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REPORTING DESIGN – A SYSTEMATIC LITERATURE REVIEW

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Abstract*. Due to the fact, that the quality of decisions is directly linked to the availability and the perception of information, its selection and representation are of major importance in business communication. The purpose of this paper is to identify the current status quo of existing research in the field of information design in business reports (reporting design) in order to cluster empirical contributions and to generate new findings. A systematic literature review consisting of 48 international studies published between 2003 and 2013 was conducted. The extended cognitive fit model from Shaft and Vessey (2006) serves as a research framework. The analysis of its four main perspectives: "External Problem Representation", "Internal Problem Representation", "Problem-Solving Task" and "Mental Representation" revealed the following eight literature streams: (1) Tables versus Graphs, (2) Analyses of annual reports, (3) Reporting Guidelines, (4) Knowledge and Skills, (5) Task Type, (6) Task Complexity, (7) Working Memory and Memory Affection, and (8) Information Overload. Based on this literature review a research agenda was developed.*

Key words: *Reporting Design, Information Design, Information Perception, Visualization, Tables and Graphs, Information Overload*

Introduction

The rate at which big data is generated in business is increasing exponentially (Gantz et al 2008 in Agrawala et al 2011; Mukherjee/Hahn 2007) whilst the techniques and methods for sorting and representing remain largely the same, resulting in a gap between presented and perceived information. The optimal selection and visualization of information has been proposed as one especially important perspective of representation in business reports conveying information targeted at managers and shareholders alike (Wong 2011).

When selecting the data, the amount of the information presented seems to be crucial when it comes to the ability of the human brain to fully perceive and process relevant information (Chandler/Sweller 1991). Too much data tends to have a negative effect on the ability to capture information and information overload can occur (Edmunds/Morris 2000). Sending signals to the reader by highlighting the message that should be transmitted by choosing to use graphs or tables, for example, rather than text for specific information, attracts the attention of the reader and therefore helps the processing of the presented material. This way of dealing with Information Overload is called Signaling and is used in business communications (Mayer/Moreno 2003).

Techniques of visualization then can support the human brain to deal with complex data (Heisters/Leu 2004). In total, 70% of our sensory receptors are used for visual perception. Therefore, our individual visual perception has a great influence on our business mindset and decision-making (Few 2006). An appropriate information design improves and accelerates the process of information perception and relieves its recipients cognitively (Beattie/John-Jones 1993). In view of the scope and the sustainability of decisions based on data, the economic leverage of an improved visualization, resulting in an improved perception of this information is fundamental (Hellbrück 2011; Peterson 1983; Beattie/John-Jones 1993; Schaubroeck/Muralidhar 1991).

As the conference call states, information as a prerequisite for rational decisions has become almost overly affluent - in terms of timeliness, scope and delivery. The quality of managers' and investors' decisions is directly linked to the representation of information: Information controls reaction (Weber et al 2008; Laux 2005). The following figure shows the causal link between information, perception and decision-making:

Figure 1: Information and Perception as a basis for decision-making (Source: Eisl et al 2012)

Information design in general means the focus on the fusion of content, structure, and appearance of documents. Data, statistics and images as its resources have to be organized and presented in an optimal way, so an efficient and effective understanding of the presented information can be achieved (McLaughlin 2009). Information design is applicable in a broad variety of scientific disciplines and therefore various definitions can be found (Carliner 2002). However, the specific application of information design in the field of business reporting lacks a definition. In this paper this specific field of research will be referred to as Reporting Design which focuses on the visualization of information in business reports (e.g. management and annual reports). Reporting Design aims at a recipient-oriented preparation of primarily quantitative information of reports for business owners, managers, shareholders, and other stakeholders. Tables, graphs and texts should be designed so that the perception of information can be as effective and efficient as possible. This effectiveness and efficiency of Reporting Design can be measured by the accuracy and speed at which information is perceived. (Eisl et al 2013)

Current studies provide evidence that management reporting strongly influences management decisions, but at the same time many recipients of management reports are only partly satisfied with the representation of the included information (Gleich et al 2007; Weber et al 2008; Eisl et al 2013). Yet this dissatisfaction of the recipients is in contrast to the intense effort dedicated to the preparation of management reports (Eisl/Mayr 2007; Schäffer et al 2012). Additionally, the contributors to these management reports face increasing uncertainty regarding the appropriate design of their reports. Esthetic and personal preferences, CI-specifications, utilization of software technology and temporal limitations in preparing the reports impact the idiosyncratic reporting design. As a consequence in current corporate practice, tables and graphs representing crucial information are prepared individually and inconsistently, preventing decision makers from focusing on the relevant data and potentially leading to wrong decisions. Ultimately this failure in information perception may even damage the companies' performance (Lurie/Mason 2007; Hummel 2007).

Empirical guidelines provided for a perceptually optimized reporting design could make a considerable contribution to increasing the effectiveness and efficiency in information processing of managers and external stakeholders.

Purpose

In order to provide a solid foundation for subsequent empirical studies, the paper analyses and clusters extant literature on information design in the context of business reports. The paper therefore addresses the following research questions:

1. Which relevant topics within the subject of "reporting design" can be identified?
2. Which empirical approaches have been applied in empirical contributions in order to generate new findings?
3. What are the research opportunities and controversies identified by the authors?

A critical review of theoretical foundations as well as empirical research is employed to determine the current status of reporting design and reveal further research relevance. As the literature covering information design is substantial yet fragmented (Kelton et al 2010), applying a systematic literature review was chosen by the authors above other alternatives to answer the stated research questions.

