29]. The interviews were held with these guidelines in mind with the ambition of collecting as honest and clear results as possible.

All interviews and evaluations were audio recorded and transcribed.

3.1.1 First Iteration Development

At the initial stage of the study a semi-structured interview with AMoST was conducted, hereby referred to as "pre-interview", in order to obtain a better view of the problem at hand. The interview had a focus on both management and broker self-assessment.

A first iteration prototype was developed, further described in 4.1.2.

This prototype was evaluated in two evaluations which hereby will be referred to as the mid-evaluations. These evaluations were conducted on the administrative part of the target group, namely HoAT and AMoST. First, the prototype was presented to each of the managers.
Feedback was then gathered together with information from a semi-structured interview. Some additions and improvements were decided based on the result of the mid-design evaluations. These were applied during the second design iteration.

3.1.2 Second Iteration Development

After having implemented additions and improvements based on feedback from the first iteration cycle, a second iteration prototype was ready to be evaluated. Before conducting the final evaluation of the target group it was heuristically analyzed by a panel of financial UX professionals. This analysis was conducted in order to secure the usability of the tool before the last evaluation so that the result of that evaluation would be more oriented towards the actual functionality. The panel analyzed the visualization based on Jakob Nielsen’s well-established ten heuristics [34].

3.2 Final Evaluation

In contrast to the previous evaluations, the final evaluations aimed primarily to evaluate whether the developed BI tool was appreciated in the terms of the research question, instead of gathering feedback for further development. The final evaluations were held on the two target groups, and were conducted based on a combination of task analysis and semi-structured interviews [2]. Both the questions in the interviews and the tasks in the task analysis were adapted to the target groups based on their different approaches of usage. The task analysis was based on twelve tasks for managers and eleven tasks for brokers. The tasks represented typical questions commonly encountered in the target groups’ work environment that the prototype was meant to be able to answer.

As AMoST and HoAT are the only management users at the department, they were deemed sufficient for a fair evaluation of what the management users need. In order to represent the group of financial brokers a few more representatives were needed however. According to Thomas K. Landauer and Jakob Nielsen it is enough to have five participants in order to find about 80% of all usability problems in the prototype, given that the evaluation is formed in a good way, hence five brokers were evaluated [35].

4. DESIGN PROCESS

This chapter will present the design process of the prototype. The first and second iteration development is described, where results from the continuous interviews and evaluations are presented along with design motives. Lastly the final evaluation is described in greater detail.

4.1 First Iteration Development

This section aims to present the first stage of the design process. The design decisions of the first iteration prototype is described based on the results of the pre-interview. Lastly the results of the mid-evaluations are stated. The handled design process clauses are displayed in Figure 2.

![Figure 2](Image)

Figure 2. An overview of the design/evaluation stages handled in 4.1.

4.1.1 Pre-Interview

Before the prototype was designed, an interview with AMoST was held.

According to AMoST the current BI tool used at the department is "very simple" and "static". The generated reports are printed on paper and put up on the office wall for the staff to analyze if they wish.

The interview provided insight into which feature AMoST considered to be useful in an interactive BI tool, from a management standpoint. These aspects can be summarized as:

- Transactional performance - the amount and frequency of orders over time
- Ability to spot time related trends and abnormalities in the transaction data
- Individual transactional performance

These three stated core aspects were deemed relevant for both target groups by AMoST. However, the latter of these should differ between the two target groups as the managers should be able to browse every broker individually while the individual broker should only be able to see their own performance.

4.1.2 First Iteration Prototype

With the information from the interview in mind, a first iteration prototype was designed and then developed. The prototype was integrated in the target groups’ native trading site, hence built using web technologies. As soon as the lo-fi prototype was designed, the backend development of the tool began. A client was built using React and Redux which fetched the data from several backend-services written in .NET Core 2.2. The data was then visualized in the client using D3.js v4. D3.js is a JavaScript library commonly used in modern web-based visualization tools, and is oriented around generation of Scalable Vector Graphic (SVG) elements. The library efficiently renders up to approximately one thousand visualized elements, which
were presumed to be more than enough for the first iteration prototype [9].

From the pre-interview it became obvious that a temporal structures-oriented visualization [33] would be optimal to fit the target groups' needs. The variables time, order quantity and broker were set as the first essential variables. As two of the variables were quantitative (time and amount) and one nominal (broker), a bar chart was chosen to visualize the order data. Since orders are always made one at the time, two orders can almost impossibly be made at the exact same time on the quantitative time scale. A histogram was created, so that the order timestamps could be gathered and quantitated. Henceforth the time span of the whole view will be called time span, and the sub-time spans contained by each bar will be called time step.

