BUILDING ON DISAGREEMENT VISUALLY: THE SYSTEM AND THE METHOD

Research paper

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Abstract

In this paper we introduce an information system and a research method that use disagreement in order to provide value adding insights relevant for research and work practice. The system includes an innovative electronic survey platform which reports and visualizes disagreement in survey results. Based on an index of disagreement algorithm, survey results are automatically aggregated into visualizations. Survey questions are displayed in descending order, with the questions that have received the most discrepant answers being placed on top. The researcher shows the visualizations to the survey participants in follow-up group conversations (dissent conversations) and uses the visualizations as focal points to guide the conversations. The visual display of disagreement spurs an exchange of interpretations and insights. Based on a study with 57 managers, we show that applying our system and method enables researchers and research participants to jointly produce interpretations that enrich survey results and revise correlational models. The system and the method introduced in this paper contribute toward improving collaborative thinking in groups by unpacking the reasons for disagreement, revealing unpopular truths and individual motivations and perceptions, and leveraging on cognitive diversity in knowledge creation.

Keywords: Disagreement, Conversations, Enriching Survey Results.

1 Introduction

> *"To say, I disagree; I refuse; you're wrong; etiam si omnes – ego non – these are the words that define our individuality, give us our freedom, enjoin our tolerance, enlarge our perspectives, seize our attention, energize our progress"* (Stephens 2017).

Consensus is rare and disagreement is frequent. Our ability to utilize disagreement as an asset, rather than avoid it as a potential source of conflict, may be vital to the continuation of human progress. The discomfort of unsettled disagreement might encourage discussion avoidance (Huckfeldt et al. 2004), the emergence of a spiral of silence (Leigh et al. 2013; Noelle-Neumann 1974) and groupthink (Janis 1971) in groups and organisations. Research has demonstrated that disagreement (or "dissent") enables creative problem solving (Edmondson & Munchus 2007; Mitchell et al. 2009) even when the dissenter is incorrect (Garner 2015; Schulz-Hardt et al. 2006). Dissent can facilitate decision quality (Landier et al. 2009) and nurture decreased turnover (Spencer 1986) and decreased burnout (Avtgis et al. 2007) in organisations.

In this paper we describe an implemented system and a method that provide the ability to visually interpret group dissent in order to produce value adding insights relevant for research and work practice. The system includes an innovative electronic survey platform which reports and visualizes disagreement. Based on an index of disagreement algorithm, the answers of survey questions are automatically aggregated into visualizations. The system sorts and visually displays the survey questions in descending order, with the questions that have received the most discrepant results being placed on top. The researcher shows these visualizations to the survey participants in follow-up group conversations (dissent conversations). We have applied the system and the method in a study with 57 managers, in which we have simulated investment decision making. The visually supported dissent conversations unpacked the reasons for disagreement and thus enabled a revision of an established correlational model of risk perceptions in investment decision making. The use of visualized disagreement as a mechanism to elicit individual motivations and perceptions extended the survey results by providing deeper insights.

The system which we introduce in this paper applies a robust statistical measure of disagreement – the index of disagreement – in a simple combination of electronic survey, followed by a visually supported conversation. The system and the method enable fruitful dissent conversations. This is in line with the call of the European Conference of Information Systems to go "beyond digitization" by advancing information systems (IS) that consist of both human and technical aspects. Although our system includes a software component, the focus of our work is human-centered. Central for us is the socio-technical idea that visually-supported dissent conversations can enable value adding research insights.

2 Literature Review

> *"To disagree well you must first understand well. You have to read deeply, listen carefully, watch closely"* (Stephens 2017).

The system and the method we propose enable to watch closely and see disagreement in a way that enables comprehension. Our system is the first to visualize dissent in survey results based on a rigorous algorithm. Other available web-based survey platforms like Survey Monkey, Survey Planet, etcetera, do not offer this feature. Disagreement is an under-represented topic in IS research. A rare attempt to tackle issues of disagreement (conflict, to be precise) is Poole et al.'s (1991) study. This study examined how a GDSS influenced conflict management in small groups. Some web based systems are designed to provide consensus support for decision making (e.g., Alonso et al. 2010). One promising field for building on disagreement is computer-aided argument mapping. The effects of computer-aided argument mapping, however, have only been studied in the field of education (e.g., Carrington et al. 2011) and are under-researched in the context of IS and management. The field of interactive information visualization is increasingly turning attention towards social visualization, with rare occasions of touching on issues of consensus (e.g., Kim, Reinecke, & Hullman, 2017). Numerous computer systems have been developed to support problem solving, decision making, strategizing, collaborative sense making, and prediction in groups. Many of these systems have the (often unfulfilled or unexplored) potential to indirectly tackle issues of disagreement. The ability of these systems to facilitate change (towards using constructive disagreement as an asset) will be impossible in isolation from the endeavours of people (Alvesson & Spicer, 2012). Disagreement in human communication is a social process and should be explored more deeply as part of the sociotechnical approach in IS research (Baxter & Sommerville, 2011; Mohr & Van Amelsvoort, 2016).