Methodology

Systematic Literature Review

The guideline of Okoli and Schabram (2010) for conducting a systematic literature review provides the foundations of the research process. The review includes 48 studies published in journals listed in the Academic Journal Quality Guide or in the VHB-JOURQUAL list, derived from the databases "EBSCO Business Source Premier", "Sage Premier" and "Science Direct" from 2003 to 2013. This broad selection of databases and journals was necessary, given the broad scope of the topic and various contributing disciplines. The databases used, allowed a keyword search in the title or abstract of an article with the following keyword-strings: "information & presentation & format", "information & display", "table & graph", "reporting & design". This keyword search resulted in a total number of 26 peer-reviewed articles with a dominant focus on the addressed subject. According to Levy and Ellis (2006), doing only a keyword search is not enough to get a comprehensive list of studies. By applying keyword search as well as backward search, theoretical saturation should be achieved. Our backward search resulted in a further 22 articles included in this paper. Table 1 shows the derived 48 articles clustered by scientific discipline and applied research approach.

Discipline / Approach	Empirical Study	Empirical study & Experiment	Experiment	Literature Review	Total
Information Management	1		12	4	17
Accounting & Finance	1	1	8	3	13
Psychology			7		7
Other			8	3	11
Total	**2**	**1**	**35**	**10**	**48**

Table 1: Included articles by discipline and empirical approach

Analyses of the found literature show that the theoretical foundation for research was established in the 90s. By analyzing the references of the 48 chosen articles, it could be found that more than 80 % of the cited references are older than 10 years and that about 40 % is even older than 20 years. It could also be found, that the work of Iris Vessey in 1991, who developed the theory of cognitive fit in the context of choosing the right display format, was incorporated into the majority of the 48 identified studies. For that reason the theory of cognitive fit was also used in this study as the theoretical background and is explained in the next paragraph.

Research Framework

Similar to Dilla et al (2010) and Kelton et al (2010), the author applied the cognitive fit theory (Vessey 1991; Vessey/Galletta 1991; Shaft/Vessey 2006) as an underlying framework for the systematic literature review.

Vessey (1991) based the model of cognitive fit on the general model of problem-solving. The general problem-solving model understands the performance of problem-solving as a result of the interaction between the problem representation and the problem-solving task. The mental representation as the product of the combination of the problem representation and the solving task is the way the problem is represented in human working memory.

Figure 2: Extended cognitive fit theory as basis for literature review (based on Shaft/Vessey 2006)

The model of cognitive fit analyses information presentation modes (Vessey 1991). This theory extends this general problem-solving model by splitting the problem representation into the internal and external problem representation (Shaft and Vessey 2006). The interaction between the internal and external problem representation contributes to the mental representation for task solution. The external problem representation stands for the information presentation format and the internal problem representation stands for the individual's task knowledge (Kelton et al 2010). If the problem representation and the problem-solving task match each other, cognitive fit exists and neither problem representation nor solving task have to be transformed. Cognitive fit leads to consistent mental representation and therefore to an effective and efficient problem-solving performance. If there is a mismatch, the recipient has to transform either the data derived from the problem representation or the solution task. This causes increased cognitive effort and task time and decreased decision outcome (Vessey, 1991).

Limitations

To ensure theoretical saturation, the authors applied the backward search method in addition to the keyword search. Despite this fact, the authors cannot guarantee that all the relevant studies for answering the research questions have been identified. By failing to identify all relevant studies, important theories or models might not be incorporated into this review. By only including studies published in journals listed in the Academic Journal Quality Guide or in the VHB-JOURQUAL List, studies relevant to the subject not published in listed journals have not have been incorporated (Bryman/Bell 2011).

Findings

As previously stated, the extended cognitive fit model serves, on the one hand, as a research framework. On the other hand, it serves as a structure for the presentation of the findings of the research, clustering them in the four main perspectives “External Problem Representation”, “Internal Representation”, “Problem-Solving Task” and “Mental Representation”. Figure 3 shows the four major perspectives including eight identified research streams.

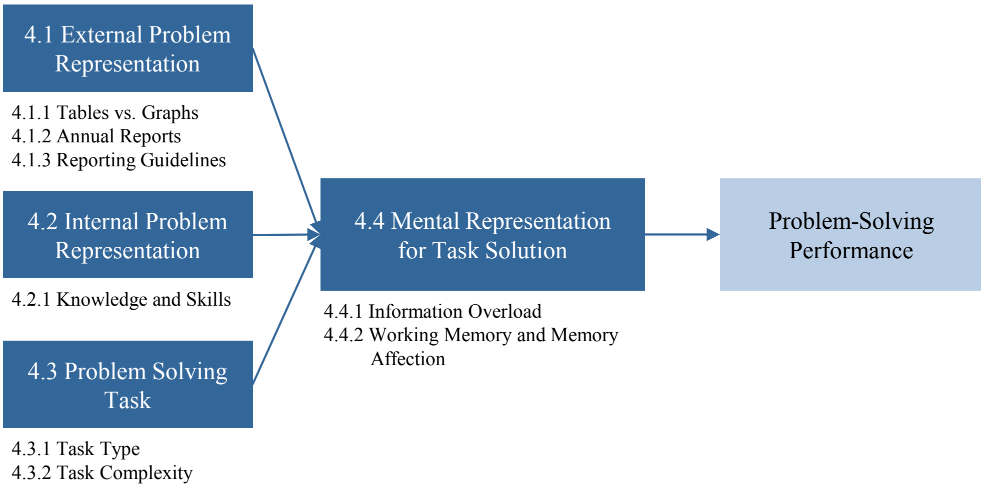

Figure 3: Structure of the literature review.

Perspective “External Problem Representation”

The external problem representation refers to the information display, i.e. which format best suits a given task (Kelton et al 2010). The literature review resulted in three main research streams, namely: (1) Tables versus graphs, (2) Analysis of annual reports and (3) Development of reporting design guidelines, which will be discussed separately in the following chapters.

Out of the 48 included studies, 36 studies deal with topics regarding external problem representation. The Venn diagram presented in Figure 4 gives an overview of the incorporated studies and the distribution among the three streams. It shows a majority of studies in the cluster “Reporting Guidelines” and a major intersection with the cluster “Table versus Graph”.