Before starting developing the prototype, an analysis of the other order related data in the multiple database tables was made. If some other variables were likely to be deemed helpful in the future, the design decision of a histogram might have become suboptimal. After the analysis it was stated that most other potential relevant variables were nominal (categorical) - a structure that tends to scale well with bar charts [33]. With that in mind, the development of the first iteration prototype started. The result can be viewed in Figure 3.

![Figure 3. First Iteration Prototype displaying all transactions during the week 41, 2018. The y-value represents the amount of transactions during each time step. Each day is represented with two time steps, morning and noon. Solely based on test data.](image)

The visualization defaults to displaying today's transactions for the two whole offices. In this view the histogram bins hold timestamps from a 30 minute-interval. The user then has the possibility to either choose another day by using a date picker (at the top right corner of the tool), or choose to view another timespan through the button group placed at the bottom of the tool. The one-day view displays time steps of 30 minute intervals, the week-view half-day intervals, and the rest of the time spans show one-week intervals. Each of these time spans are compatible with the date picker, which enables the user to for instance choose another year or set of three months to view.

In order to make the interaction more seamless, the tool also allows the user to filter the data through more interaction forms. To look further into a cluster of bars, the user can either zoom in on them, or click on them to choose it's time span. Each bar’s time step is revealed on hover, as chosen in Figure 3. For example in a view that depicts 12 months’ worth of data, each bar represents a week. Uses can click on a bar to change the time span to that particular week. From the week view, the user can continue filtering data by clicking the bars and decreasing the time spans down to the day view.

A similar visualization for the individual broker was also developed. This tool was identical to the other tool, but it only displayed transaction of the logged in broker, as AMoST did not think the brokers should be able to see any other performance except his/her own. This way it was meant that the broker could browse through his/her order history to get to know his/her own trading trends better. The same view was also enabled for the managers, but with the addition of a search field for employee ID:s/ names. This way the managers could browse every broker’s individual performance, while the brokers only was presented with their own transaction history.

4.1.3 Mid-Design Evaluations

The purpose of the first prototype was to test whether the histogram design and interactions were sufficient in performing the desired task for the target group. Multiple additions to the prototype were already thought of, but before implementing them it was valuable to evaluate if the base of the design was satisfactory.

From the mid-design evaluation some further functional aspects were gathered from both managers. These aspects can be aggregated as the following:

- Filter data on Gothenburg/Stockholm office
- Details on demand when the filtering has been applied
- Historical analyzation of the presented transaction data

When asked about the tool for the individual brokers, the two managers had split opinions. HoAT did think the tool would yield self-assessment opportunities to the brokers, but unlike AMoST he did not think they would use it
so much. HoAT argued that they already know through “gut feeling” how their individual trends look and why they are. However, he thought that it would still be interesting to let the brokers evaluate the tool and tell for themselves.

4.2 Second Iteration Development

This section aims to present the second stage of the design process. The design decisions of the second iteration prototype is described based on the results of the mid-evaluations. Lastly the results of the heuristic analysis are stated. The handled design process clauses are displayed in Figure 4.

4.2.1 Second Iteration Prototype

After multiple points of improvements were articulated during the mid-design evaluation, an upgraded design of the BPM tool was made. This section will display the second iteration prototype and provide further details on a selection of the design decisions.

4.2.1.1 Split Offices

Comparing the two offices was enabled using mirrored bars. Having the bars mirrored lets the user compare the offices’ differences at each time step with ease, while still being able to see a continuous representation of the individual office’s performance over time. The functionality can be toggled through a button which is visible at every time span. The tool defaults to viewing both office’s merged performance, however if the button is pressed each bar is split in two (given that the time step contains orders from both offices) in a smooth transition. The result of the visualization with the office split enabled can be seen in Figure 5.

4.2.1.2 History Average & Uncertainty Visualization

The concept of displaying the history average would become the main improvement of the prototype, and play a key role in the tool as a whole. The idea was to not only show the current transaction data in each time span, but also the history average of that very time span. For instance, if the user would browse the past 12 months and enable the history average, he/she would also see the average performance on each time step. This was made in order to enable the user to compare abnormalities and trends in the current data to the history average. The functionality was designed in order to aid the users to detect abnormalities that not only differs to adjacent time steps, but also in a simple way spot if this abnormality usually occurs at that given time each year.

