TU WIEN Informatics

Group Recommendations - What Counts?

PhD THESIS

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Vienna, 26th February, 2020

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Declaration of Authorship

Mag. Amra Delic, BSc

I hereby declare that I have written this Doctoral Thesis independently, that I have completely specified the utilized sources and resources and that I have definitely marked all parts of the work - including tables, maps and figures - which belong to other works or to the internet, literally or extracted, by referencing the source as borrowed.

Vienna, 26th February, 2020

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Amra Delic

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Abstract

The main focus of the thesis is to better understand how people decide in groups with a use case in the travel and tourism domain. The goal is to use this knowledge for the future research and design of group decision-support systems, user / group modeling and personalization, and group recommender systems. We take an approach where we observe actual groups before, during and after their decision-making process, having the groups choosing a destination to visit together. Hereby, we investigate a wide range of individual and group characteristics, for instance, explicit preferences, travel behavioral patterns, personality, group diversity, social relationships, etc., and their relation to the travel-related group discussions. Due to the complexity of the tourism product, the travel and tourism domain makes quite a challenging use case for the research of group decision-making. In our best knowledge, we have been the first with an opportunity to look at this topic by accounting for so many dimensions. Our findings indicate that the current research overlooks the importance of this dimensionality, and that future researchers and practitioners will have to account for more than users' explicit preferences when designing effective group recommender systems in order to truly help groups in their travel-related group decision-making process.

Contents

CHAPTER 1

Introduction

The travel and tourism domain is one of the leading industries regarding the e-commerce presence with the constant growth of online transactions [WR04], products and services [Kab10]. As the number of alternatives (i.e., tourism products) offered online has increased it has become a tedious challenge for consumers to find what fits their preferences. As a consequence, among the most influential and most challenging topics are personalization and recommender systems.

Recommender Systems (RSs), in general, are tools that help individual users to make decisions by suggesting them items that are likely to meet their needs and preferences [RRS15]. RSs are employed in various domains, for recommending books, music, movies, restaurants, Points of Interest (POIs), events, destinations, even people to get in contact with. In essence, the system exploits observed user behavior within the system, i.e., user's implicit preferences (e.g., user purchase behaviour, clicks, viewing time, etc.), or, explicit preferences (e.g., likes and dislikes, ratings or rankings of the options, etc.), in order to deliver personalize recommendations.

In the travel and tourism domain, RSs, personalization and user modeling face specific challenges, unusual for other domains. The tourism product bears a higher complexity than products from other domains [WR04]: 1) It is a package of products and services (e.g., means of transportation, hotels, activities); 2) Traveling is not a pure rational experience, but rather an emotional one, and explicit preference expression is not a trivial task particularly in the early phase of the decision-making process; and, 3) Traveling is usually experienced in a group of people - thus, the recommendations should account for the preferences of the group as a whole, which has brought up new challenges and led to the research of Group Recommender Systems (GRSs) in the travel and tourism domain [JS07, Mas15]. GRSs also make use of users' observed (historical) preferences, the same as individual RSs do, but they have yet another crucial task - to combine these individual preferences into a group preference model in order to find items that the whole

group would enjoy experiencing. Clearly, this is a tough task in general, but in the travel and tourism domain especially, considering the challenges of the domain.

The focus of this PhD thesis are GRSs, group modeling, personalization, and group decision-making in the travel and tourism domain, when a decision task that a group faces is a travel destination to visit together. In order to address emotional aspects of touristic experience, users' difficulties to characterize their preferences, our lack of knowledge about group behavior in such a context (i.e., what drives the group members in the decision-making process, what makes the process difficult or easy, what differentiates satisfying choice from the dissatisfying one, etc.), our research goes beyond standard approaches of GRSs (i.e., combining group members' individual preferences into a group preference model), and we study the role of various individual and group characteristics in the travel-related group decision-making process, such as, the role of explicit and implicit preferences, personality, social relationships, group diversity, strength of group identity, etc., and in essence we try to answer what is it that counts for designing an efficient group recommender that delivers acceptable and satisfying suggestions for all group members.

When it comes to the GRSs, regardless of the application domain, there are four main challenges [Jam04]: 1) Eliciting group members' individual preferences; 2) Combining group members' individual preferences into a group model; 3) Representing and explaining recommendations; and 4) Supporting the group to reach their final decision. As already mentioned, most often, the research deals with the second challenge [Mas15], combining individual preferences in order to generate group recommendations that satisfy all the members in the group as much as possible (further referred to as the "satisfaction goal"). In 1960s, Arrow [Arr63] has shown that an optimal method to combine individual preferences that is better than all the others, does not exist. This was confirmed by various studies in GRSs, demonstrating that different methods perform differently for different tasks, and domains [Mas15]. However, in our best knowledge, even though the "satisfaction goal" is usually clearly stated in the GRSs research, we have not found studies that analyse the determinants of group members' satisfaction in the decision-making process. Therefore, various questions remain unanswered - does the satisfaction depend only upon the preferences and the outcome of the decision-making process; does it depend on certain characteristics of group members; does it depend on a certain common mood of the group members towards the group, as a consequence of their social relationships, and respective social closeness; etc. For the most part, it is assumed that an option that represents the "middle ground" of group members preferences should be the best option for that group, and that it would maximize the satisfaction of the group as a whole. In this PhD thesis, we actually question this assumption, and we analyse what is it that truly determines the group members' satisfaction level in a decision-making process. This is a crucial question since what is assumed to be the best for a group, might not even be an acceptable option. Moreover, having in mind the second challenge of the travel and tourism domain (i.e., explicit preference characterization for travellers is troublesome), the researchers tackled this problem in RSs by developing models that

enable users to express their unknown (implicit), travel-related preferences, and to deliver individual recommendations based on these implicit preferences (for instance see the work of Neidhardt et al. [NSSW14, NSSW15]), however how to use these implicit preferences in group settings is yet not clear.

Furthermore, the fourth challenge of GRSs is about supporting groups to reach their final decision. In order to address this challenge, naturally, the first step would be to understand how real groups make decisions in their face-to-face discussions. Nonetheless, our knowledge about the topic is quite limited. For instance, the research in psychology and sociology [For18] defines several approaches, i.e., the decision-reaching schemes, that groups adopt when faced with a decision-making task, however, we do not know why different groups choose different decision schemes to reach their decisions, managing to finish the task equally successful. If the goal is to support groups in their decision-making process, we need to learn what fits the best to the group at hand, by adapting the support according to the group characteristics. Hereby, we tackle this challenge, and investigate whether we can identify these group characteristics that would help us adapt the support a particular group needs in their decision-making process.

To summarize, figure 1.1 illustrates different concepts (individual and group characteristics), and their impact on the travel-related group decision-making process, that will be analysed in this PhD research project.
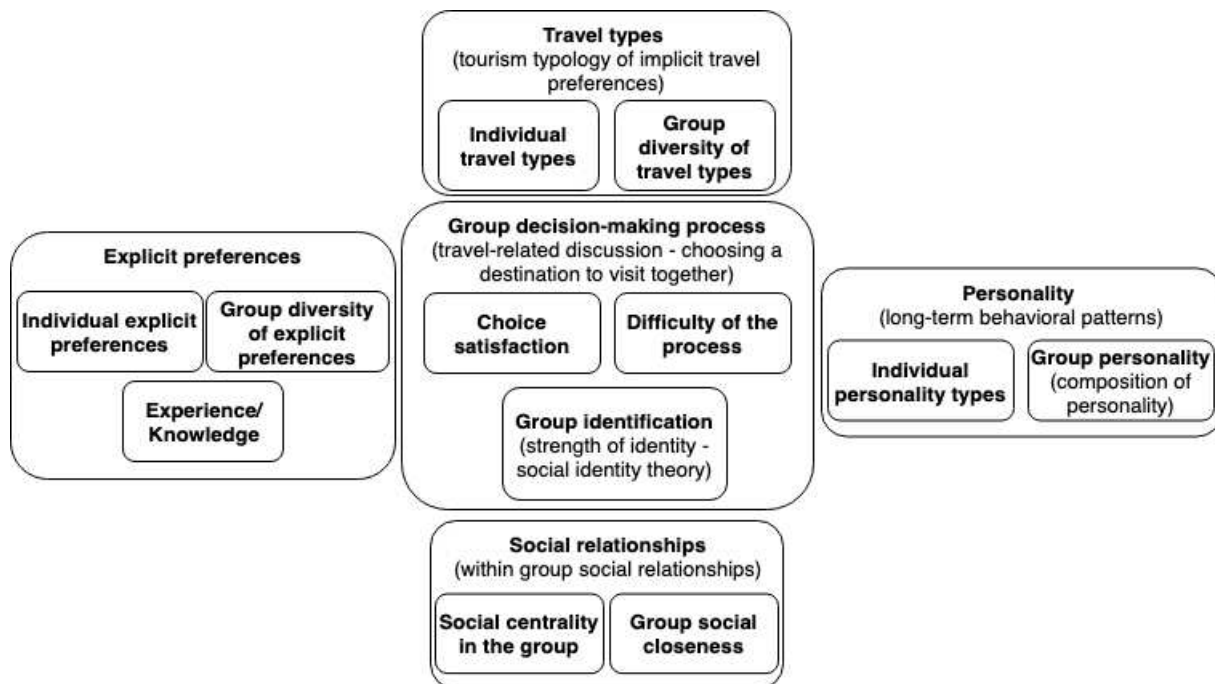

Figure 1.1: Overview of the concepts analysed in the thesis

1.1   Research questions

In this section, research questions (RQ) that were answered within the PhD thesis are provided. For every analysed topic, a research question is stated, together with its sub-questions.

The first topic analysed in the thesis were the members' individual preferences, brought together in a group, and their influence on the group decision-making process. Hereby, we evaluated the basic assumption of the GRSs research, i.e., diverse preferences lead to conflict and dissatisfaction in groups, while the "middle ground" options in such situations maximize the satisfaction of the group as a whole. Due to the complexity of the topic, this analysis was broken down into the three sub-analyses, and the following research questions:

RQ 1 What is the role of the group members' explicit preferences in the travel-related group decision-making process?

    RQ 1.1 What is the relationship between the match-mismatch between member's individual preferences and the group choice, and the choice satisfaction of that member?

    RQ 1.2 How does the composition of members' preferences relate to group members' "well-being" and their performance in the decision-making process?

    RQ 1.3 Can we use network structures of preferences within the group to better predict the actual group choices?

    RQ 1.4 Can we use non-linear transformations of preferences to better predict the actual group choices?

Motivated by the first analysis, the obtained results (i.e., in majority of cases group members were satisfied with the group choice even when a member "lost" in the decision-making process), and the existing literature about the group dynamics and group behavior we proceeded with our investigation on determinants of choice satisfaction, which led us to the following research questions:

RQ 2 What is the role of personality, and travel types in the group decision-making process?

    RQ 2.1 How is the personality, and the travel type of a member related to her satisfaction with the group choice?

    RQ 2.2 How does the group personality composition relate to the performance of that group in the decision making-process?

Going deeper into the group structures, the next topic we investigated were social relationships within the group, knowing that these structures play a significant role in various group processes, and therefore, the following was examined:

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RQ 3 What is the role of the social relationships within the group for the group decision-making process?

RQ 3.1 Are socially central members of the group perceived as more influential in the decision-making process?

RQ 3.2 Are socially central members of the group actually more influential in the decision-making process?

RQ 3.3 Can we use social relationships within the group as an indicator of the members' level of identification with the group (i.e., group identity as defined by the social identity theory)?

RQ 3.4 Is the social structure of the group related to the group members' perception of their preference similarity?

RQ 3.5 Are socially central members of the group, and socially close groups happier with the outcomes of the decision-making process?

Having analysed the function of preferences, personality and social relationships in the group decision-making process individually, the question about a combined effect was raised:

RQ 4 How can we model the combined effect of the preferences, personality and social relationships on the group members' satisfaction with the outcome of the group decision-making process?

Finally, as mentioned previously, one of the most important goals of GRSs is supporting groups in their decision-making process. To this end, we investigated:

RQ 5 How do the group characteristics relate to the group decision-making process?

RQ 5.1 How can we characterize group decision-making process?

RQ 5.2 Is there a relationship between group characteristics and the characteristics of the group decision-making process?

RQ 5.3 Which group characteristics can be used to predict a decision-reaching approach that a group adapts?

1.2 Methodology

In order to answer these research questions, two methodological frameworks were adopted, as further described.

1.2.1 Design Science

This PhD research, in general, followed the design science framework [HC10, Hev07], which emerged due to the requirements of the research conducted in the Information Systems (IS) field. The basis of the design science methodology is to develop and evaluate artifacts and processes that build those artifacts. Artifacts, in reality can be, models, methods (algorithms), instantiations (software), or a set of advises and practices for future researchers in the specific IS field. The processes and artifacts are assessed as they improve and extend the knowledge base for further research and practice.

The design science framework in the context of the thesis: As one of the greatest challenges was the lack of appropriate data sets (i.e., representation of group decision-making process, or the groups' interaction with real GRSs) it was mandatory to develop a process to acquire the necessary data. To this end, in the first step, an exhaustive literature review was carried out, with the goal to determine different aspects that are essential to better understand, not just individual, but also group behavior in the travel-related discussions. The review included computer science literature, as well as, the literature from the social disciplines. In the second step, having in mind the objective of the research (i.e., the research questions), a data collection procedure was defined (in detailed described in Chapter 3). Collecting a new data set about group decision-making in the travel and tourism domain is considered as a **design science process**. Furthermore, following the design science framework, in the next steps we conducted various empirical studies (i.e., exploratory analyses, as well explanatory analyses) to answer the previously defined research questions. As processes and artifacts in the design science are under a constant scrutiny, a second, improved data collection procedure was defined. This allowed us to further explain certain group phenomena, and to answer **RQ 3**.