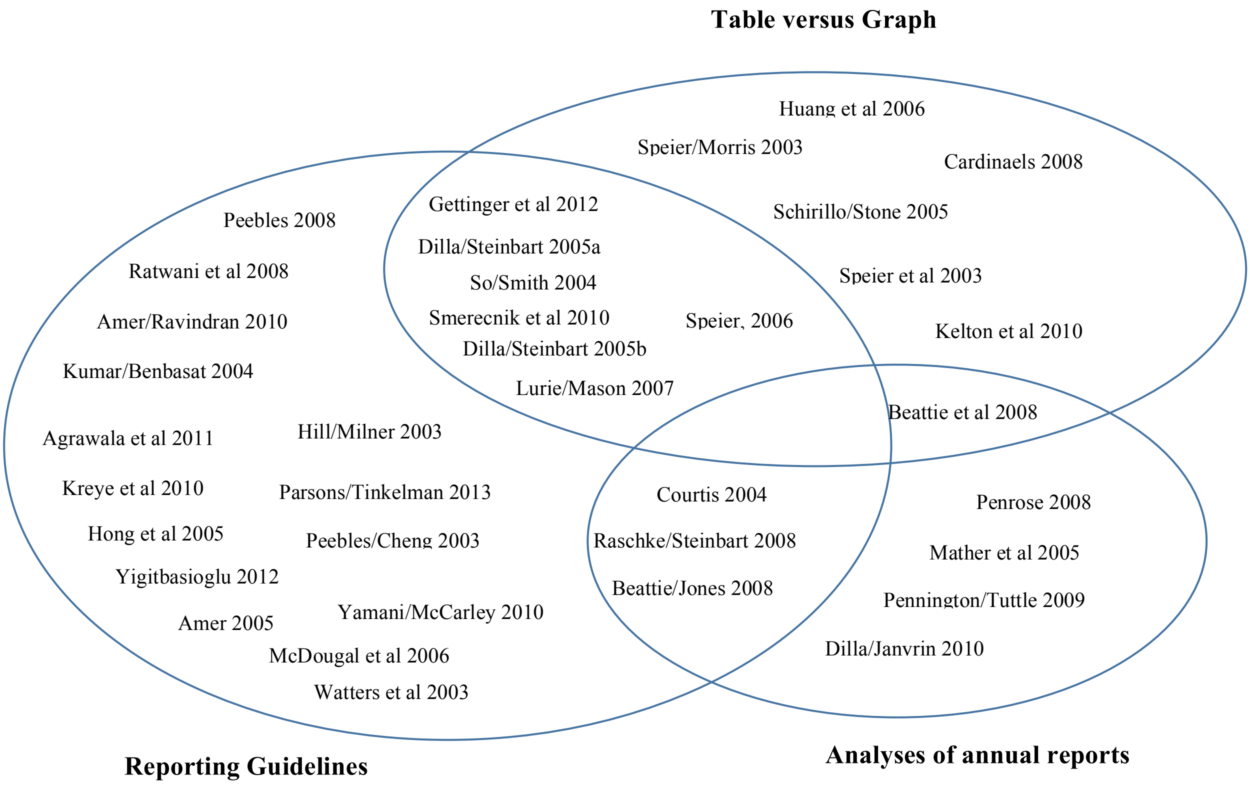

Figure 4: Overview of incorporated studies (External Problem Representation) Tables versus Graphs

The most frequently used formats for displaying numerical information are tables and graphs (Smerecnik et al 2010). Choosing the right format, table or graph, is discussed extensively in the literature and each format tends to be better under certain circumstances. The pros and cons of these display formats are discussed in the following paragraphs.

By analysing various studies, Gettinger et al (2012) find that tables are qualified information displays when decision makers search for specific amounts, accurate values or compare data. Also Speier and Morris (2003) indicate that tables are effective for searching for specific details or to directly compare specific data attributes. On the other hand, tables do not display integrative information and the decision makers have to link the single data values by themselves to detect patterns or trends (Shah/Hoeffiner 2002, in Gettinger et al 2012; So/Smith 2004). This process of creating associations between data is time consuming and can lead to wrong decisions (So/Smith 2004).

Graphical displays provide an overview of the displayed information (Gettinger et al 2012) and lead to more intuitive and holistic processing (Holbrok/Moore 1981, Sloman 1996, in Lurie/Mason 2007). Research show that graphical information displays can reduce the cognitive burden and information overload (Miller 1956, Tegarde 1999, in Lurie/Mason, 2007; Moriarity 1979, Stock/Watson 1984, Wright 1995, in Cardinaels 2008). Graphs support the comprehension of large amounts of quantitative information and are more effective for detecting trends, patterns or time sequence data (Beattie et al 2008; Dickson et al 1986, Meyer et al 1997, Shah/Hoeffner 2002, Smelcer/Carmel 1997, Umanath/Scamell 1988, in Gettinger et al 2012). In addition, people are more likely to remember visual patterns than data presented in tabular form (Beattie et al 2008). Speier and Morris (2003) state that graphical displays may enhance the processing of large, complex data sets. Similarly, So and Smith (2004) find that the information presentation format has a significant impact on decision accuracy when complex information is displayed. Despite their positive features, graphs can lead to biased interpretations (Cleveland/McGill 1984, Krider et al 2001, Raghuber/Krishna 1996, Raghuber/Krishna 1999, in Lurie/Mason 2007).

By analysing various experiments following these rules for choosing the right display formats, it could be found that the studies tend to show inconsistent results. Beattie et al (2008) tested table-graphical-display combinations and they detect a tendency to pick graphs rather than tables but results show also a decline in accuracy. This is because the graphical display receives more attention which is even heightened when the graphical display uses colours (Beattie et al 2008; Lurie/Mason 2007). The experiment of Speier (2006), on the other hand, show a better result for simple-spatial as well as for complex-spatial tasks by using the graphical format, although participants receiving the tabular display had greater confidence in their solutions. In the field of risk management, graphical risk information attracts more attention than tabular and textual information displays (Smerecnik et al 2010). Gettinger et al (2012) find that the information presentation format does affect the negotiation processes.