Since the averages should be usable in combination with the office filter a form of stacked bars was used to visualize the history average. The bars were not stacked in the traditional sense however. On each time step the actual data was rendered as usual. If the history average was larger than the actual data, a bar overneath the actual data would be rendered in red. Similarly, if the average was lower than the actual data the difference between average and actual data would be rendered in green. The concept was combined with MacEachren’s uncertainty visualization, i.e the less samples that made out the average, the less reliable the average would be, which in turn should be communicated to the user. The amount of average samples was counted for each render, and that number then decided the transparency of the color representing the average, according to MacEachren’s retinal variable of uncertainty. This way the user would be able to tell how reliable the history average is for each time span. The implementation can be seen in Figure 7.

When viewing the 12 month view the user also got the opportunity to enable a future prognosis for the three upcoming months through an uncertainty visualization. This prognosis was made by rendering the history average of the coming three months. The bars representing the future months were rendered in grey, with the same factor of transparency as the comparison average bars.
4.2.1.3 Details on Demand

Based on AMoST’s feedback on filtering and details on demand, a solution was implemented. When the user is viewing the day view and hovers a bar, they are presented with a list of timestamps with corresponding broker and the ordered instrument name. The list is ordered on descending timestamps. The result of this can be seen in Figure 6.

![Figure 6. Final Prototype, hovering the 16:30-17:00 time step and viewing its order details. Solely based on test data.](image)

4.2.2 Heuristic Evaluation

The heuristic evaluation was performed by a UX panel from the bank, consisting of two junior and two senior UX designers. The panel is an internal bank resource, which aims to secure the bank’s interfaces and its user experiences.

Overall the UX panel approved the usability and user flow of the BI tool. The experts found the representation of the history average to be confusing. They did not think that it was clear to have the positive (transparent green) difference of history and actual data on top, as it in combination with the negative (transparent red) difference made it look like the bar on the top was an average when in fact it was the positive difference. The panel suggested to have the transparent green represent the average and place it as the bottom bars, and to display the difference with the standard green, leaving the total height of these two bars representing the actual amount of orders. This way the difference would always be represented by the transparent green. The proposed improvement was implemented for the final prototype, together with a legend for clarifications on what the transparent colors represent. The final result can be seen in Figure 7.

![Figure 7. Final Prototype with the improved visualization of history average. Solely based on test data.](image)

4.3 Final Evaluation

The final evaluation consisted of a task analysis which was followed by a semi-structured interview. The interviews aimed to collect information on the different impressions of the prototype, both in a pure functional sense as well as from a usability perspective.

![Figure 8. An overview of the design/evaluation stages handled in 4.3.](image)

The task analysis was designed to evaluate four different functionalities for the managers; Overview & Filtering, Details on Demand, History Average & Uncertainty Visualization, and lastly Individual Broker Performance. The latter of these was not evaluated on the five financial brokers as they would not use that functionality. The aim of each category of tasks and its questions are further described below.

4.3.1 Overview & Filtering

The tasks for testing the overview and filtering were the same for both groups. The purpose of these tasks was to establish how the user interprets the visualized data, first aggregated and later when navigating their way to shorter, more detailed time spans. This set of tasks were also supposed to detect potential problems with the user flow in filtering the data, both when filtering time and offices. The tasks were formulated as follows:

- Is there any week in the last year which had the exact same amount of orders as week 48, 2018?
- Which day had the largest difference in orders over morning/noon during week 48, 2018?
- What was the time with most order activity this day?
• Was there any time this day that the Gothenburg office made far less orders than the Stockholm office?

4.3.2 Details on Demand

Details on demand was important to evaluate in order to see how clearly the data nodes were presented once filtered. These tasks were designed to see how the users perceived the order details data on the day view. The tasks were formulated as follows:
• Who made the most orders during 13.00-13.30 on November 13th, 2018?
• Which instrument was the most popular during these 30 minutes?

The brokers were only asked the latter of these, as they were only presented with their own performance in contrast to the managers who could see the whole office’s performance.