From a methodological point of view, literature shows a turn toward qualitative (as distinct from quantitative) research (Myers 1997; Kaplan & Maxwell 2005; Myers 2013) or mixed methods research (Venkatesh et al. 2013; Molina-Azorin 2011) in IS and management studies. According to Prasad and Prasad (2002), this turn toward qualitative and mixed methods research denotes an intense dissatisfaction with the use of increasingly complex statistical techniques which have often proven to be somewhat decontextualized, reductionist, aphilosophical, and nonreflexive. The predominance of survey research has also spurred dissatisfaction with the weaknesses of this type of research. One weakness is that survey research is incapable of revealing the full narrative regarding an issue. Other weaknesses of survey research include the "limitations of asking" or the "now that you mention it effect" (see, e.g., Weisberg 2008; Visser et al. 2005).

The need to make survey results more "realistic" has been consistently noticed by mixed methods scholars. For example Schoonenboom (2017) proposed the "realist survey" – a methodology for using respondents' voices to test and revise correlational models (i.e., the models that served as a basis for formulating the survey questions). In a realist survey, a researcher presents his or her theory to the survey respondents for evaluation. The researcher asks to what extent the theory applies to the respondent. Over several rounds of feedback, the theory is adapted, presented again, reviewed, and further elaborated in a collaborative effort by the researcher and the respondent.

Like Schoonenboom's method, ours also is a method of democratic participation in mixed methods research (Torrance 2012), because we involve survey respondents in the process of data interpretation. What we add is the power of visualization to make disagreement surface and become meaningfully discussable. Another difference from Schoonenboom is that our method is fully digital – the time and trouble of doing mixed methods research (Freshwater 2013) is considerably reduced. Our dissent conversations yield valuable revelations quickly and efficiently, because they are digitally and visually supported.

The system and method introduced in this paper have one core component – the visually supported dissent conversation. A dissent conversation is one in which a survey respondent explains his or her dissenting survey response and another person responds to that explanation. The qualitative insights based on the dissent conversations extend or challenge the quantitative survey results. It is important to review how existing literature has mapped the potential benefits of dissent conversations. The rest of this section provides a literature review on the potential benefits of dissent conversations for teams (or work-related collaborative ensembles of people) and for research. It also reviews various ways of measuring disagreement within groups and explains our choice of the "index of disagreement" as a measurement best suited for our purposes.

2.1 The benefits of dissent conversations for work

Work-related dissent occurs where one or more employees explicitly disagree with current practices or policies (Garner 2012; Kassing 2007). The defining element of dissent is that the dissenter is challenging the status quo in a way that is counter to managerial expectations (Garner 2015). Dissent conversations are ones during which an employee expresses a contrary opinion and another person responds to that expression (Garner 2015, p.180). The contrary are conversations in which the dissenter is ignored and/or punished by a manager. Research has examined dissent conversational outcomes and has emphasized that what the dissenter says is beneficial for the team, even when the dissenter is wrong. Dissenter views help managers make effective decisions (Ibid., p.180), lead to perceptions of procedural justice (Korsgaard & Roberson 1995), and to perceptions of increased job satisfaction (Lutgen-Sandvik et al. 2011). Outcomes of past dissent conversations determine whether employees will be willing to express dissent in the future (Milliken et al. 2003), which means that dissent conversations in which the employee is rejected will likely lead others to withhold their ideas, resulting in less dissent, more myopic decision making (Garner 2015, p.181), functional stupidity (Alvesson & Spicer, 2012) and wilful blindness (Heffernan 2011) in work-related situations.

2.2 The potential benefits of dissent conversations for research

Dissent conversations are rare in research and dissenting views are under-represented in research findings. This is especially problematic in social, including IS and management research, because findings here are derived mostly based on human perception rather than factual evidence. The interpretation of research results is largely seen as a prerogative of the researcher in both quantitative and qualitative research. Stark dissenters, or outliers, are normally deleted from quantitative data sets before the actual analysis of the data. Precious insights might be lost, because parts of the data remain unpacked (see, e.g., Burgelman et al. 2013; Gibbert et al. 2014; Lewin 1992; Välikangas 2013; White 2000). In qualitative research data interpretation is also done by the researchers, usually without involving the research participants in the data interpretation process.