11 out of 14 included studies about “tables versus graphs” refer to Vessey’s (1991) and Vessey’s and Galleta`s (1991) studies. This reveals that Vessey’s cognitive fit theory is widely applied and may be seen as an appropriate underling theory in this field. This suitability of cognitive fit theory, however, is not entirely undisputed. A few studies contradict this theory. Speier (2006) examines whether cognitive fit theory can be applied to more complex tasks, indicating that a match between task type and information presentation format may not always lead to the most effective and efficient problem-solving performance. So and Smith (2004) also found that on low information complexity, the information presentation format has no significant effects.

Analyses of Annual Reports

An important issue regarding annual reports is the presentation of important information and in this context the perception of the recipient (investor, bank, state etc.). Although accounting standards ensure that accounting numbers are unbiased and correctly displayed, the narrative section and especially financial graphs and other presentational formats are subject to little regulation and no official guidelines (Beattie et al 2008; Penrose 2008). The perception of graphical displays in annual reports can be manipulated through the selection of different graph types, colours, scales, emphasis, size or other modifications (Penrose 2008). Various research studies in the area of impression management state that graphs in annual reports are manipulated worldwide to display better results than the underlying data would permit (Beattie/Jones 2008; Pennington/Tuttle 2009).

Possible distortions affecting graphs are classified into three categories (Beattie et al 2008; Beattie and Jones 2008):

1. **Selectivity** meaning that companies choose whether they use graphs to present their financial information or not and what information should be presented.
2. **Measurement distortion** exists when the underlying data is not displayed in the same proportion in the graphical display.
3. **Presentational enhancement** exists when the design is used to enhance or disguise certain features.

According to Arunachalam et al (2002, in Pennington/Tuttle 2009), graphical distortions with the greatest impact are distortions involving the X- and Y-scales.

Beattie et al (2008) detect in their study of annual reports in the U.K. various ways of impression management. A selective displaying of graphed Key Financial Variables (KFVs) was used to conceal negative effects, like avoiding the display of the normal 5-year time series. Comparable evidence of selectivity of KFVs was revealed by Dilla and Janvrin (2010).

Pennington and Tuttle (2009) find that distorted graphs, despite the fact that all necessary information for detecting the distortions were provided, influence decisions, lead to incorrect conclusions and that these wrong interpretations persist in the reader's memory.

To measure graphical distortions, the two aspects of the magnitude and the nature (i.e. favourable or unfavourable) of the distortion have to be considered. The Graph Discrepancy Index (GDI) (Mather et al 2005) is a common measure that originates from Tufte's "lie factor" (1983, in Mather et al 2005) and compares the change in the displayed graph with the percentage change in the underlying data. The result quantifies the magnitude of the graph's distortion. According to Mather et al (2005) a measure for identifying and quantifying distortions must be robust. The GDI does not fulfil this criterion as a high or low GDI value is not always linked with a high or low visual distortion. This inconsistency is overcome by the Relative Graph Discrepancy Index (RGD) as a possible alternative (Mather et al 2005).

The use of different colours is an integral part of annual reports and internationally used as a component of visual rhetoric. Analyses of annual reports indicate that the use of different colours causes different judgements. Courtis (2004), however, states that there are no guidelines regarding how to use colours in annual reports.

A number of studies also argue for the need for guidelines regarding graphical display formats in business communication. Graphs are used as a tool for impression management, preparers as well as users would benefit from graphical guidelines (Beattie et al 2008; Dilla/Janvrin 2010; Raschke/Steinbart 2008). Guidelines could be published by standard-setting or regulatory bodies (Beattie et al 2008). Beside the question which format (table or graph) to choose, apparently there is also the question of how to use each format correctly.

Reporting Guidelines

The question is not whether the chosen format is eye-catching or not, but rather if the information display format and style have positive effects on decision making (Speier 2006). Guidelines which include appropriate standards for the design and which help to understand what graphical formats are best suited for certain strategies would help to increase competency in graphical design and would improve interpretive skills (Hill/Milner 2003).

As already stated above (in Figure 4), the subject "Reporting Guidelines" is also mainly addressed by the reviewed studies in the field of external problem representation (25 of 36 studies), reflecting the importance of this issue. There are guidelines dealing with the correct display of graphs, however, there is a lack of guidelines for tables.

Regarding guidelines for graphical displays, Hill and Milner (2003), suggest a three step approach for determining the best fitting graphical display:

1. **Aims and objectives of graphical display:** The purpose of graphical design influences, for example, the type of data displayed, the level of aggregation or the format. Data, displayed for internal receptors may be more detailed than data displayed for external ones. The different characteristics and level of knowledge has to be considered as well as the question if other display formats, for example tables, are more suitable (Hill/Milner 2003).
2. **Graphs Choice:** After determining the aims and objectives of the data display, the suitable graphical display has to be identified (Hill/Milner, 2003). In order to determine which graph is best suited, the task at hand has to be considered (Visschers et al 2009, in Smerecnik et al 2010), the nature of the phenomenon and the measurement scales or components (Hill/Milner 2003). Graphical systems are able to display these measurement scales by using different visual variables. According to Kumar and Benbasat (2004) by referring to Bertin (1981), there are eight visual variables: the two dimensions of the plane graph, the size, value, texture, colour, orientation and the shape of the graph.

There is still no clarity as to which graphic type supports which scope of application best. According to Peebles (2008), data is displayed in bar charts or line graphs in different ways. Bar charts are most appropriate when displaying nominal data (Hill/Milner 2003). Bar charts are usually interpreted by their height, direct the attention to their separate values and are useful for comparing and evaluating specific quantities (Culbertson/Powers 1959, Zacks/Tversky 1999, in Peebles 2008). According to Visschers et al (2009, in Smerecnik et al 2010), bar graphs are best suited for depicting trends. Contrary to this belief, Peebles (2008) argues that line graphs are more suitable for identifying trends and according to Hollands and Spence (1992, in Hill/Milner 2003), both bar and line graphs, are adequate for displaying trends and changes in the data.