4.3.3 History Average & Uncertainty Visualization

This set of tasks were designed to determine the usefulness of the uncertainty visualized history average. The functionality included both future prognosis and past data monitoring comparison. Both managers and brokers were presented with the average of the whole office. The tasks were formulated as follows:
• Were the orders higher or lower than average during week 2, 2019? How much higher/lower?
• Name a week of unusually low activity during the last 12 months.
• How does July 2019 seem to come to perform in comparison with the current month (April, 2019)?
• How does the upcoming summer month seem to differ between Gothenburg and Stockholm in terms of order activity?
• How reliable does this estimate seem?

4.3.4 Individual Broker Performance

This task was only performed by the managers. It was meant to test how well the managers could perform a task similar to the ones above, but on only one broker (Person X) instead of the whole office. The comprehension of other factors had already been evaluated by previous tasks. The task was formulated as follows:
• Name the instrument that Person X made the most orders on on 27/9, 2018.

5. RESULT

This chapter will present the results of the final evaluation. Relevant data collected during the task analysis is displayed, categorized into Overview & Filtering, Details on Demand, History Average & Uncertainty Visualization and lastly Individual Broker Performance. Thereafter the general impressions of the prototype collected from the interviews are presented.

5.1 Tasks

This section will display the results of the aforementioned four categories of tasks respectively; Overview & Filtering, Details on Demand, History Average & Uncertainty Visualization, and Individual Broker Performance as stated in 4.3.1 - 4.3.4.

5.1.1 Overview & Filtering

The tasks regarding general overview and time filtering were handled with ease by all participants of both target groups. Every participant navigated their way through different time spans by using both the button group in the bottom, and by clicking the bar desired to inspect further. Three participants spontaneously called the filtering process “intuitive” when performing the filtering tasks.

Whilst most participants completed the office filtering task without a problem, some did find the representation confusing. One participant who found and used the button to split the offices up quickly had problems to draw conclusions about the Gothenburg office. This participant’s spontaneous perception was that the down-directed Gothenburg bars represented negative numbers. After some further analysis he saw the positive numbers on the down-directed y-axis and completed the task however. This participant commented that he found that design decision logical after finding out how it worked.

5.1.2 Details on Demand

All participants were able to complete the tasks quickly and precisely. One of the managers got his first task prolonged as he first thought that the transaction details list was ordered on broker activity and not time. As soon as he saw a name occurring twice he noticed the actual ordering of the list, and corrected his answer.

One manager and two brokers expressly commented the unique color-tagging of the instrument types, and that this fact made them complete the task quickly.

One broker drew the false conclusion that the most common instrument type during the most active 30 minutes was the instrument that was most ordered that day. This participant did not realize the problem with that conclusion until informed about it.

5.1.3 History Average & Uncertainty Visualization

The history average was the most popular feature but also the most confusing for the users. Four participants completed the first two tasks by comparing a bar to it’s adjacent ones instead of analyzing it’s stacked bar. Two of
these participants realized the use of the history average for these tasks quickly after they used the adjacent ones, the two other did however not. When trying to analyze the average they analyzed the perceived average of the nearest time steps (weeks) instead of looking at the average based on multiple years of data.

Every participant was able to grasp the concept of toggling a prognosis of the future three months without any problem. This feature was also precisely used in combination with the office split. The participant who previously had problems comprehending the Gothenburg bars solved this office-related task quickly.

Overall the uncertainty visualization seemed to be easily perceived by the participants. When answering the last question in this category, many compared the current average transparency to the one they had previously seen in the tool, and could in this case tell that the average seemed to be less reliable because of its [perceived] hue. One participant had problems telling the green and red averages apart when the transparency was low due to his colorblindness. This participant however commented that he was able to tell the difference between them as the darker green was over the [perceived] grey bars when being over average, and under them when being under average.

5.1.4 Individual Broker Performance

Both managers found the separate view of the individual broker visualization quickly. One of the managers searched for the broker’s employee ID while the other used the last name to get the desired search suggestion. From there both expressed that the process was easy as they had performed similar tasks previously. Both searched for the broker, chose the 12 month time span and filtered their way down to the desired day and answered the question correctly.

5.2 Impressions

During the task analysis and interviews, some points were frequently mentioned by most participants. In order to provide a more comprehensible view of these points, they are plotted in Table 1.

The grid displays the seven participants’ opinions on the frequently mentioned points, where numbers 1-2 are the managers (brown) and numbers 3-7 are financial brokers (blue). Most of these points were mentioned when speaking freely about the tool, while some were induced through the interview questions, e.g what the users found unclear, and whether or not they use QlikView. Individual findings that were not mentioned as frequently is not represented in the grid, instead it is mentioned in the following text.