Weakly-supported findings are often omitted from the presentation of research results, presumably in an effort to comply with criteria for academic rigor. Weiner-Levy & Popper-Giveon (2013) called this purposefully excluded data the missing "dark matter" (p.1) in research reports. According to Baruch et al. (2006) there is a publication bias against studies without statistically significant results – the emphasis on psychometric standards of measurement characteristic of rigorous research has led to a focus on what is readily observable and measurable and neglect of those variables that are important but not as subject of rigorous analysis. The treatment of research participants as a homogenous mass of objects to be manipulated and controlled often leads to pseudo-scientific research results, because the "objects" start acting like such – they outwit the researchers or passively submit to researcher demands (similar to employees working to rule). This may lead to producing correlational models that have little to do with reality. In particular, correlational models that may seem realistic on a group level, are often disentangled from individual realities.

We believe that dissent conversations are potentially beneficial for research, as they can (a) question the conceptualizing of work-related phenomena as belonging to a world of "facts", (b) challenge the givenness of group reality, for example by revealing individual realities, and (c) revise correlational models by challenging or extending them (see e.g., Prasad & Prasad 2002; Denzin & Lincoln 2000).

3 Measuring disagreement within groups

One of the most common and easiest to calculate measures of disagreement (or consensus) is the percentage agreement measure. It estimates the percentage of group members who endorse a particular belief (Gailbreath et al. 1997; Prapavessis & Carron 1997). However, this measure works only for binary responses. Another measure often used as a measure of disagreement is the variance. High variance is seen as a high disagreement in a group. However, since the range of the variance is a function of the mean, this implies that for a mean close to the end points of the survey's Likert scale, the range of the variance is relatively small and for a mean at the centre of the Likert scale the range of the variance is larger (Akiyama et al. 2016). This means that for two or more survey questions that have yielded different means (which happens in most of the cases), the two resulting variances will not be comparable. In other words, the level of disagreement will also not be comparable (see Conway III & Schaller 1998). A slightly more refined measure of consensus that can be applied to Likert data is the within-group agreement index (r_{WG}). This index is calculated by dividing the variance by an estimate of the amount of variance that would be expected by chance alone, and then subtracting this value from one (James et al. 1993). The problem with the r_{WG} is that it is a function of the variance, which in turn is a function of the mean. This again means that for two or more survey questions that have yielded different means the resulting r_{WG} indices will not be comparable.

Akiyama et al. (2016) developed a new index of disagreement (or measure of consensus) which takes into account both the mean and the variance by exploiting the conditional distribution of the variance for a given mean. We have chosen this new index as most suitable for our needs because of the following reasons. First, it allows for comparison between survey questions based on the disagreement among survey respondents, including for cases when the answers of different survey questions have yielded different means. We are building on this crucial advantage of this index – our system compares and sorts survey questions based on disagreement. Second, the index of disagreement can be applied to data collected using a five-point Likert scale (like in our study). Third, the index of disagreement is not affected by sample size, can be used for across-time and across-study comparisons and controls for chance by exploiting a conditional probability distribution (these characteristics are not provided by other measures).

4 The Proposed System and Method

> *"Disagreement is neither an accident nor an anomaly. Rather, the survival of disagreement is the systematic consequence of complex social organization. But if disagreement is fostered by the dynamic logic of complex social organization, it must also be introduced and sustained by particular mechanisms"* (Huckfeldt et al. 2004).

According to Huckfeldt et al. (2004) the opportunity for collective disagreement-driven deliberation must be given because individuals tend to resist information with which they disagree. In other words, constructive disagreement as a way of thinking must be introduced and sustained by particular mechanisms. The system and method we propose provide one such mechanism. We use the power of digital visualization as a means to facilitate the identification of disagreement in survey data. Respondent-generated rich feedback is subsequently produced. We hold dissent conversations within groups of our survey respondents shortly (on the same day) after the respondents have filled in the survey. During these conversations, we show visualizations of the aggregated results which display the level of disagreement in survey answers. We facilitate the conversations by systematically inviting feedback on the reasons for disagreement and on individual motivations and perceptions.

4.1 Overview of the system

Figure 1 (in the Web Appendix) describes the system using a data flow diagram symbolic notation (explained in the legend of Figure 1). As a first step, each participant fills an electronic survey on a personal computer or a mobile device like a smart phone. The system saves all individual survey responses in a .csv file stored online. As soon as all respondents have submitted their survey responses, the researcher downloads the .csv file from the web. As a next step, the researcher runs the .csv file through the Java program. The Java program has been written by the first author in Java 8.0. The Java program performs two basic functions. First, it aggregates the individual survey responses by summing the response counts question-wise, thus enabling the data to be visualized in charts at a later stage. Second, the Java program calculates the index of disagreement for the responses to each survey question and sorts the survey questions accordingly. Finally, the Java program produces an .xls file containing the aggregate, sorted survey responses. As a next stage, the researcher uploads this .xls file online. The web system component, then, produces online visualizations fed dynamically by the .xls file. These visualizations are then shown to the respondents and discussed in groups of eight to ten people.