Further graphical display possibilities which have been discussed in the included studies are the history and the negotiation dance graph (Gettinger et al 2012), pie charts (Penrose 2008), schematic faces (So/Smith 2004), kiviat (also spider, radar or star) graphs (Peebles 2008), small multiples (Parsons/Tinkelman 2013), 3D line graphs (Kumar/Benbasat 2004) and three point trend and fan diagrams (Kreye et al 2010).

3. **Graphical Design:** Arunachalam et al (2002, in Amer 2005) found that improperly designed graphs may affect recipients' choices. Therefore, authors (e.g., Bertin 1983, Kosslyn 1994, Tufte 1983, in Amer/Ravindran 2010) developed graphical display guidelines which should ensure that the information taken from the graphical display is consistent with the information which would be taken when analysing the data instead of the graphical display (Amer/Ravindran 2010).

   The most important characteristics a graphical display should have are: clarity, simplicity, fidelity, accuracy, information impact and good design (Hill/Milner 2003). Understandability is generated by clear graphs, which show the essence of the results and include clear titles and labels for the axes (Cleveland 1985, in Hill/Milner 2003). Raschke and Steinbart (2008) argue that one of the most important guidelines for graphical displays is that the underlying data has to be represented correctly by the visual display. A clear, understandable title should be located at the top of each graphical display (Schmid 1983, Kosslyn 1989, in Beattie/Jones 2008).

   Redundant visual variables like decorated frames or unnecessarily added 3D objects may also distort the attention paid to the displayed information (Tufte 2006, in Yigitbasioglu 2012).

   Recommendations regarding colour use should enable users to easily distinguish visual clusters (use of spectral colour (e.g., rainbow colours) and avoidance of too many different colour codes) (Ratwani et al 2008). According to Curran (1999, in Hill/Milner 2003), no more than four colour codes should be used (Hill/Milner 2003). Too much colour use may distract the user and therefore can have negative effects on the decision making process.

Similar to graphs, different tabular display styles affect the decision making process (Dilla/Steinbart 2005b). Compared to graphical displays the optimal design of tables is barely reflected in the literature. The cognitive effort needed to evaluate and compare the same information displayed in separate lists is significantly higher than by displaying the information in tables with a matrix format (Dilla/Steinbart 2005b). By using the competition-for-attention theory, Hong et al (2005) describe these differences and impacts of matrix and listed formats in online shopping (Hong et al 2005).

Perspective "Internal Problem Representation"

The second research stream of the cognitive fit model "Internal Problem Representation" is represented by the discussion about knowledge and skills. The internal problem representation reflects the existing knowledge of the percipients, which can be used for the problem-solving process (Shaft/Vessey 2006). Seven studies (Cardinales 2008; Kumar/Benbasat 2004; Peebles/Cheng 2003; Raschke/Steinbart 2008; So/Smith 2003; Speier 2006; Yigitbasioglu/Velcu 2012) address the topic of knowledge and skills.

Carinales (2008) found in various studies that the level of knowledge and skills possessed influences how percipients process displayed information. Percipients with a higher level of knowledge are better in retrieving and searching for important data and may also derive better solutions. So and Smith (2003) found in their literature review that the different cognitive styles, abilities and personalities affect information processing and decision making. Furthermore, the level of knowledge influences the memory of the percipients (Cardinaels 2008).

Cardinales (2008) also shows in his review that percipients that exhibit more knowledge in a specific area tend to apply analytical processing to the displayed data. A more focused search enables them to distinguish the more important from the less important information. In addition to this, Benbasat and Schroeder (1977, in Cardinaels 2008) state that knowledgeable decision makers look for specific data and details. Contrary to this, less knowledgeable percipients access information through an overview of the displayed data. As a result, the different skills of decision makers result in different needs regarding the aggregation of the displayed data (Lederer/Smith 1988, in Yigitbasioglu/Velcu 2012).

Further research indicates that decision makers with little task-specific knowledge are greatly influenced by how the information is presented (Bonner/Pennington 1991, Chi et al 1981, in Raschke/Steinbart 2008). When a graphical display format is familiar to the percipient, the user will be able to resort to previous learned strategies and retrieval processes. The way the information is obtained will therefore be more effective than for users unfamiliar with the display (Peebles/Cheng 2003).

Percipients processing knowledge about graphical design are able to use this knowledge to detect misleading graphs. They are also able to mentally change the misleading graphical display and thus obtain unbiased information (Kosslyn 1989, Shah/Shellhammer 1999, in Raschke/Steinbart 2008).

Perspective "Problem-Solving Task"

So and Smith (2004) state in their literature review that both task type and task complexity are seen as important factors in evaluating the suitability of certain display formats. The display format and the task characteristics therefore have to be taken into account. Vessey (1991) also states that an effective and efficient decision-making process can only occur when a match between the problem representation and the task exists (Vessey 1991). By citing De Sanctis (1984) and Libby and Lewis (1982), So and Smith (2004, p. 284) argue that:

> "The issue of task characteristics is, however, quite complex, given the variety of definition, interpretation and measurement, and the absence of a ready taxonomy of classification. Task characteristics have many dimensions, among them, those more commonly reported in the literature: task type and task complexity."

These two streams of discussion – task type and task complexity – are also represented in the analysed literature. In total, nine studies addressed the topics regarding problem-solving tasks. The Venn diagram (

Figure 5) shows the incorporated studies and the distribution among these two literature streams.

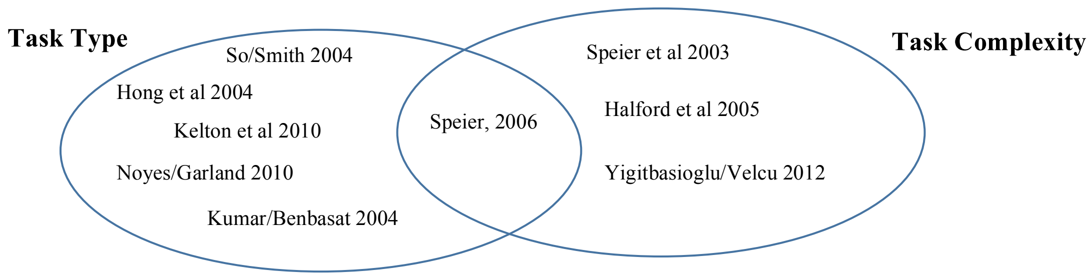

Figure 5: Overview of incorporated studies (Problem-Solving Task)

Task Type

Speier (2006) analysed various studies and found that there might be a great consensus that the suitability of a certain information display format depends on the type of task at hand (for further evidence see also Kelton et al 2010; So/Smith 2004). There is not "one" definition or classification of task types. The authors of this paper therefore outline the different classification of task types identified in the analysed studies in an overview of all these classifications (2).