Figure 1.2 illustrates the design science framework as adapted to the research at hand. The overall environment, i.e., domains that the thesis is contributing to, are group recommendations, group modeling, personalization and group decision-making in the eTourism domain. As mentioned previously, design science process is a data collection procedure, more precisely, a user study, with students given a group decision-making task to choose a destination that they would visit together; as design science artifacts, we consider numerous exploratory analyses, descriptive and predictive models, carried out and developed upon the collected data. Finally, the basis for constructing, both process and artifacts is a knowledge-base consisting of combination of theories, i.e., group dynamics, and group behavior; personality typologies; tourist typologies; social identity theory; social networks analysis; group diversity measurements; and group recommendation algorithms.

1.2.2 Data Science

On the other side, a great deal of the PhD thesis, i.e., various analyses and methods applied have its origin in Data Science. In recent years, researchers have raised an
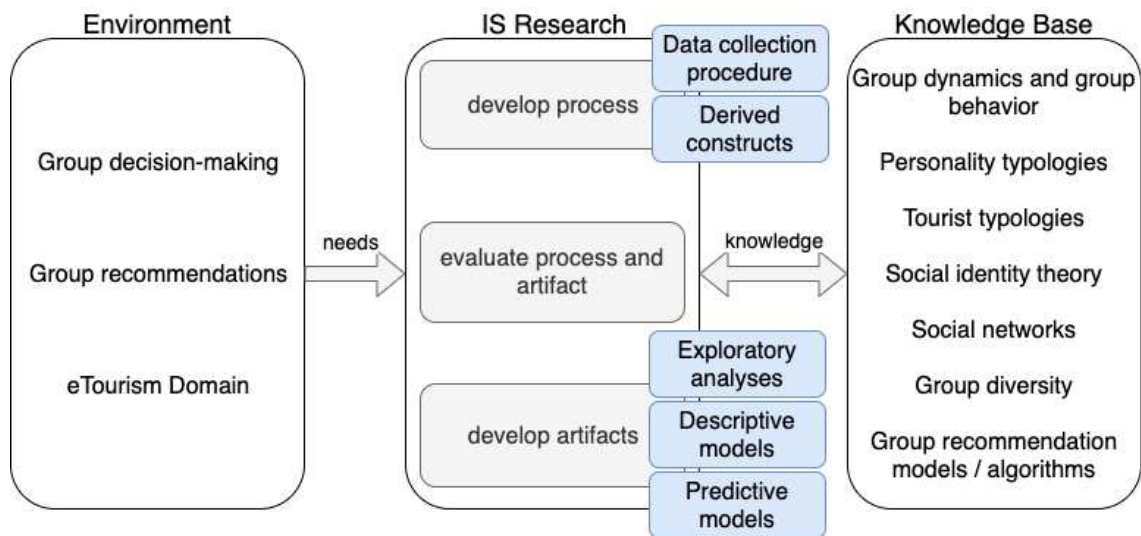
Figure 1.2: Design science methodology framework

immense amount of discussion about scientific paradigms applicable in the relatively new field of Data Science. In general, there are two streams of cogitation about the paradigm which Data Science should follow [Kit14]. The first stream of researchers believe it is a new form of empiricism epistemology / experimental science. For instance, Anderson [And08] says, "*We can analyze the data without hypotheses about what it might show.*"; Prensky [Pre09] agrees, and adds, "*Instead, scientists can mine the complete set of data for patterns that reveal effects, producing scientific conclusions without further experimentation.*". Furthermore, Dyche [Dyc12] argues that "*Traditional database inquiry requires some level of hypothesis, but mining big data reveals relationships and patterns that we didn't even know to look for.*". This view has especially gained popularity within business circles. The second stream, on the other hand, argues for a new, forth paradigm, i.e., exploratory science / data-intensive, statistical exploration and data mining [HTT⁺09]. This view, does not abandon the principles of the scientific method, "*but is more open to using a hybrid combination of abductive, inductive and deductive approaches to advance the understanding of a phenomenon*" [Kit14]. In practice, this means, that the process of knowledge discovery is guided by the existing theory.

The data science paradigm in the context of the thesis: In this thesis, the second approach is followed. In my own personal opinion, there are several reasons, why the first stream would not be acceptable, as noted by Kitchin [Kit14]: 1) Big Data, even though massive, still captures only a sample, not the population, and, the data is shaped by the technology and tools used to capture the data, therefore it is biased [Cra13, Kit13, AT02, RJ13]; 2) Data, analytics and algorithms do not occur in a scientific vacuum, since it is all built upon previous findings and theories, based on scientific reasoning [Leo12]; 3) As data and algorithms are not generated free from theory, neither

can the conclusions be interpreted without a human bias [Kit14]; and 4) If we follow the assumption that data can speak for itself, then anybody with reasonable knowledge in statistics can interpret those results, without a specific domain-knowledge, in this way, we ignore centuries of research conducted in a specific field.

1.3 Contributions

The contributions of this thesis can be seen as theoretical, practical and methodological:

- **A data collection procedure**: Based on the literature review, and in collaboration with researchers from social sciences, we developed a unique procedure to collect data about the travel-related group decision-making process, which is a methodological contribution of this thesis. The collected data enabled us to answer defined research questions, covering preferences, personality, social relationships, etc.

- **Determinants of the choice satisfaction**: The empirical evidence is provided to show that individuals' preferences are not a sole predictor of the group members' choice satisfaction, as assumed in previous research, but that GRSs have to account for the personality, social relationships, group identity, etc., in order to provide satisfying recommendations. At the moment, this is a theoretical contribution which we also plan to use in practice, in an implementation of a GRS, in our future research.

- **A path model of the aspects related to the choice satisfaction**: Not only that we identified the determinants of the choice satisfaction, but we also developed a model that captures different paths and effects that those determinants exhibit on the group members' choice satisfaction and their performance in the group decision-making process.

- **A method to predict group choices (deliver group recommendations)**: We extended the state-of-the-art methods for predicting group choices (delivering group recommendations), so that we account for the network structure of the group members' preferences, and the non-linearity of human perception/stimuli. We show that our approach is better than the state-of-the-art methods when predicting group choices, and we consider it as a practical contribution of the thesis. It is important to note that hereby we say that we propose a new method to predict group choices, but in essence it is a method that generates group recommendations. The reason behind is that in our data set, we collected group choices (decisions), just like in offline evaluation experiments for individual RSs, where individual user's choices are collected, RSs algorithms are then evaluated against predicting these past choices, with a goal to achieve the best possible performance, with respect to a certain, chosen performance measure [GS15].

- **Predictors of the decision-reaching techniques that groups adopt**: Analysing face-to-face discussions of the real groups, we were able to identify certain group characteristics as the significant predictors of the decision-reaching technique that the group at hand is the most likely to adopt during their decision-making process. Again, this contribution is more theoretical in its nature, and we believe it will find its practical uses in the future research of decision support systems.

1.4 Structure of the thesis

The rest of the thesis is organized in eight chapters, and in this section the abstracts of those chapters are presented.

Chapter 2: Literature Review

In this chapter an overview of the related work and the background theory is provided. First of all, the rise of the tourism industry in the last decades, and the role of the eTourism platforms is elaborated, motivating the research in the travel and tourism domain, in general. Secondly, an introduction to the RSs is provided, and concrete examples of the tourism RSs implementations. Then, the GRSs literature is reviewed in details, more specifically, preference aggregation strategies (i.e., methods to combine individual preferences into a group preference model), role-based, and influence-based models, together with the GRSs in the travel and tourism domain. Finally, the background theory, related to the individual and group characteristics recognized as relevant aspects when analysing group decision-making process, is presented. The background theory covers personality theory (i.e., Big Five factors, and Thomas-Kilmann conflict resolution styles), short-term travel-related typology (i.e., 17 tourism roles), social identity theory, the theory of social networks, etc. Therefore, this chapter positions the work conducted in the thesis within the knowledge-base, and it introduces various aspects that will be explored throughout the thesis.

Chapter 3: Data Acquisition and Data Description

This chapter is organized in three major sections: 1) Data collection procedure; 2) Definition of derived constructs; and 3) Descriptive statistics.

Based on the literature review and the background theory from the previous chapter, the data collection procedure, together with the measurements is defined. The data was collected in a three-phases study, where participants were observed before, during, and after the group decision-making task. In the next section, constructs derived from the observed measurements (obtained in the data collection procedure), used throughout the thesis in the various analyses, are described. In the last section of the chapter, descriptive statistics of the observed, as well as, of the derived constructs is presented.

Chapter 4: Preferences and Group Decision-Making Process

In this chapter, as the first analysis discussed in the thesis, the focal point is on group members' individual (group-independent) preferences and their role in the group decision-making process. Since this section covers three distinctive analyses, presented in three sections, with a goal to answer RQ 1, hereby we summarize the three sections separately:

1. In the first part, the focus is on the role of the match/mismatch between individual and group preferences (group choice) in the group decision-making process. The analysis shows that match between group members' preferences and the actual group choice, correlates with group members' individual choice satisfaction, however, this relationship is only moderate in its magnitude. Therefore, in this section the answer for RQ 1.1 is provided.

2. In the second part, the role of group diversity (i.e., diversity of group members' individual, explicit preferences) in the group decision-making process is evaluated. The analysis indicates that high diversity of group members' preferences has a negative effect on the individuals' "well being" (it decreases individual satisfaction with the group choice, and "happiness" with belonging to a specific group, while it increases the perceived difficulty of the overall process), as well as on the group performance. However, it does not necessarily show that members of highly diverse groups are dissatisfied with the group choice - even though choice satisfaction is decreased in diverse groups, majority of participants are still satisfied. Hence, in this section RQ 1.2 is answered.

3. In the third part, two approaches for predicting actual group choices are proposed. The first approach is based on network science, and, in particular, it relies on the computation of node centrality scores in preferences similarity networks of groups. Here, network relationships between pairs of group members are measured by their pairwise preference agreement, by means of Spearman's Footrule Distance. In the second approach, a non-linear (exponential) remapping of the individuals' preferences is used in the well-known preference aggregation strategies. The results indicate: 1) non-linear remapping of preferences is useful to better predict group choices and generate recommendation; and 2) the weighted approach predicts the actual group choices more accurately than the current state-of-the-art methods for group recommendations. Thus, this section answered RQ 1.3 and RQ 1.4.

Chapter 5: Personality, Travel Types and Group Decision-Making Process

In this chapter, an analysis that explores the role of personality, and travel-related types in the group decision-making process is presented. More precisely, 1) whether the members' individual satisfaction with the group choice depends on their personality, and their travel types, and 2) whether the group performance, depends on the group composition of the members' personality types. The analysis shows that group members' personality characteristics is related with their satisfaction levels (i.e., Big Five factors,

and the travel-related types) in ways that are consistent with the existing literature. At the group level, looking at the group composition in terms of group members' personality types, the results indicate that mixed groups, with respect to Thomas-Kilmann conflict resolution styles, perform the best in the group decision-making process, managing to reach an agreement that satisfies everybody almost equally. Hereby, RQ 2, together with sub-questions RQ 2.1, and RQ 2.2, is answered.

Chapter 6: Social Relationships and Group Decision-Making Process

In this chapter, two aspects related to social relationships within groups are evaluated: 1) social closeness of the group (considered as a group level characteristic), and 2) social centrality of individual group members (considered as an individual level characteristic). The analysis demonstrates that social centrality is hardly an indicator of the social influence in the group decision-making process, which contradicts the state-of-the-art approaches in GRSs. However, socially central group members and socially close groups are significantly more satisfied with group decisions than those who are loosely related. Moreover, hereby it is demonstrated that social relationships are indicators of other concepts relevant for GRSs research, i.e., group identity, perceived group similarity, etc. Hence, RQ 3, and sub-questions RQ 3.1, RQ 3.2, RQ 3.3, RQ 3.4, and RQ 3.5 are answered in this chapter.

Chapter 7: Putting it All Together

GRSs research often overlooks, or disregards the importance of the group members' individual satisfaction with the group choice - not in a sense that group members' satisfaction is not measured in the experiments, but in the way that the research objective is never to identify the determinants of the satisfaction. However, by ignoring these determinants, we cannot build user models, nor group models that will be able to predict whether or not individuals are happy with the suggestions made by the system. Therefore, in this chapter we investigate how well the previously, individually analysed characteristics of groups, group behavior, and group decision-making process fit together in a single model for inferring group members' individual choice satisfaction. Hereby, with the Conditional Process Analysis, we show how various individual and group aspects when brought together in a single model, relate to the choice satisfaction, through direct, mediation and moderation effects. The chapter answers RQ 4.

Chapter 8: A Look at the Process itself

In this chapter, the group decision-making process itself is explored, in particular, variations in the decision-reaching approaches adopted by different groups. In essence, we aim to learn how a GRS should adapt the decision support approach according to the group at hand. The results demonstrate that it is possible to relate certain group characteristics with the decision-reaching approach that the group adopted. Moreover, we provide evidence that different aspects of the decision-making process can be, and in

essence should be, personalized/adapted according to the characteristics of the group at hand. RQ 5, and sub-questions RQ 5.1, RQ 5.2 and RQ 5.3 are answered.