We performed a unit test to make sure that our calculations for the index of disagreement were correct and that the Java code exactly represented the formula of the index. The unit test was successful for multiple randomly chosen values of the mean and the variance. We also made sure (based on a series of tests) that our calculations of the index of disagreement yielded values between 0 and 1, which are compliant with Tastle & Wierman's (2005) set of rules that must be satisfied before any measure can be considered a viable measure of disagreement/consensus: for a given (even) number n of respondents, if an equal number of respondents, $n/2$, separate themselves into two disjoint groups, each centered on the strongly disagree and strongly agree Likert categories, the index of disagreement will be equal to 1; if all respondents assign themselves to the same (any one) category of the Likert scale, the index of disagreement will be equal to 0. If at least $n/2+1$ respondents assign themselves to any one category, the index of disagreement will be greater than 0; as the number of categories to which respondents assign themselves increases, the index of disagreement must increase, eventually approaching 1.

4.2 Overview of the method

Figure 2 presents an overview of the method as part of which the system is to be applied. As a first step, each respondent fills in an electronic survey. Next, each respondent takes part (during the same day) in a group conversation (in a group of eight to ten people). These conversations are facilitated by the researchers. Importantly, the central facilitating role during these conversations is played by the visualized survey results and not by the researchers. Our system visualizes the survey responses into online charts (visualizations). These visualizations display survey questions in a descending order, according to the disagreement in their answers. The descending order is based on the index of disagreement ranking algorithm, i.e., the survey questions with the highest index of disagreement are placed on top.

Phase	Procedure	Product
Data collection – electronic survey (quantitative)	Each respondent fills an electronic survey on a personal computer or a mobile device.	A .csv file containing all individual survey responses stored online
Data analysis (quantitative)	The researcher downloads the .csv file from the web and runs the .csv file through the Java program. The Java program: 1) aggregates the individual survey responses by summing the response counts question-wise; 2) calculates the **index of disagreement** for the responses to each survey question and sorts the survey questions **in a descending order** accordingly.	An .xls file containing the aggregate, sorted survey responses
Data visualization (quantitative)	The web system component produces online **visualizations**, fed dynamically by the .xls file.	Online **visualizations** displaying survey questions sorted according to the **disagreement** in their answers
Data interpretation (qualitative)	The online **visualizations** are shown to survey respondents, who are gathered in groups of eight to ten people. The researcher facilitates group **conversations** (**dissent conversations**) aimed at interpreting the disagreement shown in the visualizations. The researcher asks the respondents to explain the reasons for disagreement. The conversations are audio or video recorded.	Audio recordings of the dissent conversations
Data analysis (qualitative)	The audio recordings are fully or partially transcribed and coded.	Coded transcripts of audio recordings
Data analysis (quantitative)	The survey results are analysed with the help of a statistical tool (like SPSS).	Descriptive and inferential statistical results; re-tested correlational model
Critical interpretation	The qualitative and quantitative findings are interpreted critically. Post-hoc hypotheses are formulated and existing hypotheses are re-formulated based on qualitative findings.	**Revised or extended** correlation **model**

Figure 2. Overview of the Method

Figure 3 provides an example of a visualization. An online version of this figure is available on https://research-democratisation.org/dissensus1. The first bar chart (depicted in black) represents the index of disagreement of the answers given to each survey question, in descending order. The second bar chart (depicted in colour) shows the spread of answers to each survey question, again in descending order according to the index of disagreement. The visualizations are shown to each group of respondents on a large screen projector in the room. The screen serves as a central point around which the group conversations take place. The visualizations play the role of "structuration devices" (Massey & Wallace 1996) guiding (Silver 2008; Suthers & Hundhausen 2003) each group conversation. The researcher-facilitator asks trigger questions like, "If we look at this, you gave varied answers to this question. Help us understand why. What might have prompted you to answer so diversely? What are the reasons for your high disagreement regarding this issue? Could you explain?". Such trigger questions spur collaborative interpretations and surfacing of insights which explain the reasons for disagreement and shed light on individual motivations and perceptions.