Author	Task Classification	Description	Suitable Display Format
Liberatore et al (1988, in Kelton et al 2010)	Simple	n/a	n/a
	Range	n/a	Tables
	Integration	n/a	Graphs
Amer (1991, in Kelton et al 2010; So/Smith 2004)	Integrative	Integration of multiple cues	n/a
	Selective	Examination of one single cue	Tables
Hard/Vanecek (1991, in Kelton et al 2010; So/Smith 2004)	Accumulation	Acquiring a single cue	Tables
	Recognition	Patterns or relationships between 2 or 3 cues	Tables & Graphs
	Estimation	Trends between numerous cues	Tables & Graphs
	Projection	Future values	Tables
Coll (1992, in Kelton et al 2010)	Relational information	Retrieval of relational information	Graphs
	Specific values	Retrieval of specific values	Tables
Greeno (1987, in So/Smith 2004)	Induction	n/a	n/a
	Transformation	n/a	n/a
	Arrangement	n/a	n/a
Tan/Benbasat (1991, in Kumar/Benbasat 2004)	Elementary	Extraction of single data point	n/a
	Advanced	Integration is needed, also trend or pattern identification	n/a
Vessey (1991); Vessey/Galletta (1991)	Spatial	Assessing the problem as a whole	Graphs
	Symbolic	Precise data values	Tables
Hong et al (2005)	Searching	Looking for specific product	Listed Format
	Browsing	Looking for potential products	Matrix Format
Larking/Simon (1987, in Speier 2006)	Information acquisition	n/a	Graphs

Table 2: Overview of Task Type Classifications

Although the analysed studies use different terms for task classification, similarities between the recommendations of the most suitable information display format can be identified. A widely used distinction is the identification of single cues versus the evaluation of multiple cues (e.g., pattern or trend identification). There seems to be consensus that for single cue evaluations, tables are the most appropriate display format, whereas for the processing of multiple data cues, graphs or both graphs and tables are recommended (Coll 1992, in Kelton et al 2010; Amer 1991, Hard/Vanecek 1991, in Kelton et al 2010; So/Smith 2004; Vessey 1991; Vessey/Galletta 1991).

Task Complexity

The complexity of a task can be classified into objective task complexity and experienced task complexity (Bonner 1994, Campbell 1988, Wood 1986, in Speier 2006, p. 1117):

> *"Objective task complexity has been conceptualized and operationalized in a number of ways, however, there is a consistent belief that task complexity is: (1) a function of the number of distinct information cues that must be processed; (2) the number of distinct processes that must be executed; and (3) the relationship (i.e., interdependence and change of time) between the cues and processes."*

Experienced task complexity is a product of the interplay between the task and the characteristics or the cognitive skills of the percipient (Campbell 1988, in Speier 2006). As the complexity of a task increases, the cognitive load and the required mental attention become higher (Baecker et al 1995, in Speier 2003). Speier (2006) presents a model including four task types used for different levels of complexity:

1. **Simple tasks** which require very low cognitive processing (Speier 2006).
2. **Feasibly solvable tasks** with relatively low objective complexity. A decision maker possessing the right knowledge and given the time needed would be able to reach an optimal decision outcome (Paquette/Kida 1988, in Speier 2006).
3. **Trade-off tasks** reach a level of complexity where decision-makers try to reduce the cognitive burden (Ho/Weigelt 1996, Hohnson/Payne 1985, in Speier 2006). Such strategies for reducing the cognitive workload can reduce accuracy and may negatively affect the decision outcome. Decision makers reducing cognitive burden, may however, be satisfied with non-optimal solutions (Paquette/Kida 1988, Payne et al 1988, in Speier 2006).
4. **Limiting tasks** possess a very high task complexity and the necessary cognitive processing is likely to exceed the abilities of the percipients. Such tasks will therefore either not be completed or a solution is derived by guessing (Johnson/Paynes 1985, Te'eni 1989, Vessey 1994, in Speier, 2006).

Halford et al (2005) examined the concept of complexity by adjusting the variables depicted in a graphical display. In order to assess the given task, all variables had to be integrated. In their study they found that the accuracy and speed were heavily affected when the variables were increased from three to four, the increase to five variables could only be evaluated by guessing (Halford et al 2005).

The way information is displayed can mitigate the problems caused by complex tasks. Furthermore, information should be visualised in a way that helps to focus on the relevant information (Yigitbasioglu/Velcu 2012).

Perspective "Mental Representation"

> "The mental representation is the way the problem is represented in human working memory." *(Vessey 1991, p. 221)*

It is affected and formulated by the characteristics of the three remaining factors of the cognitive fit model and thereby influencing the problem-solving performance, namely the external problem representation, the internal problem representation and the problem-solving task (Shaft/Vessey 2006).

Again two streams of discussion – "Working memory & memory affection" and "information overload"– are represented in the analysed literature. 14 studies were incorporated into this section of the literature review, displayed by a Venn diagram in

Figure 6.