Chapter 9: Conclusion

Finally, this chapter summarises the main findings of this thesis, provides answers to the stated research questions, describes the limitations of our work and proposes future directions for research in this area.

Figure 1.3 illustrates the structure (a road-map) of the thesis. Clearly, the research has begun with the literature review, which led us to the design of the data acquisition procedure. With the collected data we started with the analysis about the role of explicit preferences in the group decision-making process, presented in Chapter 4. The results of this analysis, together with the two previous steps motivated us to explore the effects of personality, travel types and social relationships on the group decision-making process, presented in Chapters 5 and 6 respectively. In parallel, we were interested in the process itself, and the relationship between group characteristics and characteristics of the process, bringing us to Chapter 8. Finally, as our analyses indicated that the effect of preferences, personality, travel types, and social relationships on the individuals and the process was interrelated, we evaluated the combined effect, presented in Chapter 7.
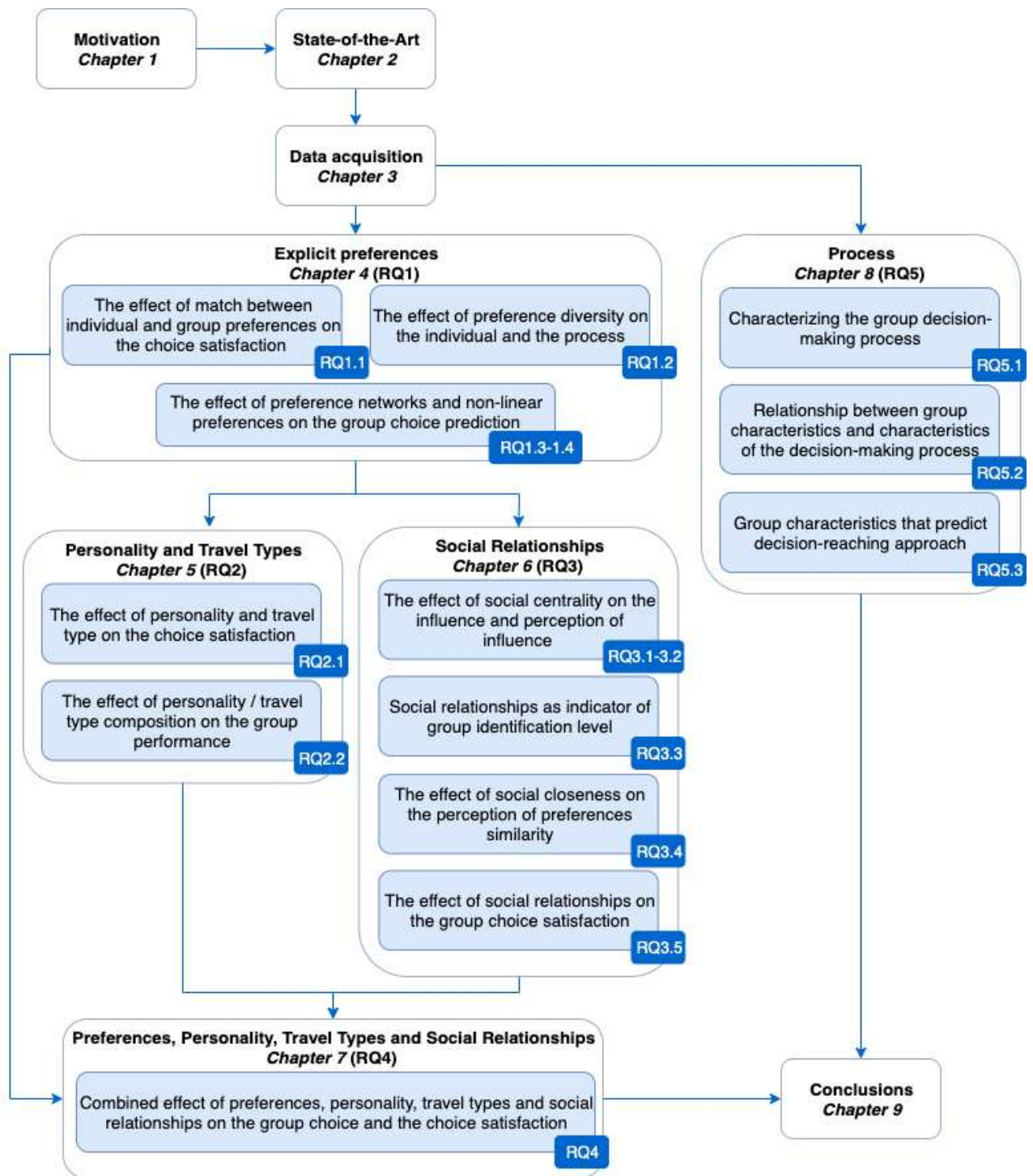
Figure 1.3: Structure of the thesis - Chapters and Research Questions

1.5   Related publications

This thesis expands on the following publications that have been published in the course of this PhD:

- Delic, A., Neidhardt, J., & Werthner, H. (2016). Are sun lovers nervous. In *Research notes at enter 2016 etourism conference.* Bilbao, Spain.

- Delic, A. (2016). Picture-based Approach to Group Recommender Systems in the E-Tourism Domain. In *Proceedings of the 2016 Conference on User Modeling Adaptation and Personalization* (pp. 337-340). ACM.

- Delic, A., Neidhardt, J., Nguyen, T. N., Ricci, F., Rook, L., Werthner, H., & Zanker, M. (2016). Observing group decision making processes. In *Proceedings of the 10th ACM Conference on Recommender Systems.* ACM.

- Delic, A., Neidhardt, J., Nguyen, N., & Ricci, F. (2016). Research Methods for Group Recommender System. CEUR-WS.

- Delic, A., Neidhardt, J., Rook, L., Werthner, H., & Zanker, M. (2017). Researching individual satisfaction with group decisions in tourism: experimental evidence. In *Information and Communication Technologies in Tourism 2017.* Springer.

- Delic, A., & Neidhardt, J. (2017). A comprehensive approach to group recommendations in the travel and tourism domain. In *Adjunct publication of the 25th Conference on User Modeling, Adaptation and Personalization.* ACM.

- Delic, A., Neidhardt, J., Nguyen, T. N., & Ricci, F. (2018). An observational user study for group recommender systems in the tourism domain. *Information Technology & Tourism*, (Vol. 19). Springer.

- Delic, A., Masthoff, J., Neidhardt, J., & Werthner, H. (2018). How to Use Social Relationships in Group Recommenders: Empirical Evidence. In *Proceedings of the 26th Conference on User Modeling, Adaptation and Personalization.* ACM.

- Delic, A., & Masthoff, J. (2018). Group recommender systems. In *Proceedings of the 26th Conference on User Modeling, Adaptation and Personalization.* ACM.

- Delic, A., Neidhardt, J., & Werthner, H. (2018). Group decision making and group recommendations. In *2018 IEEE 20th conference on business informatics (CBI).* IEEE.

- Tkalcic, M., Delic, A., & Felfernig, A. (2018). Personality, emotions, and group dynamics. In *Group Recommender Systems.* Springer

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1.6 The personal journey

At the beginning of this PhD project, the plan was to design and implement a group recommender system for travel destinations. It was intended that the GRS extend the picture-based approach of Neidhardt et al. [NSSW14, NSSW15], just as presented in [Del16]. As a quick reminder for a reader, the picture-based approach elicits user preferences from a set of predefined pictures that illustrate different generalized types of vacation (destination). The user is asked to select his/her favourite three to seven pictures, based on which a user profile is computed, and accordingly a set of recommendations (destinations) is generated. The core of the picture-based approach is actually the seven-factor user profile (captured with the picture selection process). The seven factors are orthogonal dimensions that, in a way, represent the "travel personality" of a user. They indicate travel behavioral patterns, but they as well account for personality of a user.

Clearly, extending such an approach to groups is a challenging task. The common approach of GRSs is to aggregate individual preferences into a group preference model, but these preferences are usually in the form of ratings or rankings of items. However, simply aggregating the seven factors to represent the group as a whole was not really acceptable - the meaning of seven factors in comparison to ratings and rankings is quite different, therefore, in order to treat them in the same way we had to better understand the overall group decision-making process, individual and group preferences (implicit and explicit), and the role of personality in all of it.

To this end, the first user study was designed, hoping that it would shed light on our understanding of the issue, and that it would help us to make certain decisions about the design of the GRS. Having collected the data, we had the opportunity to look at the topic from different perspectives, and while doing this the initial results indicated that it is of tremendous importance to account for yet another concept present in group context - the social relationships. Therefore, we designed and implemented another user study that collected additional data about implicit (travel behavioral patterns) and explicit user preferences, personality, social relationships and social influence.

The two studies, collected data, and various analyses resulted in quite some research activities, but in the capacity of the PhD research, no time was for a design and implementation of a GRS, and our initial goal was in fact navigated to a different direction. Nevertheless, the research outputs did help us to better understand how people in groups reach decisions, and in the future, these findings will help us design and develop a GRS that extends the picture-based approach, but as well takes into the consideration other aspects shown as relevant in this particular context.

CHAPTER 2

Literature Review

The purpose of this chapter is to motivate and position this PhD work from a set of perspectives, i.e., travel and tourism domain, GRSs research, and group behavior analysis.

2.1 Travel and tourism domain

The travel and tourism industry is one of the largest, and fastest growing in the world, with approximately 2.5 trillion US dollars of direct contribution to the global economy in 2017, which is 34% increase from 2006[1]. When factoring in the direct, indirect and induced contributions, travel and tourism accounts for 10.2% of global GDP[2]. Moreover, international tourist arrivals increased from 528 million in 2005 to 1.19 billion in 2015[3], according to *Statista*[4].

Online travel industry consists of travel e-commerce platforms that sell products such as flights, hotels, rental cars, package travels, etc. With the development of these e-commerce platforms, online travel sales, also, record a steady growth - in 2014 14.1% (global online travel sales totaled 470 billion US dollars), in 2015, even 15.4% growth[5], and in 2016 it reached 564 billion US dollars[6]. The largest share of online travel sales was generated by North America (35.8% in 2015), followed by Asia Pacific (28.4%), and Western Europe (26.2%)[7]. Interestingly, OTAs (Online Travel Agents - third party booking websites,

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[1]https://www.statista.com/topics/962/global-tourism/

[2]https://www.wttc.org/-/media/files/reports/economic-impact-research/regions-2017/world2017.pdf

[3]https://www.statista.com/topics/962/global-tourism/

[4]www.statista.com

[5]https://www.statista.com/statistics/499690/forecast-of-online-travel-sales-growth-worldwide/

[6]https://www.statista.com/statistics/499694/forecast-of-online-travel-sales-worldwide/

[7]https://www.statista.com/statistics/499760/forecast-of-online-travel-sales-share-by-region/

e.g., Expedia, that enable easy search of travel providers) occupied 39% of digital travel market in 2015, and predictions say that the share will reach 41% in 2020[8].

To emphasize the importance of online platforms, and their growth in popularity, a study conducted in US in 2017 showed that 95% of participants prefer to use online channels when searching for spring vacation destinations[9]. Moreover, only 12% of respondents said they prefer offline channels for booking a hotel[10], and 17% for booking a transport[11]. A study carried out by *Think with Google* and *Phocuswright*[12] indicates that almost 57% of US travelers think that online platforms should personalize information and services according to the past behavior and preferences of their users. *"For marketers, there's a great opportunity to assist today's travelers with decision-making at every step of the journey"*, since: a) only 9% of US travelers know a priori which brand they want to book; b) 76% of US travelers would probably sign up for a loyalty program that provides tailored information and travel experience based on their previous preferences; and c) 36% of them would pay more for such a service. To this end, customers' needs open new possibilities for online platforms and research in the travel and tourism domain.

Personalization (and recommendations) within the tourism domain faces some specific challenges according to Werthner [WR04]: 1) The tourism product is more complex, as it is a combination of products and services, and at the same time it is less tangible; 2) It is much more expensive, budget-wise and time-wise, to experience a tourism product than other types of products, such as books, movies, music, etc.; 3) It is an emotional experience and explicit preference characterization is problematic especially in the early phases of the travel decision-making process; 4) The lack of knowledge about the past user behavior and preferences directly affect the quality of personalization (recommendation) approaches, such as collaborative or content-based filtering (explained in the further text); 5) Traveling is a social activity, thus, adaptation according to an individual user might be useless. Therefore, when building personalization systems, such as RSs, in the travel and tourism domain, these challenges should be accounted for. To this end, a great amount of research in the travel and tourism domain, that is summarized later in this chapter, has been dedicated to model user preferences and to exploit them in order to deliver personalized service.

2.2 Recommender systems (RSs)

Hereby, an overview of the RSs approaches and their application in the tourism domain is provided.

RSs use a variety of approaches to deliver personalized information and services to their users [FWW06]. In general, Burke [Bur07] classifies RSs approaches based on the type

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[8]https://www.traveltrends.biz/ttn555-otas-increase-market-share-at-suppliers-expense/

[9]https://www.statista.com/statistics/666622/preference-of-online-or-offline-vacation-research-us/

[10]https://www.statista.com/statistics/666695/preference-of-offline-planning-spring-vacations/

[11]https://www.statista.com/statistics/666664/preference-of-online-or-offline-transport-booking-us/

[12]https://www.thinkwithgoogle.com/consumer-insights/age-of-assistance-travel-marketing/

of user data that the system exploits in order to deliver recommendations, and proposes the following classification: a) demographic-based, b) collaborative-filtering, c) content-based, and d) knowledge-based recommendation approaches. Often, a combination of these approaches is employed, as a hybrid approach, in order to obtain more accurate recommendations and to overcome various weak points of the single approaches. In the following, these basic recommendation approaches are shortly introduces.