Table 1. Grid representing the six most frequently mentioned points during the task analysis and semi-structured interviews. The two brown columns represent managers’ feedback while the blue represent the brokers’.

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<td>History average unclear</td>
<td>Good overview</td>
<td>Great idea</td>
<td>Good user flow</td>
<td>Would use</td>
<td>Uses QlikView</td>
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The vast majority of the participants stated that the data was clearly visualized with a good overview.

Both managers and one broker expressed that the idea behind the visualization was great for their own usage. When asked if the participant would use the tool both of the managers said they definitely would, while four out of five brokers said they would not. Most of the brokers said that they did appreciate the tool for its looks and its management values, but were fairly certain that they would not gain any self-assessment values from using it, and therefore found it uninteresting to use. According to these brokers, it is useless to compare oneself to an average on an individual level - never mind which average - since all previous orders are based on the global market’s state at the time. Most brokers that pointed this out also stressed the fact that managers’ overview of performance averages is not as dependent on the market state. This was also strengthened by the managers themselves; they are aware of the current market state and would be capable of using the visualization in management, regardless of the market state.

The two managers both stated that they appreciated the uncertainty-visualized history average and individual broker performance function the most. While both managers established the monitoring value of the tool in general, the enabling of strategy planning and human resource evaluation was the most appreciated aspects from a management standpoint. The possibility to search for a broker and compare him/her to the office average performance was something both managers found very useful for browsing the workload of their employees.

Three brokers stated that while the visualization might not be useful in their everyday job, it could be valuable for monitoring their performance and using in salary discussions.

One broker said that he would certainly use the visualization. This broker motivated this statement with “I have
a more scientific and measurable approach to my work than most other brokers. I cannot get my head around that so few are self-assessing themselves in this line of work".

Furthermore he stated that he knows a few who try to monitor similar data manually for themselves, but that they are a clear minority.

As seen in Table 1, none of the brokers claimed that they were using the daily QlikView reports. One manager claimed to use the QlikView reports daily. The other stated that he was using it very rarely. Four of the brokers who did not use QlikView stated that they did not because of the same reason as they were not likely to use the developed BI tool. Two brokers and the manager who did not use the reports expressed that they did not enjoy the static representation of the data in the QlikView report.

One manager and one broker expressed that they had problems with quickly understanding the visualization of the history average, but that they could get used to it.

During the semi-structured interview, one manager stated “This opens up for analysis much more easily than just browsing tables”. However, both managers stressed the fact that this kind of tool should include visualization of other sets of variables as well, such as stock- and customer behavior-ones, in order to improve management processes further.

6. DISCUSSION

The goal of this paper was to analyze the affordances and challenges with an information visualization for improvement of management and self-assessment of financial brokers in private banking. The research question served as a guideline for the implementation and design of a BPM visualization for both financial brokers and their managers in private banking. This chapter will discuss the results of the study from a design- and functional perspective. Furthermore, it will review the chosen methodology used in the study, as well as propose future solutions to the established problems.

The most obvious trend of the result was the fact that the satisfaction of the concept differed greatly between the two target groups; managers appreciated the visualization a lot, while the group of brokers were more sceptic. As it turns out, while the brokers to a large extent analyze the market state and their customers interests, most of the broker participants do not self-assess their own trades at all. Hence, identifying the challenges with an information visualization for improvement of self-assessment of financial brokers is not tedious; there are no challenges as they generally do not self-assess their work. To quote one of the sceptic brokers; "Sure, I can state my transaction trends with ease [using the prototype], but how should I use that information? The market state is not going to change because of that. You live in the present as a broker". While HoAT did mention this during the mid-evaluation, he also advocated to let the brokers test the tool and tell for themselves. In hindsight, this is something that definitely should have been done, which will be further discussed in 6.1.

However, as previously stated the managers did value the prototype a lot. The design was confirmed to provide good overview and filter the data in an efficient and relevant way.

From a corporate standpoint, both HoAT and AMoST found the future average view to be useful for strategy planning. Even though the future average was fairly simply calculated, the managers said that it gave a quick comprehension of how the future might look. This in turn would give them a strategic advantage in distribution of workload. In the same manner HoAT saw great potential in the individual broker view, as it would let him evaluate which employees are under the largest workload. As the brokerage differ between customers, the broker with the highest generated income might not be the one with the largest amount of trades (workload). As the managers generally look at brokerage today, HoAT stressed the fact that the individual broker functionality could provide a more nuanced view of the workload of his employees. This is of interest from a management point of view due to several factors, such as scheduling, employee assessment and salary decisions.