Figure 3. Example of a Visualization of Survey Results (based on Disagreement) used to Guide a Dissent Conversation

Two types of analysis – qualitative and quantitative – follow after the dissent conversations (see Figure 2). These analyses may be performed simultaneously. The correlational model, which initially served as a theoretical basis for the survey, is revised based on a critical interpretation of the qualitative and quantitative findings. The quantitative analysis of the survey data basically (re-)tests the correlational model. Some hypothesis may get (re-)confirmed and others may not. The insights from the qualitative analysis of the group conversations, then, explain why some hypothesis get reconfirmed and others do not. The researchers are able to reformulate existing hypotheses and formulate post-hoc hypotheses or develop new variables based on this critical interpretation of quantitative results and qualitative findings.

5 Applying the System and the Method: a Study

We applied our system and method in a study with a total of 57 experienced managers coming from 17 different countries enrolled in an executive MBA program in Switzerland. (All participants were informed that their participation in the study is optional and is not graded). We simulated investment decision making – our participants played the role of investors and had to make an investment decision as part of an online survey. We were interested in uncovering the motivations of the participants-investors, with particular attention to dissenting views within survey responses. The participants first watched a short introductory video and read our self-authored two-page case study (available at https://research-democratisation.org/) about Phazon – a crowdfunded start-up, which aims at developing the world's first one-size-fits-all wireless earbuds. Our participants-investors had to decide whether to invest $500,000 in order to get 10 percent of the Phazon company. The participants filled the online survey (Table 1 in the Web Appendix), which contained the "invest or not invest" question. Following this, we randomly assigned all participants to 7 focus groups (of 8 to 9 people). Each participant was randomly given a focus group number, written on a piece of paper, together with a room number (the latter identified the focus group room, which each participant was asked to join after a following break). All participants then left the big plenary room for a break. The random selection of focus group participants was necessary in order to obtain a non-biased interpretation of the visualization (of the aggregate quantitative results), which was to be shown later, in the focus groups. The size of the focus groups (8 to 9 people) was chosen because this is the optimal focus group size recommended by focus group researchers (see Krueger & Casey, 2014). After a break of 30 minutes, the participants discussed their visualized survey results in the focus groups. A total of 7 group conversations were held, with one of the authors facilitating each conversation. We followed the procedure described above and depicted in Figure 2. We used Forlani and Mullins's (2000) model of risk perception in investment decision making as a basis for formulating our survey questions. We revised and modified this model based on critical interpretation of our quantitative survey results and our qualitative findings from the group conversations. The original model and the revised model are presented in Figure 4.

Table 2 provides a list of the original hypotheses (as in Forlani & Mullins 2000) and the post-hoc hypotheses which were reformulated or newly formulated based on our mixed methods analysis. We tested the hypotheses with the help of ordinal regression analyses. The quantitative analysis is available to the reviewers on request. We did not get renewed confirmation for Hypothesis 1 and Hypothesis 2 and therefore discarded these two hypotheses from the model (see Figure 4, where the lack of an arrow means a lack of correlational dependence). We reformulated Hypothesis 3 by adding a new direction in this correlational dependence, namely from "risk" to "loss". By testing Hypothesis 5, we did not get renewed confirmation that the "risk propensity" trait of the decision maker influenced his or her decision to invest. Another trait influenced the decision, and that was the age of the decision maker (as our check for the effect of demographic control variables revealed), with younger decision makers deciding to invest more often. Our quantitative analysis also revealed the existence of additional statistically significant correlational dependencies. The formulation of new hypotheses (Hypotheses 6, 7 and 8 – see Figure 4) based on these dependencies, however, only became possible at a later stage – i.e., based on our qualitative analysis of the dissent conversations. In other words, the quantitative analysis revealed the significant correlations, while the dissent conversations explained these correlations and enabled the development of post-hoc hypotheses.