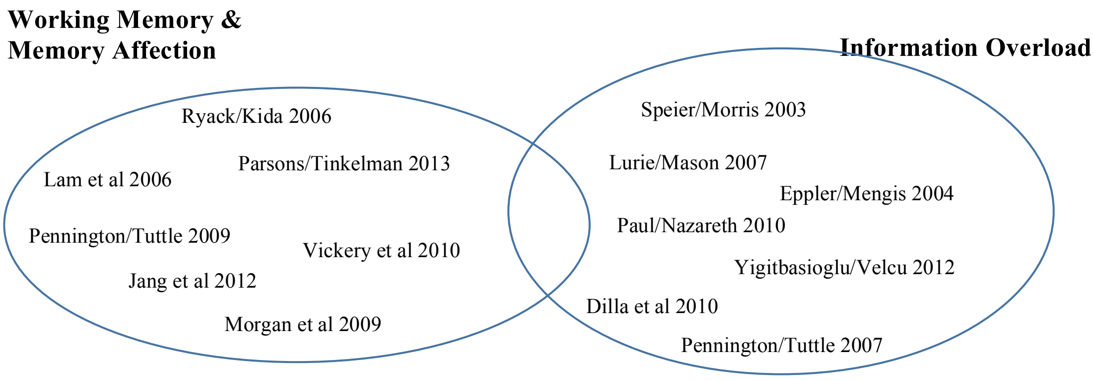

Figure 6: Overview of incorporated studies (Mental Representation)

Working Memory & Memory Affection

Users often need to recall financial information for making decisions. This is the case when information is no longer available. But even if information is at hand in one display format, percipients have to recall and transfer it to another format. Percipients may be more familiar with another display format or they currently work with another format (Ryack/Kida 2006).

Ryack and Kida (2006) found that memory improves when the conditions of information retrieval are similar to those for encoding. Recall of information may be enhanced by applying standardised presentation formats.

For decision makers the comparison between different information variables is easier when they are displayed in close proximity. This is the case because of the limitations of the short-term memory (Parsons/Tinkelman 2013). Zach et al (1988) cited in Pennington and Tuttle (2009) found, for example, that short delays in viewing information are already enough to affect decision making and outcomes. Similar, Jang et al (2012) found that a stacked display of information leads to slower processing, as it becomes harder to integrate data.

Percipients remember the basics of a displayed graph more easily while specific details of a graphical display tend to decay over time (Pennington/Tuttle 2009). Pennington and Tuttle (2009) find evidence that distorted graphs lead to biased decisions and that these errors persist in memory. The effects of distorted graphs were further increased when the percipients had to rely on their own memories. The findings also indicate that the effect of distortions on memory is dependent on the type of distortions employed (Pennington/Tuttle 2009).

Information Overload

In today's business environments, companies generate and deal with extensive amounts of data. This is caused by advances in information and communication technology (Dillon 2000, in Speier/Morris 2003; Yigitbasioglu/Velcu 2012). As a result of this vast amount of data, decision makers are often unable to comprehend all of the information provided and do not realize their beneficial impact on decisions (Farhoomand/Drury 2002, Lurie 2004, Schwartz 2004, in Lurie/Mason 2007). Additionally, this large amount of information might lead to inaccuracy (Paul/Nazareth 2010) and is further heightened by poorly designed management reports (Yigitbasioglu/Velcu 2012). This problem, which arises when the mental capacity for processing the displayed information is exceeded by information-processing demands (Schick et al 1990, in Pennington/Tuttle 2007) is generally referred to as information overload.

Performance is usually positively affected by the amount of information provided. If a certain point is crossed, however, performance will be affected negatively (Chewning/Harrell 1990, in Eppler/Mengis 2004). This effect is illustrated by the inverted U-curve (Figure 7), developed by Schroder et al (1967, in Eppler/Mengis 2004).

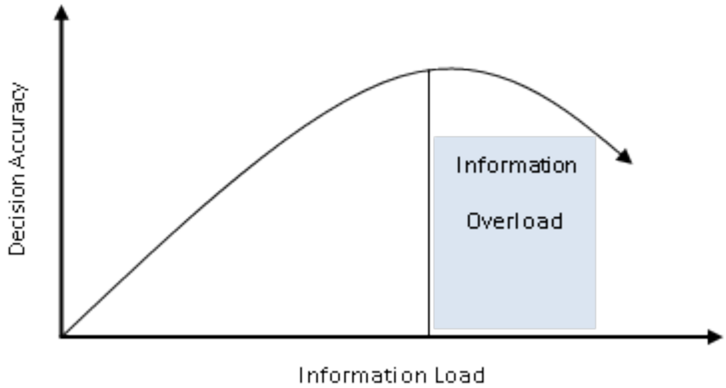

Figure 7: Information overload as the inverted U-curve, Source: Schroder et al (1967, in Eppler/Mengis 2004)

Paul and Nazareth (2010) summarise review the factors leading to information overload in their literature which are: the number of information cues, the diversity of information, the task, task interruptions and non-routine tasks and time pressure. Eppler and Mengis (2004) also provide an overview of the main reasons for information overload. The overarching factors are information, the percipients, the task, the working structures and the way information technology is used or not used. They also state that information overload is mostly a result of the interaction of all of these factors.

Eppler and Mengis (2004) also summarise a list of effects occurring because of information overload: Percipients may have problems in assessing the most important information, only take a certain amount of information into account and the process of decision-making is affected regarding both time and decision outcome. They also divide possible countermeasures into categories regarding the information (e.g., visualization, display format or aggregation), the individual level (e.g., the percipient), organizational design (e.g., collaborative work), processes (e.g., standardization) and information technology (e.g., information management systems).

Interactive visualisation tools help to deal with large and complex data sets (Dilla et al 2010). According to Dilla et al (2010), more and more companies are using interactive visualisation tools both for internal and external information display.

Summarizing the perspectives

Based on the relevance, range and depth of the analysed literature our findings can be distilled into the following propositions:

1. Reporting Design is an important area of research.
   This can be seen by the fact that
   - information presentation has an impact on decision accuracy when complex information is displayed (Yigitbasioglu/Velcu 2012).
   - display format and display style affect the decision making process (Speier 2006).

- information presentation affects the negotiation process (Gettinger et al 2012).
- distorted graphs lead to incorrect decisions and these conclusions persist in memory (Pennington/Tuttle 2009).