In the managers’ everyday work both said that they would use the daily and yearly view the most, as these time spans are what they usually browse today. The other time spans are usually only analyzed on the tertial business meetings. For these meetings some manual work in data aggregation has been required. AMoST pointed out that the developed prototype’s time spans would reduce the preparation work for these meetings, not to mention the improved overview and detail that could be utilized during the actual meeting.

The results of the user flow and design were positive in general. Even though the brokers generally did not see any use for themselves, they also found the different interactions to be clear and efficient. The retro interactions (buttons and date pickers) seemed to be harder to understand than the more uncommon interaction forms such as bar-clicking, zooming and hovering, which was surprising. Furthermore, the fairly simple method of having a dynamic transparency dependent on the amount of samples the average was made of seemed to be comprehended correctly. One aspect that was not thought of before the final evaluation was that this method of uncertainty visualization does not work well for color blind users.
The proposed solution was proven to improve management of financial brokers in private banking. Just like Bandara et. al. stated, “Some companies, they print out ‘wall-papers’...they are sitting in the middle of the room with glasses and take a look at the comprehension of business processes”. The method of aggregating data onto static pieces of papers for analysis indeed seems to be an issue business process management. This study has proposed a design which can aid solve this issue through interactive information visualization.

6.1 Method Criticism

As previously mentioned, the lack of broker interest could have been discovered earlier if the financial brokers had been included in the design process’ earliest stage; the pre-interview. Despite the fact that one could argue that the managers should know exactly what their employees need and do not need, it would have been better to gather direct information from the specific target group. This way, the risk of collecting information about how the managers think that the brokers should be working and comprehending it as the actual way of working would be minimized.

Furthermore, more information could have been collected on financial brokers’ way of working before stating the research question in the first place.

Even though the design was generally appreciated, it did have some flaws. The stacked-bars approach of the history average was unclear to some users, which could have affected the participants’ perception of that functionality to the worse. Hence most participants seemed to be more impressed by the future average, which was not stacked as it did not have any current value to compare to. This fact partly confirms that the future average functionality is appreciated within management, but also that the ordinary history average potentially could have been visualized more clearly.

6.2 Future Work

6.2.1 Development

During the final evaluation, several concepts that would improve the prototype were discovered. There are lots of changes that could be implemented to make the presented BPM tool more useful. Smaller fixes include using another retinal variable for the uncertainty visualization that is more easily comprehended by color blinds in order to achieve a more including design. Furthermore, it became clear from the final evaluation that enabling the user to change the sample time spans for the history average would improve the tool’s strategic value.

There are also some larger changes that could be implemented to improve the tool. Firstly, despite the fact that most users eventually got confident using the history average, it could be visualized using another method than stacked bars to decrease confusion. Secondly, the managers stressed the fact that while the tool is very useful, it needs to be completed with several other sources of information to enhance its management value further. These sources of information include stock- and customer behavior, which could be visualized and used in combination with the developed prototype.

6.2.2 Research

As stated in 1.3, the study was oriented around private banking. Hence, the conclusions can only be drawn on management concerning financial broker’s transaction performance. However, as the tool was proven to be successful from a management standpoint, it would be interesting to see studies on how well a similar tool can perform in other fields than finance.

It would also be interesting to extract the broker target group and investigate how visualizations can improve their way of working on an individual level. During the final evaluation, one broker stated that “[...] it’s like financial brokers in general are stuck in the 1980s [...]” when discussing their standard way of working. Surely, some kind of BI visualization could aid the way of working to modernize, though not through the visualization in this study.

7. CONCLUSION

This was a design-oriented experimental research study, which aimed to improve the management and self-assessment of financial brokers in private banking through developing an interactive BI tool.

The explored subject is valuable, and the design presented with the prototype was positively received by all users. However, the concept of the prototype was only approved by the management users as the financial brokers rarely self-assess themselves due to their dependency on the global market state.

As the thesis is an experimental research study, there are many potential improvements to the prototype. These include uncertainty-visualization tweaks and completing BI visualizations for other categories of variables, such as stock- and customer behavior. Even though the tool would be more effective with these aspects implemented, most design decisions had merit which leads to believe a further developed tool would make management of financial brokers simplified.
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