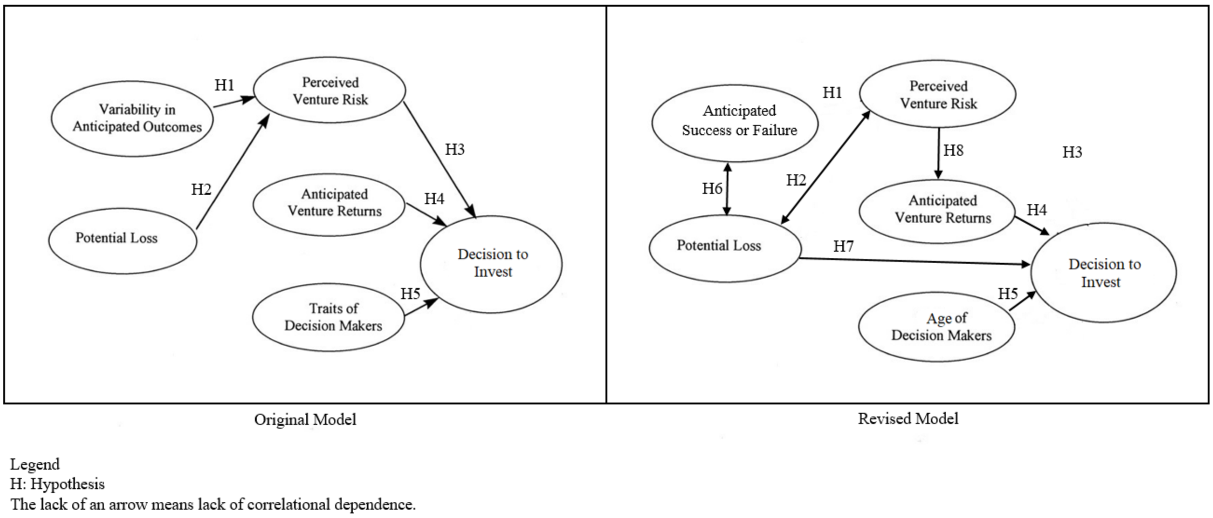

Figure 4. Original Model (Forlani & Mullins 2000) and our Revised Model

Original Hypothesis (H) as in Forlani and Mullins (2000)	Based on our analysis the hypothesis was…	Post-hoc Hypothesis (H)
H1. The greater the variability in predicted outcomes of a proposed new venture, the greater will be its perceived risk.	not confirmed and discarded	N.A.
H2. The greater the magnitude of a proposed new venture's largest potential loss, the greater will be its perceived risk.	reformulated (a new dependence direction was added)	H2. The greater the perceived magnitude of a proposed new venture's largest potential loss, the greater will be its perceived risk and vice versa.
H3. The greater the perceived risk of a proposed new venture, the less likely it will be selected for funding.	not confirmed and discarded	N.A.
H4. The greater the anticipated venture returns of a proposed new venture, the more likely it will be selected for funding.	confirmed	H4. The greater the anticipated venture returns of a proposed new venture, the more likely it will be selected for funding.
H5. The greater the risk propensity of the decision maker, the more likely he or she will be to select new ventures having higher levels of risk.	reformulated	H5. The younger the decision maker is, the more likely he or she will be to select new ventures having higher levels of risk.
N.A.	newly formulated	H6a. The greater the magnitude of a proposed new venture's success, the smaller will be its perceived potential loss. H6b. The greater the magnitude of a proposed new venture's failure, the greater will be its perceived potential loss.
N.A.	newly formulated	H7. The greater the perceived potential loss of a proposed new venture, the less likely it will be selected for funding.
N.A.	newly formulated	H8. The smaller the perceived risk of a proposed new venture, the greater will be its anticipated returns.

Table 2. Original and Post-hoc Hypotheses

The visual ranking of dissent (see Figure 3) triggered the exchange of comments and opinions during the conversations. We then compared our quantitative survey results with the qualitative findings from the dissent conversations. This comparison: 1) explained why some original hypotheses were not confirmed, 2) enabled us to formulate new hypotheses (Hypotheses 6, 7, and 8), and 3) provided insight, which prompted us to modify one of the variables in the model – what was "Variability of Anticipated Outcomes" in the original model became "Anticipated Success or Failure" in our model. Table 3 provides examples of utterances from dissent conversations and their corresponding effect in the model.

Example Utterances from Dissent Conversations	Corresponding Effect in Model	Type of Effect in Model
Participant: *If you go to the bank and apply for a loan, or if you invest in a fund, they will say – the bigger the risk the higher the return.* Participant (**dissenting view: differs from the typical perception of risk-return dependence**): *but doesn't it depend on the type of risk?* Facilitator: *aha, so you thought the other way round.* Participant: *I was just thinking, according to the information that we have, they gave a lot of information out, and that's what makes it riskier. So it is risky in terms of the idea itself. Because of this, it can either yield a lot of returns, or not be profitable at all.*	There is no variability in anticipated outcomes on a continuum, but only two anticipated outcomes – huge success or complete failure (see H1).	modified variable in model (success or failure instead of variability)
	The perceived venture risk lies in making the idea itself public and this influences the anticipated venture returns (see H8).	newly discovered and confirmed correlational dependence (H8)
Participant (**dissenting view: voted that Selection of Manufacturer was not important – see Figure 3**): *There is a bit of a bias. Nowadays China is one of the highest creators of [incomprehensible], for example, and competitors have to have a partner in Chi-*	There is no variability in anticipated outcomes on a continuum, but only two anticipated outcomes – huge suc-	disconfirmed correlational dependence (H1);