Demographic-based approach is one of the simplest approaches that uses the "demographic profile" of a user. "Demographic profile" usually contains user data, such as, *age*, *gender*, *country*, etc. These user characteristics can serve as means to find similar users, and then provide appropriate recommendations. The advantage of this approach is that recommendations can be provided to a new user without inquiring for her preferences, however, the greatest drawback is the limited personalization (i.e., only based on the demographic data).

Collaborative-filtering approach (CF) is a technique that generates recommendations for a user by exploiting the preferences of other people similar to that user [HKTR04]. Most often, the preferences are expressed in form of ratings. Thus, a RS does not need item features in order to deliver recommendations. Basically, a rating is a value for an item, given by a specific user and represents the extent to which the user likes that item. A rating can be either given in an explicit form (e.g., the user gives an explicit opinion on an item), or in an implicit form (e.g., by observing the user's interaction with the system and monitoring her behavior, i.e., clicks, transactions, viewing duration, etc.). Scalar ratings are heavily used for collaborative-filtering approaches, but other rating schemes can be used as well, including binary models (e.g., likes/dislikes) or even unary models (e.g., clicked, purchased, etc.) [BM07]. In essence, regardless of the user preference model, the approach generates recommendations based on the *historical data of similar users*. This means, given an active user, and her previous item-ratings (historical data), the task of the approach is to: 1) find similar users (i.e., neighbors), by using some similarity function (e.g., Pearson correlation, cosine similarity, etc.) for the items that the active user has rated; 2) predict ratings for the previously unseen items by the active user, based on the identified neighborhood of the active user [SKKR01].

The advantage of CF approach is that it does not need any content-related information about items, nor users, for delivering recommendations (it is domain-independent). However, a critical issue is the, so-called, *cold-start problem* [SKKR01]. The cold-start problem happens when new items (users) are added to the system, having that the new items have no recorded ratings (the new users provided no item-ratings) [SPUP02]. In this case, or when there are too few ratings available, it is either impossible to calculate recommendations, or the quality of recommendations is low. Moreover, even well-established RSs may have to fight against the sparsity problems (i.e., majority of users rate only a small portion of the items available in the system) [DK11].

Content-based approach exploits features of items that a user has previously rated [PB07, LDGS11]. The idea is to find items that have similar features to those which the user already liked. Then, items with the highest similarity are recommended. In case of unstructured data (e.g., textual descriptions, news articles, etc.), information extraction techniques are used to convert the unstructured data to a structured representation. For instance, text can be represented in a vector space model based on TF-IDF (term frequency - inverse document frequency) scores [Aiz03, LDGS11]. Clearly, to learn a user model, a RS looks into the historical data of user's likes, and dislikes. Here, the same as in CF approaches, user preferences can take the form of either explicit or implicit feedback. A number of algorithms have been proposed in order to estimate the user's interest in a new item, based on her known preferred items [PB07, LDGS11].

Content-based RSs easily avoid sparsity problems, since they do not need ratings of a community to provide recommendations. These approaches perform well if the items are properly represented. However, in certain situations this is a rather challenging task (e.g., multimedia content such as images or video). Additionally, content-based approaches might suffer from over-specialization, i.e., due to the applied similarity metrics, users are narrowed by rather similar items being recommended.

Knowledge-based approach generates recommendations based on user's explicit requirements [Bur00]. The domain knowledge, used to associate user requirements with the items, is stored in a knowledge base. The knowledge base does not store ratings or previous user preferences. Knowledge-base RSs are typically employed when deep knowledge about the product domain is required, e.g., computers and computer equipment, cameras, financial services, etc. For such complex products, more intelligent interaction mechanisms are required that engage the user in a form of a dialogue in order to find products/services that fit the user's needs and pre-defined constraints. Usually, the "conversation" is used to elicit the requirements of the user which serve as an input to find appropriate solutions. If no solution can be found, relaxation of filter constraints can be used to come up with at least one suggestion [FFJZ06].

Clearly, the advantage of such systems is that they do not have a cold-start problem, as their recommendations are not based on user-item ratings. They also do not require a pre-defined user model as they follow a conversational approach that elicits users' preferences interactively. However, establishing a knowledge base is quite expensive, usually done manually by the domain experts.

2.3 Personalization in the travel and tourism domain

As previously mentioned, personalization, user modeling, and RSs in the travel and tourism domain face specific challenges that are not really common in other domains. Particularly, the emotional aspects of tourism products, the fact that there is a lack of data about user past behaviors and preferences, and that recommending tourism products, such as destinations, is far more riskier than recommending books or movies.

In [GSO11], actually, two types of tourism RSs are distinguished, i.e., 1) RSs that help users to select a destination to visit; and 2) RSs that help users select activities that can be performed at a certain destination. In this PhD thesis, we are analysing group decision-making process in which a group decides on a destination that they would like to visit together. Hereby we will mainly focus on the tourism RSs that deal with travel destinations, and that characterize users according to the specificity of tourism products, in order to find appropriate items of interest.

Before introducing tourism RSs, we will shortly present the state-of-the-art in the travel and tourism domain that deals with characterisation of tourists' preferences and behaviour.

2.3.1 Traveler types

Understanding travellers' behaviours, needs and interests is a hot researched topic in the travel and tourism industry. In the early days, two purposes of traveling were distinguished, i.e., the leisure and business-related travel. Cohen [Coh74] investigated these distinctions and identified four travel roles: *Organized Mass Tourist*, *Individual Mass Tourist*, *Explorer* and *Drifter*. Moreover, in [Coh72], he tried to find a relationship between the travel behavioural patterns, on the one side, and interests, needs and social environment of an individual, on the other. Following this line of literature, Pearce [Pea13] identified 15 travel roles using fuzzy set analysis (i.e., *Tourist*, *Traveller*, *Holidaymaker*, *Jet-setter*, *Businessman*, *Migrant*, *Conservationist*, *Explorer*, *Missionary*, *Overseas student*, *Anthropologist*, *Hippie*, *International Athlete*, *Overseas Journalist*, and *Religious Pilgrim*). Furthermore, in a three phases study, Yiannakis and Gibson [YG88] defined 15 tourist roles:

1. *Action Seeker* ("Mostly interested in partying, going to night clubs and meeting people for uncomplicated romantic experiences");

2. *Active Sport Tourist* ("Primary emphasis while on vacation is to remain active engaging in favourite sports")

3. *Anthropologist* ("Mostly interested in meeting the local people, trying the food and speaking the language");

4. *Archaeologist* ("Primarily interested in archaeological sites and ruins; enjoys studying history of ancient civilizations")

5. *Drifter* ("Drifts from place to place living a hippie-style existence");

6. *Educational Tourist* ("Participates in planned study tours and seminars to acquire new skills and knowledge");

7. *Escapist* ("Enjoys taking it easy and getting away from it all in quiet and peaceful places");

8. *Explorer* ("Prefers adventure travel, exploring out of the way places and enjoys challenge in getting there");

9. *High Class Tourist* ("Travels first class, stays in the best hotels, goes to shows and enjoys fine dining");

10. *Independent Mass Tourist* ("Visits regular tourist attractions but makes own travel arrangements and often plays it by ear");

11. *Jet-setter* ("Vacations in elite, world class resorts, goes to exclusive night clubs, and socializes with celebrities");

12. *Organized Mass Tourist* ("Mostly interested in organized vacations, packaged tours, taking pictures/buying lots of souvenirs");

13. *Seeker* ("Seeker of spiritual and/or personal knowledge to better understand self and meaning of life");

14. *Sun Lover* ("Interested in relaxing and sunbathing in warm places with lots of sun, sand and ocean");

15. *Thrill Seeker* ("Interested in risky, exhilarating activities which provide emotional highs for the participant").

Their study was conducted using a 30 items questionnaire named "Tourist Role Preference Scale". In the questionnaire, each role was related to two questions. Later on, Yiannakis and Gibson [GY02] studied the influence of the psychological needs and the demographic characteristics on these 15 roles. They found statistical evidence of a correlation between the tourist roles and the life stage, gender, and personal needs. Moreover, they subdivided the roles Escapist and Independent Mass Tourist into two new categories each, namely *Escapist I* ("Enjoys taking it easy away from the stresses and pressures of home environment"), and *Escapist II* ("Gets away from it all by escaping to peaceful, deserted or out of the way places"); and *Independent Mass Tourist I* ("Visits regular tourist attractions but avoids packaged vacations and organized tours"), and *Independent Mass Tourist II* ("Plans own destination and hotel reservations and often plays it by ear").

Gretzel et al. [GMHF04] studied the impact of twelve travel personality types (i.e., *Culture Creature*, *City Slicker*, *Sight Seeker*, *Family Guy*, *Beach Bum*, *Avid Athlete*, *Shopping Shark*, *All Arounder*, *Trail Trekker*, *History Buff*, *Boater* and *Gamer*) on the choice of travel activities and travel destinations. Survey data were collected in Chicago and Northern Indiana. The study showed a significant relation between travel personality types and the choice of travel activities, but no relation between these travel personality types and the choice of the travel destination. A similar study was conducted by Moscardo et al.[MMP+96], analysing the choice of travel destinations based on the travellers' motivations and preferred activities during their vacation. The study identified relationships between the benefits that traveller seek and the activities that travellers undertake.

In this PhD, in order to characterize these "unaware", travel-related preferences, we use the 17 Tourist Roles by Yiannakis and Gibson [GY02]. The reason behind is the seven factor model for characterizing travelers' behavior, introduced by Neidhardt et al.[NSSW14, NSSW15]. The authors did a factor analysis on a data set comprising

information about the 17 Tourist Roles, and the Big Five Factor model (a personality model explained in further text), for nearly a thousand study participants. The analysis yielded seven basic traveler types, i.e., *Sun & Chill-out*, *Knowledge & Travel*, *Independence & History*, *Culture & Indulgence*, *Social & Sport*, *Action & Fun* and *Nature & Recreation*, which actually combine user short-term travel related preferences (i.e., Tourist Roles), and the rather long-term behavioral patterns (i.e., personality traits). In this thesis, we will, nevertheless, treat the 17 Tourist Roles and the personality traits separately, in order to determine their role and to quantify their lone weight in the group decision-making process. However, in the future work, according to our findings, the goal is to use the seven factor model as a representation of users' (group members') implicit travel preferences.

2.3.2 Examples of tourism recommender systems

Not so many tourism RSs actually characterize their users in terms of the travelers' types/roles. A simple example is the *AirBnBs Trip Matcher* [Air17], which makes use of the ten predefined travelers' types. In this approach, the user answers a number of questions based on which his traveller type is estimated. Then, the system accordingly recommends a destination. In contrary to the AirBnB's plain approach, a rather sophisticated tourism RS, that relies on the previously introduced seven factor model, is a picture-based RS. For each of the seven factors, pictures were identified that represent the respective factor. Then, user preferences are captured by prompting the user to select pictures from this predefined set. By mapping the selected pictures onto the seven factors, a score for each of the factors can be determined for the user. Since destinations can be represented with respect to the same seven factors, the recommendations for a user can be calculated as Euclidean distance between his/her user profile and the destination. User interface of the picture-based approach is illustrated in figure 2.1. Figure 2.1a illustrates the picture set, and the picture selection option. Then, in figure 2.1b, user profile that is calculated from the picture selection, is shown. Finally, figure 2.1c depicts a set of recommendations generated from the calculated profile.