2. The suitability of a design depends on the task and the knowledge and abilities of the decision maker.
   a) The problem-solving task, meaning task type and task complexity, impacts information processing and its task classification distinguishes in literature
   Task types are categorized in different ways and are divided into broad categories (e.g. Vessey 1991: spatial tasks – use graphs, symbolic tasks – use tables). Related to the practical application these broad categories are highly questionable.
   The complexity of design leads to difficulties for the decision makers. Graphs should not include too many variables. As the number of displayed variables rise, information processing gets harder. When processing four variables in one display, the limit of human processing capacity is reached therefore, relevant information should be highlighted for the recipients.
   b) Knowledge and personal abilities influence the processing of information.
   Cognitive styles and personalities have an impact on the process of information perception. Individuals with higher levels of knowledge show improved information processing abilities. They tend to look for specific data and details, detect distortions and therefore make better decisions. Decision makers with less know-how are more strongly affected by the way information is processed. Although this affect can be reduced by training, it cannot be completely avoided.
3. Impression management is widely used for presenting key financial data and can lead to wrong decisions.
   Worldwide, graphs in annual reports are manipulated to display better results than the underlying data would permit. Distorted graphs influence decisions, lead to incorrect conclusions, and these wrong interpretations persist in memory. A number of studies argue for the need for guidelines regarding graphical display formats in business communication.
4. Information overload literature focuses on theoretical concepts and the identification of countermeasures. However, these theoretical concepts are not entirely empirically tested.
   It is a well-known fact that the decision making ability is initially enhanced by increasing information, but from a certain point onwards performance decreases with a further increase of information (concept of the u-curve). But no empirical method for an exact determination of this turning point was detected within the analysed studies.
5. Reporting guidelines can increase the effectiveness and efficiency of information perception and reduce information overload as well as perception illusions.
   a) Guidelines for graphical display: The most important characteristics a graphical display should have are: clarity, simplicity, fidelity, accuracy, information impact and good design (Hill/Milner 2003). Related to the specific design of these design elements, a number of questions remain unanswered and statements of authors often diverge.
   b) Guidelines for tabular display: The literature focuses more on the design of graphs than on the design of tables resulting in few guidelines for tables being available.
   c) Standardization and Condensation: The standardization and condensation of information help recipients of business reports to recall information within the decision making process. As widespread information causes a slower processing of information, different information variables should be displayed in close proximity.

Conclusion and further research

The aim of this article was the identification of relevant topics and research opportunities regarding the subject of Reporting Design. Therefore a definition of reporting design was established. Based on this definition and related key words 48 peer-reviewed articles could be identified and incorporated in the literature review. These papers were clustered by scientific discipline and empirical approach. The selected literature was structured according to the four main perspectives of cognitive fit theory which seems to be firmly established in the subject of information design. Due to the relevance, range and depth of the literature, five main propositions were deducted.

Although there has been a lot of research in the past, there are still questions left unanswered regarding the field of Reporting Design. Based on the propositions of this paper the authors suggest the following further research activities:

Development of an empirically validated design concept

The literature review shows that – as already stated by Meyer and Speier in 2006 – no generally accepted reporting design guidelines exist. Recent research activities focused solely on the discussion of table versus graph and on questions related to the best type of graph (primarily line-versus bar graph) and the design of certain elements (e.g. use of colours, reference lines in diagrams, etc.). However, there is a lack of an empirically validated and generally accepted design concept. As authors recommend various distinct design elements, further validation is necessary. Additionally, a need for further research activities in the fields of information perception and commenting can be deduced. Another field of interest is the combined use of graphical and textual information displays for percipients (Lurie/Mason 2007). According to Speier (2006), research should not only focus on "graphs versus tables". Research should also evaluate the effectiveness of other visualizations (Speier 2006). In this context we recommend a qualitative study, addressing the identification of relevant test objects by experts.

To determine if the dominant reading direction affects which part is first addressed, the results should be verified with participants applying a right-to-left reading pattern (Lam et al, 2007).

Further verification and expansion of findings of the cognitive fit theory

Although the underlying cognitive fit theory is well established and recognised, additional findings suggest further research activities, especially in the fields of task type and task complexity. Speier (2006) indicates that cognitive fit theory and the match between task type and information presentation does not always lead to the most effective decision processes. As complexity of symbolic tasks increases, a certain point will be reached at which symbolic complex tasks are no longer best supported by symbolic display formats. In addition to this, studies have shown that not only the display format (i.e., table or graph) but also the display style and the reporting design have to be considered and further examined.

Further development of objective assessment methods and performance indicators

For Agrawala et al (2011) methods for analysing the effectiveness of graphical displays and design principles should be improved. Measures should also be identified for preventing the creation of misleading graphs (Raschke/Steinbart 2008). As the Graph Discrepancy Index (GDI) is inconsistent, future research is needed to find a generally accepted measure for graphical distortion. The Relative Graph Discrepancy Index (RGD) introduced in 2005 may overcome the problems associated with the GDI (Mather et al 2005). Future research using process tracking methodology to assess mental representation differences between various information presentation formats is needed and has the greatest potential to contribute to information presentation format research. In this context the development of a test concept can give companies the opportunity to test their reports regarding efficiency and effectiveness.

Information Overload

Information overload, its effects and countermeasures, should be examined more deeply in the field of group or team work (Paul/Nazareth 2010). The variables and the function of the u-curve are still undiscovered and should be examined in further detail.

Working Memory and Memory Affection

Within the interrelated subjects memory, abilities, and knowledge the authors suggest analyzing:

a) the effect of information access costs on the memory by using different tasks and methods for interruptions (Morgan et al 2009)
b) if different levels of accounting knowledge affect memory, and the variation of time delay between encoding and retrieval (Ryack/Kida 2006)
c) the effects on long-term memory caused by improperly designed graphs
d) the possibilities for percipients to mitigate the effects caused by misleading graphs on memory (Pennington/Tuttle 2009)
e) the usage of subjective mental workload, as employed by Speier and Morris (2003). Subjective workload could also be validated by comparing it with objective workload measures like the heart rate (Speier/Morris 2003).

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