na. They create faster than you do…. You are worrying about putting information online, but the way we have to see this in another way is – he was giving a try to see the product work. The product is good, it fits the market. So, it is a bit of a risk but it pays off if you are quick enough to put your product to market. Participant (**majority view: voted that Selection of Manufacturer was important to very important**): *But – another thing about China. I think they are very fast. They can duplicate whatever. They need... just show them a picture or design of it and they can do it very fast. And I did not like the fact that this guy, he put every step of his product he put online. For me there can be only one outcome – failure...*	cess or complete failure (see H1).	modified variable in model (success or failure instead of variability)
Participant (**majority view: decided not to invest**): *We did not believe that the market segment was big enough... I decided not to invest. The potential loss is too big…* Participant: *The format can be adapted to 95 percent of the people, I don't think so…* Participant: *They got traction, which shows that people are really inspired.* Participant (**dissenting view: decided to invest**): *I don't know how many have seen Kickstarter. I'm not saying that there is a direct correlation, but if you get funded, you get funded way after. I mean – it's a very good technology. For me there is no risk, the market has been proven.* Facilitator: *So you said "yes", you would invest?* Participant: *I was one of the crazy ones that said "invest".*	Potential loss influences the decision not to invest (see H7).	newly discovered and confirmed correlational dependence (H7)
	The perceived venture risk is low/constant because of crowdfunding (see H3).	disconfirmed correlational dependence (H3)
Participant (**dissenting view**): *Like, if you have a slow start, you will still make a big loss. If you get the buzz because your orders go to the roof, then it can give you a boost and it can really help drive your ROI. But if expectations are badly managed, it may mean that it's actually resulting in loss.*	The anticipated venture returns depend on managing the expectations of the crowdfunding supporters (see H8).	newly discovered and confirmed correlational dependence (H8)
	Potential loss can be influenced by expectations management (see H2).	newly discovered direction in correlational dependence (in H2)

Table 3. Examples of Utterances from Dissent Conversations and their Corresponding Effect in the Model

The lack of (re-)confirmation for Hypothesis 1 and Hypothesis 3 was surprising. It sounded counterintuitive not to find a correlational dependence between perceived risk and the decision to invest (H3) and between the variability of the anticipated outcomes and the perceived risk (H1). We found an explanation of this surprising finding in the transcripts of our dissent conversations. Interestingly, our investors anticipated two possible outcomes – either huge success or complete failure (*"Because of this, it can either yield a lot of returns, or not be profitable at all", "For me there can be only one outcome – failure...").* Our investors perceived "variability in outcome" as a binary construct, with some accepting the likelihood of two outcomes, and others excluding one of the two outcomes categorically. This was probably the reason why Hypothesis 1 was not confirmed and had to be discarded (H1: The greater the variability in predicted outcomes of a proposed new venture, the greater will be its perceived risk). The qualitative phase in our analysis helped to look inside the "Variability in Anticipated Outcomes" variable and we found out that the construct validity of this variable was pretty low in the case of crowdfunding (like the case of Phazon). In order to improve construct validity, we reformulated this variable into "Anticipated Success or Failure". The expression of dissenting views (e.g., by a dissenter who was not affected by the "worry" bias – see Baker & Ricciardi 2014 and Table 3) prompted the revelation that, in our case, there was no variability (on a continuum) in anticipated outcomes, but binary variability (either anticipated success or anticipated failure).

The expression of another dissenting view uncovered that it was questionable whether "perceived risk", thought of as a variable on a continuum, was a valid construct in the context of crowdfunding either. A woman who described herself as "*one of the crazy ones that said "invest"*" shared that "*I don't know how many have seen Kickstarter. I'm not saying that there is a direct correlation, but if you get funded, you get funded way after… For me there is no risk, the market has been proven.*". In this case, the perceived venture risk was pretty low, as it was split among the crowdfunding supporters. The Phazon company had received the support of thousands of backers who had pre-ordered Phazon's earbuds and had paid over 2 million dollars in advance (before the final product had even been developed) on an online crowdfunding platform. This made some of our investors think that the market was proven and there was little to no risk. Probably for such reasons, Hypothesis 3 did not get confirmed in a crowdfunding context, i.e., the perceived risk could not possibly become greater (or smaller) on a continuum in a crowdfunding context, as it was perceived as low and relatively constant (H3: The greater the perceived risk of a proposed new venture, the less likely it will be selected for funding).

Paradoxically, even though the market for Phazon's product was perceived as proven and the risk was perceived as little to none, the majority of our participants decided not to invest in Phazon. The reasons for that were revealed in the dissent conversations and, again, had to do with the crowdfunding context. The participants were concerned about patent right issues and issues of intellectual property protection online. Concerns were also voiced about whether Phazon would be able to manage the expectations of its crowdfunding supporters – e.g., *"If expectations are badly managed, it may mean that it's actually resulting in the loss".* Such concerns were voiced in relation to perceived return on investment and potential loss and allowed us to formulate the post-hoc Hypotheses 6, 7, and 8 (Table 2).