Another destinations RS, introduced in [DAA09] follows a hybrid approach, combining the content-based and case-based reasoning approaches, to generate recommendations. To characterize destinations, the authors used a destination context ontology, which comprised social attributes of destinations (e.g., crime rate, volume of traffic, noise level). Initial recommendations were revised based on the social attribute preferences of the user. In the Reisewissen project, presented in [GNM06], a hotel recommendation engine was developed. The approach uses the Semantic Web technology to facilitate the hotel search process. User requirements are matched against hotel characteristics, resulting in a ranked list of suitable hotels. Huang and Bian [HB09] designed a personalized recommendation approach for city attractions. The approach employs Bayesian network techniques to deliver personalized recommendations by taking into account different aspects, i.e., tour motivation, traveler type, occupation and personality. In [GNW17], the authors propose an ontology-based matching between user preferences and tourism

(a) Preference elicitation

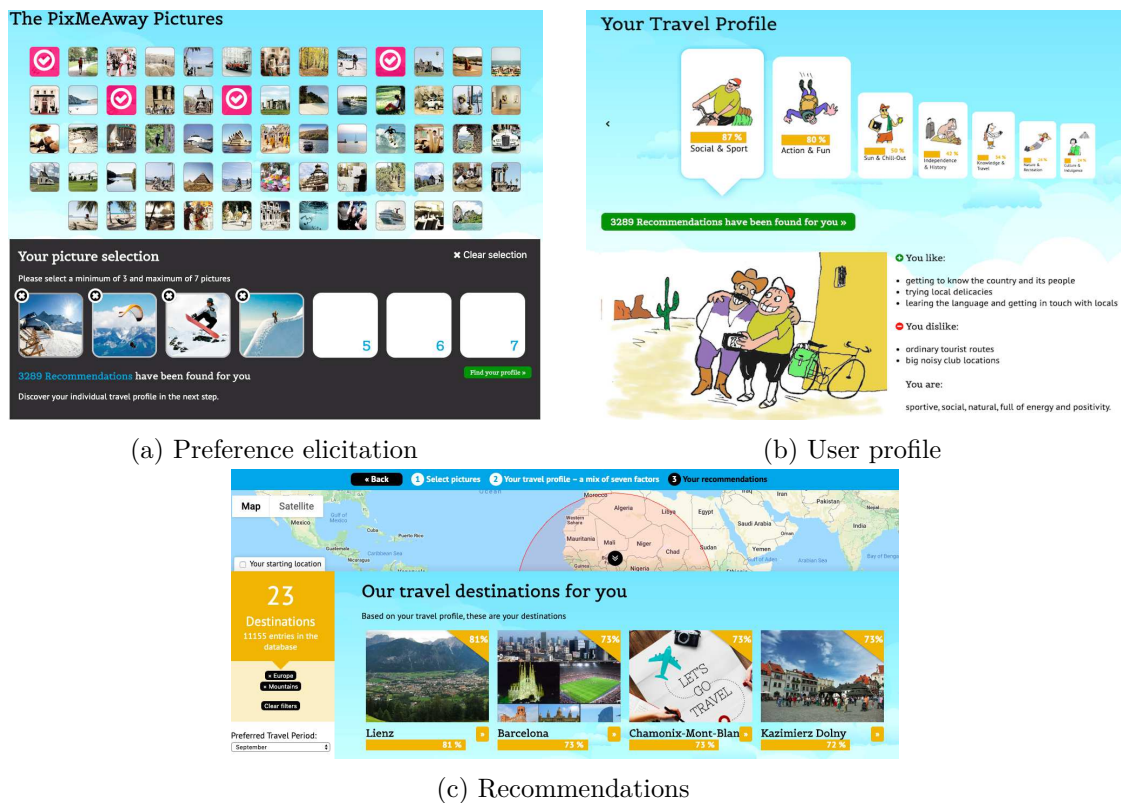(b) User profile

(c) Recommendations

Figure 2.1: PixMeAway Recommender System - The picture-based approach

objects (city attractions). However, to produce the initial set of recommendation, users are asked to rate their level of belonging to each of the seven factors, as defined in [NSSW14]. Then, based on the user's interaction with the recommeded tourism products, the user profile is updated using a tourism ontology, and a new set of recommendations is generated.

The popularity and global acceptance of the mobile devices have resulted in tourists requesting personalized advises not only during the trip planning phase, but also during their stay at a destination [GWP+08]. In this particular context, the information overload problem becomes even more evident due to the certain features of mobile devices (e.g., small screen, no keyboard, low data transfer rates). However, mobile devices have a clear advantage over the desktop computers, i.e., context-awareness. Context-awareness is the ability to make use of the contextual information (e.g., user location, time of the day, or of the week, weather conditions, etc.) to adapt user interaction with the application according to the current, context of the user. For example, the etPlanner system [HFZ+06] offers personalized information about events, sights, restaurants or accommodations and notifies user about changing weather conditions. Research about mobile, context-aware services has resulted in a wide range of mobile tourist guides [SGPR09]. Since one of the first famous prototypes [AAH+97], the sophistication of

mobile guides has increased, and research in this field now specializes on topics such as personalization, recommendation, context-awareness together with the new forms of user interaction, collaborative usage and social integration.

2.4 Group recommender systems (GRSs)

As previously mentioned, often, items that are recommended, involve activities that are experienced by a group of people, rather than by a single user, e.g., movies, music, restaurants, events, destinations, etc. Hence, research on RSs is more and more dealing with systems that generate recommendations of items that are supposed to be consumed/experienced jointly by a group of people [Mas15]. Group recommendations, unlike single-user recommendations have a task to satisfy all group members as much as possible. The applications of group recommenders can be found in variety of domains, music [MA98], movies [OCKR01], TV program [YZHG06], restaurants [GRB11], tourism destinations and points of interest [MSC+06, AGP+03].

Hereby, in order to offer a comprehensive overview of the state-of-the-art in GRSs, different research focuses are separately addressed, as follows.

2.4.1 Aggregation strategies

Previously, the four main challenges of GRSs [Jam04] were introduced. Current research is mostly focused on the second challenge, i.e., how individuals' preferences should be combined into a group preference model. Aggregation strategies are methods that combine individual preferences. Three types of aggregation approaches are defined [JS07], depending on the moment in which the aggregation is done: 1) In the first approach, the RS first generates recommendations for each group member individually and then, in order to produce a group recommendation, it aggregates the individuals' recommendations; 2) In the second approach, the RS first predicts the ratings of group members, and then aggregates predicted ratings into a group rating in order to calculate group recommendations; finally, 3) In the third approach the system generates recommendations by using a group preference model that is built from the existing information about group members.

Social Choice Theory

Commonly used aggregation strategies, i.e., methods to aggregate either *individuals' recommendations* into a group recommendation or *individuals' ratings* into a group rating, are derived from Social Choice Theory [Mas15]. The Social Choice Theory studies the link between individuals' preferences and social choices, and it explores different approaches of combining preferences, opinions, and interests of individuals in order to obtain the best possible collective decision. According to the Arrow's theorem [Arr63], an optimal aggregation strategy does not exist. As a result, a variety of aggregation strategies are required.

- *Plurality voting* - each group member votes for a preferred option and the one with the largest number of votes wins.

- *Borda count* - each group member creates a ranked list of options according to his/her preferences; points are assigned to options, separately for each individual, based on the position of an option in a list (i.e., the last option gets zero points, the second last receives one point, etc.); a group score for an option is calculated as the sum of the individually assigned points; the option with the highest score wins.

- *Copeland rule* - firstly, the pairwise comparison of options is applied, and for each option the number of wins and losses against all other options is counted (i.e., we count how many times an option was rated/ranked higher by group members in comparison to other options). To obtain group scores, number of losses is deducted from the number of wins; the option with the highest score wins.

- *Additive* - individuals' ratings are summed up, the option with the highest score wins. Possible implementations of the additive strategy are to calculate the mean value (i.e., average strategy) or the median value (i.e., median strategy) of the individuals' ratings.

- *Multiplicative* - individuals' ratings are multiplied, and the option with the highest score wins.

- *Approval voting* - individuals' ratings for an option above an approval threshold is counted and the option with the largest number of approvals is selected.

- *Least misery* - a group score is the minimum of individuals' ratings; the strategy assumes that a group is as satisfied as its least satisfied member.

- *Most pleasure* - a group score is the maximum of individuals' ratings; the strategy assumes that a group is as satisfied as its most satisfied member.

- *Weighted average* - based on certain metrics, weights are assigned to group members, and thus, a group score is a weighted average of individuals' ratings; the strategy assumes that in certain cases the wishes of some group members should be valued more than those of other group members.

Each strategy has its pros and cons since each of them aims to optimize for distinctive criteria. The *Average* strategy, for instance, aims to make a fair choice by equally accounting for all the group members' preferences. On the contrary, *Least misery* is can be employed when some members have extreme preferences (e.g., a vegetarian cannot eat meat). In the same manner, the *Plurality Voting with Veto* strategy enables members to avoid a selection of an item which they might absolutely hate [MZ15a]. Various empirical studies showed that there is no winning strategy, and the choice of strategy should be guided by the characteristics of a specific domain, tasks and group scenarios [Mas15].

Other aggregation strategies

Salamó et al. [SMS12] introduced alternative aggregation strategies, named "purity" and "completeness" with a goal of reaching a consensus on the group recommendations.

The "purity" of an item in a group measures how many positive preferences are given to that item within the group. Then, to measure the dispersion of preferences for the item within the group, the deviation from the mean of the members' preferences is used. The second aggregation strategy, "completeness", has a goal to favor high satisfaction scores of individual group members in accordance with their preferences while, at the same time, penalizing high differences in the score between the members.

Several studies in GRSs, have addressed the preference aggregation problem with the help of Multi-agent Systems (MAS) and their negotiation mechanisms. Carvalho and Macedo [CM13] consider a group decision process, users and items as a non-cooperative game, game players and game actions, respectively. Then, the payoff function is clearly the satisfaction of each member from the items chosen by other members in the decision process. The possible recommendations are viewed as the Nash Equilibrium of the game.

Another approach to address the issue of aggregating individuals' preferences was based on the Multi-Attribute Utility Theory (MAUT). In general, given a set of options described with a set of attributes (criteria), MAUT aggregates these attributes for each option with a help of a function, then the best option is the one for which this function is maximized [Dye05]. For instance, in [SFL$^+$15], the authors introduced a Group-based MAUT. It represents group members' individual MAUT values as the weighted average of their individual ratings for the features of a specific option. Then the sum of all these individual MAUT values is calculated in order to rank that option.

2.4.2 Influence and roles in GRSs

A very important section of the research on GRSs is dedicated to defining and identifying 1) the influence that a group member can have on determining the final choice of a group, and 2) the role that a group member plays in a group. The first researchers that tackled this issue were Masthoff and Gatt [MG06]. They defined group models that accounted for two types of influence: a) emotional contagion, and b) conformity. In essence, emotional contagion is a phenomenon of transferring emotions from one individual to another. In their emotional contagion model, the satisfaction of one group member depends not only on the items being recommended to the group but also on the difference between that group member's satisfaction and the satisfaction of others in the group. Conformity in groups, on the other side, can occur as a result of the majority or the minority influence [For18], and it is defined as *a change in opinion, judgment, or action to match the opinions, judgments, or actions of other group members or the group's normative standards* [For18]. In [MG06], the authors modeled conformity as the *informational influence* (i.e., trust-based conformity) in the group. In *informational influence*, a person conforms truly, in the sense that the person trusts another one, and therefore changes her opinion accordingly. Thus, to quantify the extent of conformity, the authors considered the difference between individual's opinion and the opinion of some subgroup, the size of that subgroup and also the number of people outside of that subgroup.

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Later on, contributions from other researchers arose and different types of role-based and influence-base group recommendation approaches were introduced. For example, a very simple role-based approach was introduced and evaluated in [AK15]. The authors defined group roles and corresponding weights based on the group member's activity in the system, i.e., the more item-ratings a group member provided the greater the weight would be. The weights are then used in an aggregation strategy to compute group recommendations. It is noteworthy that the group context was disregarded and only individually provided item-ratings were considered. In the work of Berkovsky & Freyne [BF10], three role-based models were proposed for family group types, and all three took the similar approach as in the previous case. The first one assigned weights to family members based on their role in the family. The other two weighting models defined weights based on the level of user interaction with the content, i.e., 1) Considers number of ratings of all the users with a specific role (regardless of group) compared to number of ratings provided by all the users; 2) Considers number of ratings provided by a single user compared to number of ratings provided by the belonging family. Therefore, the main difference is the integration of the group context in the models. Another approach introduced in [GXL$^+$10], defined weights based on the number of item-ratings, but only considering a pre-selected set of movies. The authors selected 100 popular items and determined the *expertise* (i.e., influence) of the group members as the number of ratings that each of them has provided for these selected items. It is noteworthy that none of these approaches observed the group behavior or the actual activity of a group member in the group.

A considerably different approach was introduced by Quijano-Sanchez et al. [QSRGDAJD13]. The influence of group members was defined as a function of a) personality strength of each group member in pairwise comparison to others in the group, and b) social trust between pairs of group members. The approach assumes that the influence of one person on another depends on the difference between the strengths of their personalities (i.e., assertiveness) and the level of trust that they share. Another group recommendation approach described in [ACS14] also defines and uses social relationships as an indicator of influence. However, in comparison to the previous model, the authors considered three social aspects: 1) Social trust as the affective relationship between pairs of group members, 2) Social similarity between pairs of group members, and 3) Social centrality of each group member in the social environment. Finally, in [QRT16], the authors defined influence based on the match/mismatch between users' individual choice and the group choice in which the user has participated. For example, if a user was a member of six different groups and her preferred option was selected as the group choice in three out of six cases, then her weight in the influence-based model is $3/6 = 0.5$.

In this PhD thesis, one of the contributions is a role-based model that we developed. The model that we propose is a considerably different one as it considers group members' pairwise preference similarities in order to define weights of the group members in an aggregation strategy, without making advantage of other characteristics of group members or the group. In our best knowledge, such a model has not yet been proposed.

2.4.3 GRSs in the travel and tourism domain

Various research activities were dedicated to develop and evaluate GRSs to support group decision-making process:

- *Intrigue* [AGP$^+$03] assists tour guides to plan touristic tours for heterogeneous groups with somewhat homogeneous subgroups (e.g., children, elderly). The system generates personalized recommendations by matching the attributes of tourism attractions to the explicitly given preferences of subgroups, and it uses the weighted average strategy to build a group preference model. The weights applied in the aggregation strategy are adjusted to the subgroup importance.

- *Travel Decision Forum* [Jam04] is a system that allows its users, i.e., group members, to decide on preferred attributes of a joint holiday. The main idea of the system is to simulate a face-to-face, asynchronous discussion, by allowing group members to use animated characters. In order to build the group model and to aggregate individuals' preferences, the system uses the additive and median strategies.

- *Trip@dvice* [VR06] is a case-based reasoning RS with a cooperative negotiation methodology approach. The system uses automated negotiation agents as mediators of a cooperative negotiation. The case-based reasoning module generates individuals' recommendations, which are then used as group members' proposals for the group. To generate group recommendations, the negotiation agents apply one of the available negotiation strategies (e.g., maximizing the utility of the least happy group member) and chooses one of the previously generated proposal items as an agreement for the group. Based on different aggregation approaches, the system generates several more suggestions for the group.