6 Discussion

The empirical findings from our study showed that an established model of risk perception in investment decision making can be considerably modified in the context of crowdfunding. Similar thoughts have been formulated as "open questions" of crowdfunding in Agrawal et al. (2014) and in Hsu et al. (2016). More importantly, our system and method worked well in order to provide these empirical findings. We involved our research participants in the data interpretation process by feeding their visualized survey results back to them. The digital visualizations of the survey results were based on the index of disagreement algorithm and provided a glance into the level of disagreement on each survey question. The index of disagreement visualization enabled displaying the spread of opinions, which in its turn provided an affordance (Gibson 1978) to express dissenting opinions. The meaningful use and reflection-upon-use (Bednar & Welch, 2009) of our system and method *afforded* meaningful action (Cabitza & Simone, 2012) – the research participants engaged in data interpretation during the dissent conversations and we, as researchers, reflected upon this joint data interpretation. Each dissent conversation revealed contrasts between dissenting and majority viewpoints and became a rich sense making experience. We gave voice to dissenting opinions by looking into the minds of those who are normally ignored. The dissent conversations provided explanations for our unexpected research results. They also enabled us to look inside variables, so as to be able to revise a correlational model.

The importance of our work is threefold. First, our system and method provided a mechanism to display the spread of opinions, which in its turn provided an affordance (Cabitza & Simone, 2012; Gibson 1978) to articulate dissenting opinions. Second, our system and method provided a mechanism to sustain disagreement as a way of collective thinking and constructive interpretation. And third, our visually supported dissent conversations revealed multiple realities of the individuals who had to make a decision. This enabled us to unpack variables and modify a correlational model, thus improving the model's correspondence with our empirical observations. We ultimately improved the usefulness of the model in a given context.

Our system and method can be applied by managers who are willing to build on constructive disagreement in their work practice. Our system can show them where the highest disagreement is, so that they can start their meetings with these issues. Our method can help managers introduce and sustain constructive disagreement as a way of thinking in their teams. Constructive dissent conversations during meetings can help avoid apathy, silence, and dysfunction.

Our system and method are, of course, not without limitations. One limitation comes from the risk of visualizing disagreement on delicate issues. This limitation is mitigated by the fact that we are visualizing aggregate (group) survey results, while the individual survey results remain anonymous. This limitation is also mitigated by the power of visualizations to bring tough issues to the surface in a subtle way, since visualisations are typically perceived as interactively neutral, as pure information (see Meyer et al. 2013). Another limitation of our method is its reliance on human facilitators. This limitation is mitigated by the fact that the true (and more important) facilitators in our group conversations are the visualizations themselves – they are the centre of the discussion and act as an additional person in the room (the facilitator is constantly referring to what the visualizations are "saying" and how to interpret this). In our future work we are planning to further enrich the functionalities of the Java program to consider various decision-making scenarios and develop a graphical user interface for the Java program. We shall also add various visualizations of disagreement (e.g., scatter plots) to our web interface in order to provide a set of visual alternatives for researchers and facilitators to choose from. We are also planning to replicate further test studies in other survey and decision making contexts to see if the system and the method work just as well in other situations and to further test the potentialities and limits of the system.

7 Conclusion

In this paper we introduced a system which visualizes dissent in survey results. We accompanied the system with a method, within which it is to be applied. The method is aimed at enriching survey research with qualitative insights derived by involving survey respondents in the interpretation of survey results. By means of a test study, we have shown that the system and the method are impactful by leveraging the qualities of the visual language to support respondents' understanding and involvement. Central for us was the socio-technical idea that visually supported dissent conversations can enable value adding research insights. The dissent conversations in our study enabled such value adding insights. The power of digital visualization made disagreement surface and become meaningfully discussable. We used disagreement as an elicitation mechanism. We thus revealed the reasons for disagreement by giving voice to individual motivations and perceptions. The meaningful use and reflection-upon-use of our system enabled us to unpack the variables in a correlational model and improve the model's usefulness and correspondence with our empirical observations. The ability to improve the usefulness of correlational models is important, since correlational models are the basis of collective problem solving, decision making, strategizing, and prediction in groups. Correlational models are also the basis of research. The system and the method introduced in this paper are a step toward enhancing our human ability to utilize disagreement as an asset, rather than avoid it as a potential source of conflict – an ability which may be vital to the continuation of human progress.

8 Web appendix

Table 1. *Survey (table shows by clicking on this link)*

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