- *Collaborative Advisory Travel System* (CATS) [MSC$^+$06] allows group members to express their opinion about each others preferences and preferred options by employing the critiquing approach. Critiquing-based techniques allow users to comment, i.e., critique, a specific item or item-attribute, e.g., *"I would prefer a destination that is not that distant"*, meaning that a user is critiquing the distance attribute of the destination. The system adapts the next set of recommendations accordingly. In CATS, this specific approach was used to support the negotiation process, i.e., group members can comment on each-others' item-attribute preferences and the group model is built as the average of individuals' preferences.

- *Where2eat* is a mobile app for restaurant recommendation that implements *"interactive multi-party critiquing"*, i.e., an extension of the critiquing concept to a computer-mediated conversation between two individuals [GRB11]. The system allows group members to generate proposals and counter-proposals until the agreement is reached.

- *STSGroup* (South Tyrol Suggests for Group) is also a chat-based, and a context-aware mobile application for recommending POIs (Points of Interest) for groups of people [NR17b, Ngu17, NR17a]. An exceptional feature of this system is that

it combines users' long-term preferences (based on the users' previous individual interactions with the system), and the dynamic preferences elicited during the group decision-making process. The system monitors group members' discussion, reactions and interactions and suggests applicable recommendations. STSGroup is a facilitator that guides and helps groups to reach an agreement and to come up to the final decision.

- *Hootle* is a hotel GRS that supports the discussion and negotiation of the features of the desired hotel [MZ15b]. In order to aggregate individual preferences into a single group preference model, the Borda Count method was used. Then the content-based filtering is used to generate group recommendations (based on the aggregated preferences).

- *Choicla* is not a GRS applied in a travel and tourism domain, as the previous examples are, but it has a rather wider scope of applicability. Stettinger et al. [SFL+15] developed a group decision support environment that allows users to provide feature-based feedback to flexibly configure decision tasks in a domain-independent setting.

- *TourRec* [HLW18] is a RS that suggests a route to individuals as well as groups of users. A sequence of POIs is generated by accounting for the starting time and the maximum duration of the trip. Then, surrounding POIs are scored according to the individual's preferences and contextual factors. Finally the system connects POIs in individual recommendation to create a route. To recommend tourist trips for a group of users, various social choice strategies were implemented to aggregate the users' travel preferences such as *Average*, or *Most Pleasure*. The system also allows the group to split during the trip, so that every group member is still able to visit their own favorite POIs.

In this thesis, a GRS will not be developed, as this is not one of the set research goals. However, the objective of our future work is to apply, hereby presented findings in order to generalize the seven factor model, and the picture-based approach of Neidhardt et al. [NSSW14, NSSW15] to a group model, and a GRS.

2.4.4   Evaluation of group recommendations

In order to evaluate group recommendations user studies, as well as, off-line experiments have been employed [TSBF18]. However, how to properly evaluate a GRS is still a major research topic [Mas15, DM18].

User studies

A user study is carried out when the criteria used to measure the system performance are related to system usability and user experiences (e.g., perceived user's satisfaction or recommendation quality) [BF10, GRB11, SFL+15]. This type of study can be conducted by directly interviewing participants or through crowd sourcing sites such as Amazon

Mechanical Turk [BMR17]. This approach, however, cannot be the sole method for evaluating the efficacy of a GRS as the approach does not scale. Nevertheless, user studies are crucial in determining the success of a proposed approach, to evaluate whether or not the system is even accepted by the users [RRS15].

Off-line evaluations

As when evaluating single-user recommendations, off-line evaluations are also used in GRSs research. However, these approaches are hindered since there is a lack of publicly available data sets that capture the preferences of users in actual group settings. As one of the solutions for this problem, researchers have used the so called synthetic groups. Synthetic groups are artificial groups sampled from standard data sets such as MovieLens [BMR10, DPDM14]. The main challenge of this solution is how to properly evaluate effectiveness of group recommendations once they are delivered to such groups. One stream of researchers compares the group recommendations with the joint group assessment of the recommended items, however this is indeed problematic when in essence the ground truth is not known (the actual group choice is not known). Therefore, the researchers assume that the "true" group preferences can be derived from individual preferences by some aggregation strategy, which is exactly the problem of GRSs, and we do not know which aggregation strategy truly represents group opinion. Another stream of researchers compares group recommendations with the individual preferences. This approach assumes that group members' individual satisfaction with the group recommendation depends only on their individual preferences, and the match/mismatch of these individual preferences with the group recommendations, therefore, that preferences of individuals are stable and independent from the group decision-making process, which is actually not the case in most scenarios. In fact, the opinions or judgments of users in a group are likely to be influenced by the other group members (i.e., emotional contagion and conformity effects [MG06]). As a result, specific approaches come into play, for instance, Masthoff and Gatt [MG06] conducted a simulation experiment to understand the impact of their proposed satisfaction functions on predicting users' satisfactions. Moreover, in the context of interactive GRSs, Nguyen and Ricci [NR18] proposed a group discussion simulation model where the impact of alternative combinations of long-term and session-based preferences on the recommendation performance in different group scenarios was studied.

In this thesis, we will use a specifically designed user study in order to collect the data required for testing our hypotheses and answering the stated research questions. The reason behind is clearly the lack of data sets about group decision-making, especially data sets that contain various aspects that are studied in this thesis. The detailed description of the data collection procedure is provided in Chapter 3.

2.5 Group dynamics - the background theory

The research on groups and their performance in particular tasks, such as the decision-making task, has shown that inter-subject relations, group dynamics, group identity,

social relationships, emotions, personality, similarity of interests, opinions, preferences, etc. within the group, play an important role in the final outcomes of those tasks [For18]. However, those aspects are often omitted in the research of GRSs. In this PhD research, on the contrary, we did an extensive review of the social disciplines literature, in order to select individual and group characteristics that are known to influence group decision-making process, that we then study in the context of GRSs, user modeling, and personalization. Hereby, we present those characteristics.

The Big Five Factor model: In psychology research, many models have been developed to capture individuals' characteristics and to explain their long-term behavioral patterns. One of the most widely used models, in this sense, is the five-factor model of personality, also known as the Big Five [MC87]. It breaks down the personality into five orthogonal dimensions: 1) *Openness to new experiences*, i.e., the extent to which someone is prone towards experiencing new and unusual things); 2) *Conscientiousness*, i.e., the extent to which one is precise, careful and reliable, or rather sloppy, careless, and undependable; 3) *Extroversion*, i.e., the extent to which people are outgoing, cheerful, warm, or rather quiet, timid, and withdrawn; 4) *Agreeableness*, i.e., the extent to which someone is altruistic, caring, and emotionally supportive, or rather indifferent, self-centered and hostile; and 5) *Neuroticism* also known as *Emotional stability*, i.e., the extent to which someone experiences distress or rather is calm and even-tempered [MJ92]. The five-factor model of personality has been "converted" in many bigger and smaller measures (i.e., with more and less dimensions) [DOBL06], and is used in a wide range of application domains, including tourism [NSSW14, NSSW15, DNW16]. In our research, the Big Five factors are used to characterize individual, long-term behavioral patterns.

Thomas-Kilmann Conflict Mode Instrument: When individuals engage in decision-making in a group setting, conflict is bound to arise [For18]. Even though conflict in smaller portions can positively contribute to team functioning [DDVdV97], much research exists showing that conflict typically ruins performance and satisfaction levels in teams [DDW03]. The Thomas-Kilmann Conflict Mode Instrument was developed to address the potential conflict resolution styles group members adopt when necessary. By distinguishing between high and low cooperation and high and low assertion, "competing", "collaborating", "avoiding", "accommodating", and "compromising" were identified as possible conflict resolution styles [KT77]. Using the prior studies that have connected the four (i.e., "competing", "collaborating", "avoiding", "accommodating") out of the five styles with the five-factor model of personality [WB08], we were also able to use the Thomas-Kilmann Instrument to describe individuals' behavioral tendencies in conflicting situations.

Social identity theory: Social psychology is a branch of psychology that deals with relations of individuals' circumstantial and social characteristics with individuals' attitudes and behavior in the context of social groups. It analyses the influence of social groups on personal processes, close relationships, intergroup and societal phenomena [FGL10].

Social identity theory emerged as an extension to a wide-spread research on small groups in social psychology, trying to account for another set of dimensions related to the, so called, social identity [Taj10].

Social identity is defined in terms of how one perceives himself/herself in relation to a social environment together with one's sentiment of belonging to that particular social environment. In other words, it is the *"individuals' self-concept which derives from their knowledge of their membership to a social group (or groups) together with the value and emotional significance attached to the membership"* [Taj10]. It is worth noting that social identity theory does not define the general concept of identity or the *"self-concept"*, but it rather claims that an important part of the overall *"self-concept"* is a result of one's association to a certain social group or category. Therefore, the social identity theory explores the role of social identity in relation with how groups of people are formed and how members relate to each other in those groups.

In our research, we focus on the strength of participants' identification with the others in a group (further referred as the *group identification*). In that sense, strong group identification means: a) a member feels a *high level of belonging* to a particular group; b) a member is *willing to participate* in a group activity; and c) a group member *wants to belong* to a particular group. Strong group identification occurs even when preferences related to some specific topic (e.g., in our case travel related preferences) are not shared among group members, but they perceive similarity on a more "fundamental" level, i.e., the social identity level.

Social relationships: Social network analysis focuses on the relationships among social entities. It states that "social environment can be expressed as patterns or regularities in relationships among interacting units" [WF94]. Research has shown that the network perspective provides the new tool for answering social science research questions, and further insights into them. The fundamental component of network theories are the relations between entities defined as linkages. In social networks, entities, also known as actors, are usually individuals, and linkages between them can be of various kinds, e.g., affective, economic, interactional, etc. In social network analysis it is important to have in mind that actors are interdependent, they influence each others and each others' actions [WF94]. To better understand group dynamics, a social network structure becomes of great importance [For18]. In our research, we enquired social relationships information for each group, and we analyzed how the relationships, their strength and the prominence of members within the group influenced the outcomes of the group decision-making process.

Travel types: As previously elaborated, we use 17 Tourist Roles of Yiannakis and Ginson [GY02] to characterize short-term, implicit and "unawar" travel-related preferences. In the thesis, we investigate the role of such travel preferences characterization in the travel-related discussions.

Group diversity: Group diversity is one of the essential measures that provides the first idea about the group at hand. Diversity is defined as the amount of differences among members within a social unit, i.e., group. The concept has been applied in various ways across domains, e.g., ecology, demography, sociology, economics, etc [SSNL12]. Moreover, in organizational research, different diversity measures are used to predict the performance of a team in a given task [HH07]. The current research indicates that group diversity is a function of the group size and the distribution of members within a group across a certain property being analyzed.

Depending on the task given to a group, diversity across a certain dimension might increase or decrease the group performance. In the area of GRSs, only couple of studies tackled the issue of diversity and its impact on the performance of a group recommender [BMR10, DPDM14, QSRGDAJD13]. In this thesis, we define several measures of group diversity for different dimensions, i.e., diversity of group members' individual, explicit preferences, group personality composition, and composition of travel-related types in the group. Then, we evaluated the role of these diversity measures in the group decision-making process.

Group decision-making process and observational studies: A small fraction of the research on GRSs is dedicated to understanding how groups make choices and, therefore, how the group decision-making process can be supported [CDGF+13]. An example of a group recommendation study that can be described as an *"indirect"* observational study of group decision-making processes was conducted by Masthoff [Mas04]. The participants were asked to create an item-sequence, i.e., a ranked set of recommendations, for a fictional group of people, given their individual, independent item-ratings. The objective for the study participants was to maximize the satisfaction of group members with the generated item-sequence. The author aimed at understanding if participants would use certain aggregation strategies when deciding the best item-sequence for the fictional group, and how would they explain the goodness of fit of the generated item-sequence. Moreover, in the same study, the author designed a second experiment where participants were asked to imagine themselves in a group of three, they received item-ratings of each group member, including themselves, and asked how satisfied they and the rest of the group would be if the system recommended certain item-sequences.

In social science disciplines numerous observational studies have been conducted and a considerable amount of literature about group decision-making processes exists. For example, Tindale and Kemeda in [TK00] discuss the importance of the so called *"social sharedness"*, i.e., the extent to which preferences, information or anything related to a group-decision making process, is exchanged and shared between the group members prior to the group decision-making process. The authors found evidence of *"social sharedness"* being one of the key elements in understanding group decision-making outcomes. Moreover, researchers who study the functional theory of group decision-making observed that groups that reach their decisions in a more structured fashion, actually, are more likely to make better decisions. In [For18] an approach to structure a

decision-making process is proposed, which consists of four phases:

1. *Orientation* phase - the group defines important aspects and goals of the decision-making process:

   - The problem that needs to be solved;
   - Goals that should be achieved;
   - Strategy and procedures that should be used in the process.

2. *Discussion* phase - a *"communication peak"* should be reached. Group members exchange collected information, opinions, agreements and disagreements. The main tasks of the phase are:

   - Gathering relevant information;
   - Exchanging information;
   - Discussion about possible alternatives.

3. *Decision* phase - based on the previous phases a group makes a decision using a specific social decision scheme. If a decision cannot be reached a group can return to any of the previous phases. A social decision scheme is a group's method for combining individuals' preferences, opinions, interests, etc., into a single group decision. Some groups explicitly agree on the decision scheme that they would adopt, while for other groups it is an implicit approach, taken for granted by group. Some of the common social decision schemes are:

   - *Averaging decisions* - group members make their own decisions individually (before or after the group discussion), then these individual decisions are averaged into a group decision. For instance, lets assume a group is interested in going to a cinema together, where five movies play at the same time. In order to make a decision, each group member ranks five movies individually. Then, group members combine their own rankings and select one movie with the highest score. In such an example, it is not required for a group to have an interaction/discussion in order to make a decision.
   - *Delegating decisions* - an individual or a subgroup makes a decision for the whole group. In an authority scheme, the leader of the group makes a decision. In an oligarchy scheme, a coalition makes the final decision.
   - *Plurality decisions* - group members express their preferences by voting, either publicly or by a secret ballot. Usually, the group selects an option that is favored by the majority. In some cases, to choose a winning option, majority is considered as more than 50% of members, while in other cases, majority is considered as two thirds of group members.
   - *Consensus reaching decisions* - a group discusses an issue, until an unanimous decision is reached, without voting, aggregation, or any other decision-making method.

4. *Implementation/evaluation* phase - a decision is implemented and evaluated.

While we believe that structured decision-making approaches should be considered when developing a GRS, as a matter of fact, current GRSs, as we mentioned already, focus on the generation of suggestions for a group, based on individuals' preferences, hence only marginally attacking the issue of how to better support the full decision-making process. This PhD research, in contrary, among the other things, aims to understand how to truly facilitate groups in their decision-making process with the GRSs.

Observing group decision-making process: Many different approaches to perform an observational study and record interactions within small groups exist.   In our study we use that proposed by Bales, i.e., the Interaction Process Analysis (IPA) [Bal50, For18]. IPA is a coding method for observing group interactions and it is widely used as it increases the objectivity of observations.   The approach requires from an observer to identify a *"unit"* of interaction for each group member. Bales defines a *"unit"* of interaction as a single simple sentence or its equivalent. Therefore, complex sentences containing an independent clause and at least one dependent clause, or compound sentences joined by *"and"*, *"but"*, *"or"*, should be broken down into a single expression *"unit"*. For example, if a group member states *"How about voting, but I think we still might not make our final decision."*, the observer should break down the sentence into two *"units"*: 1)*"How about voting"*, and 2) *"I think we still might not get the winner."*. Furthermore, in addition to speech, a *"unit"* of interaction includes facial expressions, gestures, body attitudes, emotional signs, etc. Then, for each group member, the observer categorizes each *"unit"* of interaction into the one of twelve predefined behavior categories:

1. Show solidarity / *"Friendly"*(e.g., expressing gratitude or appreciation; apologizing, or smiling directly at another; offering assistance, time, energy, money; etc.);

2. Show tension release (e.g., showing cheerfulness, satisfaction, enjoyment, relish, pleasure, etc.);

3. Agree (e.g., agreement reflected through verbal or nonverbal expressions);

4-6. Give suggestion (e.g., mentioning a problem to be discussed: *"I want to call your attention to the budget issue"*) / 5. Give opinion (e.g., stating judgment or inference: *"I believe that Amsterdam is the most beautiful place to visit in spring"*) / 6. Give information (e.g., reporting factual, verifiable observations or experiences: *"The weather in Amsterdam at this time is not good"*);

7-9. Ask for suggestion (e.g., requesting guidance in problem-solving process) / 8. Ask for opinion (e.g., questions seeking value judgment, beliefs or attitudes) / 9. Ask for information (e.g., questions requesting a simple factual, descriptive, objective type of answer);

10. Disagree (e.g., rejecting another person's statement);

11. Show tension (e.g., appearing startled, blushing, showing embarrassment);

12. Show antagonism (e.g., attempting to override the other in conversation, interrupting the other, making fun of others, criticizing, ill-treating, tricking, deceiving, etc.).

These categories are split in order to capture a) *relationship interactions* (i.e., categories from 1 to 3, and 10 to 12) and b) *task interactions* (i.e., categories from 4 to 9). The categories are grounded on Bales's long-term work on group interactions observations. The IPA system enables qualitative analysis as the behavior of each group member is classified and quantified in a clear manner.

In the PhD research project, the first data collection procedure (as explained in Chapter 3), included the observations of the group decision-making process. However, our experience showed that this was an exhaustive task which enabled us to collect observational data only for limited number of groups (i.e., all together eight). Due to the complexity of the procedure, it was decided that the IPA observations will not be pursued in the remaining data collection procedures. Moreover, having the observational data for only eight groups we were aware that it would be impossible to make any credible conclusions. To this end, no analysis, nor the results related to the observational data will be presented in this thesis.

Nevertheless, in the future research it would make sense to make observations of the group decision-making process. For instance, if a GRS was built with a functionality to support group discussions and decision-making process, then the process could be observed within the system. In this way, the overall observation procedure would be simplified, and we would have more insights into the decision-making process, and how group members shift their initial preferences towards the acceptable group choice.

CHAPTER 3

Data Acquisition and Data Description

In this chapter we present the data acquisition procedure, the measurements, observed (collected) data, and the concepts derived from the observed data. But prior to this, let us first motivate this approach to GRSs research.

We have previously introduced the state-of-the-art in the GRSs research. The focus is usually on the core recommendation algorithms, which are based on a preference aggregation strategies, even though we know, a winning strategy (the one that is better than all the other strategies in any given situation) actually does not exist. On a wider perspective, there are only a few studies that concentrate on the full problem of how to design decision/negotiation support functionalities in GRSs: *Travel Decision Forum* [Jam04], *Trip@dvice* [BKR06], *Collaborative Advisory Travel System* (CATS) [MSC$^+$06], *Choicla* [SFL$^+$15]. However, to our best knowledge, by now, no observational study of group decision-making processes in the context of GRSs, beside the one described in this thesis, has been conducted. In fact, observational studies are usually conducted in the social science disciplines.

The main motivation to conduct an observational study is that we believe that the design of novel and more effective GRSs can be initiated if one better observes and understands groups in action, measures their behaviors, and tries to identify concrete opportunities for computerized systems to be more useful to people. Hereby, the design of an observational study where groups of people faced a concrete decision task - select a destination to visit as a group - and the researchers monitored the groups before, during and after the task, is illustrated. Clearly, the rest of the thesis containing the results of various analyses serve as a support to the claims on the importance of such an observational study for GRSs. The study has a wide range of motivations, that are listed as follows.

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- Supporting *decision-making process* is the ultimate motivation for a RS. This functionality is even more important in GRSs, which can also be used for other reasons, such as, expanding user knowledge or expressing oneself [RRS15]. But, if GRSs must effectively support decision-making process, we must understand how this task is executed in groups and how the decision issues, the group members and the contextual situation altogether impact on it.

- We also believe that the *application domain* is a crucial factor that must be considered in the design of a GRS. Recommending tourist attractions or destination for a group cannot follow the same interaction and recommendation model used for suggesting movies to watch [WR04]. Thus, we have tried to generate a realistic decision task, i.e., destination selection, in which the study participants could easily imagine themselves. In this scenario, we made observations of users' characteristics and decision outcome that have emerged as important in tourism consumer behavior research [DNW16, FTBE+16, WASC+15, YG92].

- *Group recommendation techniques* have been influenced too strongly by social choice theory [Mas15] and not enough by group dynamics studies [For18]. It is still unclear how a recommender can identify items to suggest in a group decision-making task, if the goal is not simply to aggregate the votes/preferences expressed by the group members. Hence, studies like the presented one can help to understand the key information that groups need in order to make decisions, which could not simply be the suggested outcome of the decision. We believe that the more general concept of information recommendation - which information to provide to the group next - rather than product recommendation, is important to implement [BR13].

- Another important motivation of this study design is the desire to *collect data* about group decision-making process that can be exploited by several research groups. Hence, in some sense, an additional goal was to obtain raw data that could be used for different types of analyses, from different perspectives and with alternative motivations. We plan to publish the data that we have collected. This objective is of crucial importance for the current and future research in GRSs, as one of the greatest obstacles for making advancements in the field is the lack of data sets that comprise information about groups, their choices and behaviors.

- It is clear to us that the design of more effective GRSs requires a *multidisciplinary approach*. In that sense the design of our data collection procedure brings together social and computer science disciplines. Observational studies are not part of the classical research repertoire of RSs research methods. However, we believe that these methods are now strictly required if we want to understand users in naturalistic settings and be able to generate fruitful conjectures about new and useful system functions to be added in a GRS.

- Finally, we believe that the research community on GRSs needs to discuss and build a *research agenda*. We must identify critical challenges and expected results. In this PhD thesis, we initiate this reflections by raising several issues, e.g., how to measure the collective behavior of a group, what properties of a group are more important in RSs

and how they should be measured, how to define group satisfaction, how to compare and relate user preferences and group preferences, etc.

Hence, one of the main "methodological" goals of this thesis is the design of an experimental method for observing group decision-making process and for deriving observational data useful for the implementation of GRSs in the tourism domain.

In the following sections, the data acquisition procedure is thoroughly described.

3.1 The procedure

The data acquisition procedure (further referred to as user study) that we describe was carried out twice, for the sake of clarity we will call these study implementations INSTANCE1 and INSTANCE2, respectively. INSTANCE2 study implementation was defined and extended in accordance with the results obtained from the analyses conducted upon the data acquired within the INSTANCE1 implementation. Namely, information about social relationships within groups, was not collected within INSTANCE1. However, when we came to know about the significance of the social/group identity, INSTANCE2, was designed, such that it included the social relationships data. The study was initiated in a cooperation with the International Federation for Information Technologies in Travel and Tourism (IFITT). INSTANCE1 implementation took place in late 2014 and early 2015 at the Delft University of Technology (TU Delft), the University of Klagenfurt (UNI Klagenfurt), the University of Leiden (UNI Leiden), and an extended implementation was carried out at the Vienna University of Technology (TU Wien). INSTANCE2 was implemented at the TU Wien and University of Sarajevo (UNI Sarajevo) in late 2017. Each implementation was conducted as a part of regular lectures and followed a three-phases structure: a pre-discussion phase (further referred as pre-questionnaire), groups meetings/discussions phase and a post-discussion phase (further referred as post-questionnaire).

Prior to the first study phase, an introductory presentation containing the general instructions for the participants was arranged. The first task for all participant was to form groups. The participants were free to choose their groups and the size as long as it does not exceed five members. Only participants of the extended study implementation, within INSTANCE1, at TU Wien, were instructed to form groups of six and to select two students whose task would be to observe and record activities of their group in the next study phase, therefore we further refer to them as *observers*. All the other group members took part in the decision-making process, therefore we further refer to them as *decision-makers*. It is important to repeat that the detailed recordings of the decision-makers' behavior during the group discussions/negotiations was part of the TU Wien study implementation only.

In the first study phase, the task for the decision-makers was to fill in an online, questionnaire (i.e., the pre-questionnaire). The pre-questionnaire captured participants' individual profiles, preferences and dislikes, and within INSTANCE2, social relationships

data as well. Also in this phase, at TU Wien (INSTANCE1), a short training for observers was organized. The purpose was to introduce the observers with the rest of the study, and to instruct them on how to perform and document the observations of decision-makers' behavior. A report template for documenting the behavior, i.e., actions of the decision-makers, designed based on Bales's Interaction Process Analysis (IPA) [Bal50], was clarified and distributed to the observers. Moreover, the observers received detailed written explanations on how to perform observations and a continuous contact with them was maintained until the end of the study.

In the second study phase, the groups discussions took place. To this end, the decision-makers received written instructions containing following:

1. Ten predefined destination options together with informational Wiki pages;

2. Description of the decision task scenario: *"Imagine that you are working on a research paper together with the other group members. Interestingly, your university offers you the opportunity to submit this paper to a conference in Europe. If the paper gets accepted, the university will pay to each group member the trip to the conference. In addition, you will be able to spend the weekend after the conference at the conference destination. Ten conferences will take place in European capitals around the same summer period."*;

3. Decision task: *"Decide to which conference (destination) you will submit your paper, and what would be your second choice (in case the first choice would not be feasible for some unexpected reason)"*. We decided to ask for the top two choices of the group, and not for the full ranking of the ten destinations, as the ranking task is not a natural one when making a decision, even though, from the recommender systems perspective, it would provide insights of finer granularity about the group preferences.

The two study instances, INSTANCE1 and INSTANCE2, beside the social relationships data in the pre-questionnaire, in fact differed in the pre-selected destinations, as well as in the way participants expressed their preferences about them. Within INSTANCE1, we decided for the ten European cities that the participants were well aware of (see Section 3.2). While, for INSTANCE2, some changes were made. Our results indicated that majority of the ten destinations from INSTANCE1 were highly appealing to the participants, therefore, we suspected that there was lack of incentive for more enthusiastic group discussions. To this end, within INSTANCE2, we introduced ten new destinations chosen as representatives of the ten destination categories found in travel and tourism literature [YG92, GY02, NSSW14, GMHF04, MMP+96] (for more details see Section 3.2).

In the second study phase, the groups were not instructed on how to perform the decision-making task nor whether they should necessarily check the informational Wiki pages or not. This specific design was chosen due to its simplicity. Usually, when a group is planning a trip a number of different trip aspects have to be considered, e.g., timing, budget, destination, accommodation, transport, etc. A proper discussion on all these issues would be almost impossible to simulate in a controlled environment. Thus, we

concentrated on a simple aspect, i.e., the selection of a destination, to analyze the basis of group interactions and dynamics in this specific context. At TU Wien, INSTANCE1, observers were included in the group work. They audio recorded and documented the group decision-making process using the Bales's IPA report template.

In the third phase, the decision-makers filled in another online questionnaire (i.e., the post-questionnaire) that inquired about the previous phase and the overall task experience. Moreover, during this phase, interviews with the observers were arranged at TU Wien, INSTANCE1: for each group one meeting with the two observers. At the interviews, we firstly asked the observers to explain different sections of their report template and behavior categories in order to evaluate their understanding of the task they were given. Secondly, the two observers elaborated their own submissions and compared them, if the recordings disagreed to a great extent, the observers were asked to come to an agreement and revise their reports.

Figure 3.1 summarizes the data collected and activities undertaken in the three study phases of the two implementations.
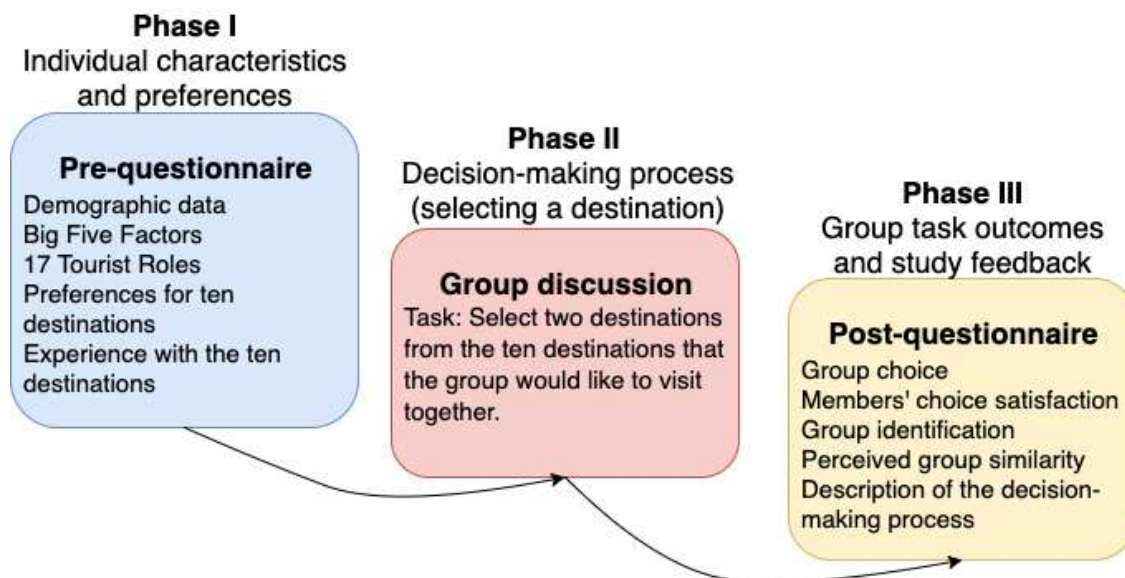
Figure 3.1: Three study phases

3.2 The measurements

In this section, the collected data and the instruments used to collect it are described: the pre-questionnaire, the template for documenting the observations of the group behavior (decision-makers), and the post-questionnaire. The instruments were designed based on existing literature (see section 2.5) having the goal to cover different aspects that might have an impact on the group decision-making process and its outcomes.

The first data collection instrument, i.e., the pre-questionnaire captured a rich user profile of the participants. The questionnaire comprises of approximately 60 questions/statements, structured in four sections (see appendix 9.3):

1. Demographic data (i.e., age, gender, country of origin, university affiliation and student identification number);

2. Tourist roles and Big Five factors:

   - 30 questionnaire statements were related to the 17 Tourist Roles (see section 2.5);
   - 20 questionnaire statements were related to the Big Five factors (see section 2.5).

3. Individual, group-unrelated, explicit preferences for the ten predefined destinations, together with the experience related to those destinations.

   - Destinations for INSTANCE1 were, as mentioned, ten big European cities: Amsterdam (at TU Wien and UNI Klagenfurt), Berlin, Copenhagen, Helsinki, Lisbon, London, Madrid, Paris, Rome, Stockholm and Vienna (at TU Delft and UNI Leiden);
   - Destinations for INSTANCE2, on the contrary to INSTANCE1, were representatives of ten destination categories found in the travel and tourism literature: 1) Porquerolles, France (*Beach & relaxing*), 2) Riga, Latvia (*Culture, architecture & museums*), 3) Budapest, Hungary (*Nightlife & parties*), 4) Serravalle Scrivia, Italy (*Shopping*), 5) Girona, Spain (*Great food & meeting local people*), 6) Lake Bled, Slovenia (*Lakes & mountains*), 7) Interlaken, Switzerland (*Extreme sports & thrill-seeking*), 8) Snaefellsnes, Island (*Eco-tourism*), 9) Portree, Scotland (*Exploration of the scenic wild regions*), and 10) Segovia, Spain (*Archaeological sites*).
   - Experience: Participants were asked how many times they visited each destination, and for an answer, they selected one of the available options, i.e., *"Never heard about it before"*, or visited the destination from "0" (zero) to "More than three times";
   - Explicit preferences: For INSTANCE1, the participants were asked to *rank* destinations, and in Vienna they were asked to rate them on a five-point scale, 1 representing the least attractive and 5 representing the most attractive destination. For INSTANCE2, the participants were asked to *rate* the destinations on a ten-point scale (1 *"Not attractive at all"*, 10 *"Highly attractive"*). Ranked lists of the ten destinations provide a fine granularity of the individual preferences, compared to the ratings, however, to make a ranked list of ten destinations, is a tiresome, and highly unnatural task for people - it is rarely the case that people rank ten items in order to make a decision. To this end, for INSTANCE2, we decided to ask for the ten-star ratings, and, since there are ten destinations, we could easily transform ratings into the partial rankings.

4. Ranking of decision criteria: When deciding on a destination to visit, there are certain decision criteria that people usually consider, hereby, we were interested in participants' individual ranking of that criteria according to their importance (i.e., budget, weather, distance, social activities, sightseeing and other).

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5. The *social relationships* section (only in INSTANCE2 - see appendix 9.3) contained three questions, and for each question, the participants provided answers for all fellow members of their group separately:

   a) Duration of the relationship (five-point scale: 1 *"For less than six months"*; 2 *"For more than six months, but less than a year"*; 3 *"For more than a year, but less than three years"*; 4 *"For more than three years, but less than five years"*; 5 *"For more than five years"*);

   b) Frequency of the contact (five-point scale: 1 *"Very infrequently"*; 2 *"Somewhat infrequently"*; 3 *"About average"*; 4 *"Somewhat frequently"*; 5 *"Very frequently"*);

   c) Emotional proximity (ten-point scale: 1 *"not emotionally close at all"*; 10 *"very emotionally close"*).

A five-point Likert scale was used for the questionnaire statements related to the 17 Tourist Roles and the Big Five factors. To obtain the scores, i.e., the level to which a person identifies with a certain tourist role or a certain personality trait, ratings of the statements were normalized (i.e., summed and divided by the number of related questionnaire statements). At the end, the scores were in a $[1, 5]$ interval, and the higher the score was, the more likely it is that a person identifies with a certain tourist role or a personality trait.

In the second phase the group decision task took place. As previously mentioned, at the TU Wien, INSTANCE1, the observers recorded behavior of the decision-makers. The report template for the observers' recordings was designed based on the Bales's Interaction Process Analysis (IPA) (see Section 2.5, and appendix 9.3). Thus, the task for observers was to audio record group discussion and to fill out the provided report template. The report template consisted of the following sections:

1. Decision-making process planning and execution: whether a specific plan for the group decision process was used or not and if yes the duration of the different decision process phases;

2. Group members' roles: e.g., leader, follower, initiator, information giver, opinion seeker;

3. Group members' behavior: Bales's IPA system and twelve categories of behavior (see Section 2.5);

4. Social decision scheme;

5. Strength of group members' preferences: the observers rated group members' willingness to give up on their initially preferred options, on a five-point scale: *1 "Very unwilling"* to *5 "Very willing"*

To complete this task properly, observers attended a lecture with instructions on how to perform observations. At the lecture, each part of the report template was elaborated, and, each behavior category of the IPA system was thoroughly clarified with examples applicable to the decision-making task at hand.

Finally, a post-questionnaire was used to collect data about participants' experience with the group decision-making process and the study in general. It consisted of the following sections (see appendix 9.3):

1. Group choice: i.e., the first and the second preferred destination of the group;

2. The usage of the provided info about the ten destinations: i.e., the participants were asked whether they used the wiki pages about the destinations during or prior to the group decision-making process;

3. Textual description of the group decision-making process employed by the group: i.e., *"Shortly describe how you reached the group decision"*;

4. Overall attractiveness of the ten destinations: e.g., *"Many destinations were appealing"*, *"I did not like any of the destinations"*;

5. Satisfaction with the group choice: e.g., *"I like the destination that we have chosen"*;

6. Difficulty of the decision-making process: e.g., *"Eventually I was in doubt between some destinations"*;

7. Participant's group identification level: e.g., *"I identify with the other students in my group"*, *"I see myself as a member of this group"*;

8. Participants' perceived preference similarity within the group: e.g., *"I considered myself similar to the other members in my group in terms of our preferences"*;

9. Assessment of the task: participants were asked to select the statements to which they agree regarding the organization of the task, i.e., *"The task was well described"*, *"More and better instructions on what we should have done would have been helpful"*, *"I did not understand what we should do"*, *"Most people in our group had no idea what we should do"*), their feedback (e.g., *"The exercise was chaotic"*, *"I learned something"*, etc.), and willingness to participate in the same or similar study (i.e., *"Would you like to participate more often in exercises like this one?"*.

10. For INSTANCE2, an additional concept was captured, i.e., participants' individual perception of influence that the fellow group members had on their acceptance of the final group choice, evaluated with one statement, i.e., *"To what extent did each of your group members influence your acceptance of the final group choice?"*, and a five-point scale: 1 *"No influence at all"*, 5 *"Strongly influenced"* (for details see appendix 9.3).

Also, the five-point Likert scale was used to assess sections 4., 5., 6., and 7. of the post-questionnaire.

The overall structure of the data, and the different aspects that were collected with the three instruments is shown in Figure 3.2. Moreover, different colors indicate different study phases, i.e., blue: pre-questionnaire, and yellow: post-questionnaire. Central entity in the diagram is the group member, i.e., the decision-maker who is connected to all the other data dimensions. As discussed in Chapter 2, section 2.5, due to the insufficient size of the collected data about the group decision-making process (i.e., IPA template observations), this data was disregarded in the rest of the thesis.
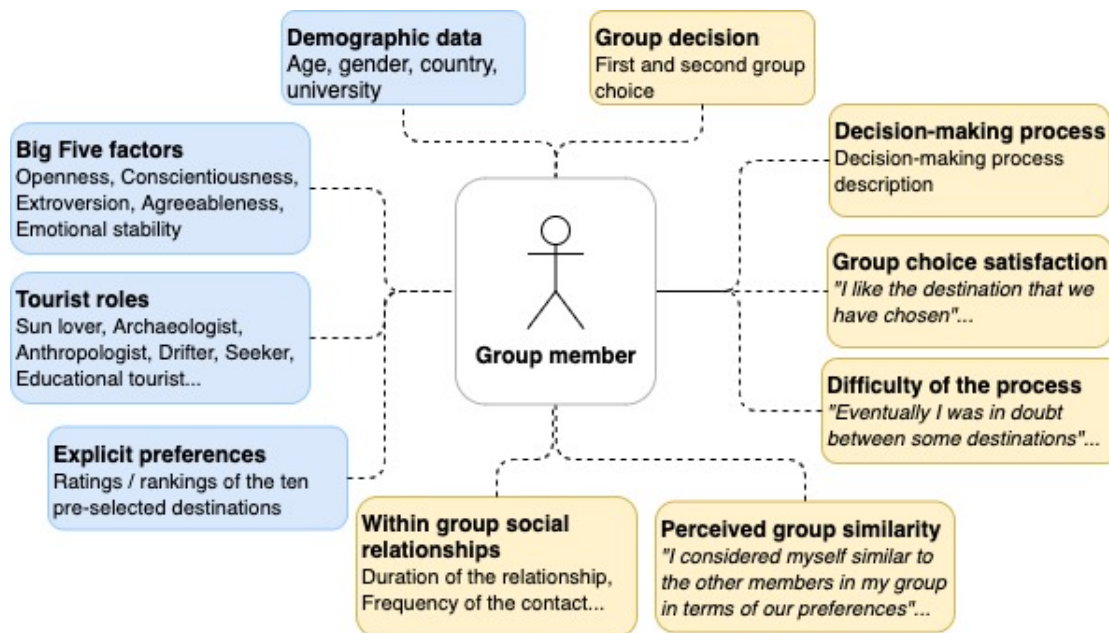
Figure 3.2: Structure of the collected data (blue - pre-questionnaire data; yellow - post-questionnaire data)

To summarize, the main differences between the two study implementations were the participants' prior knowledge about the ten destinations (better knowledge of them in the first implementation) and how they expressed their individual preferences (ranking in the INSTANCE1 vs. rating in the INSTANCE2), before discussing and choosing a destination to visit with their group.

At the end, two data sets were obtained. We will refer to the first one as INSTANCE1, and to the second on as INSTANCE2. The INSTANCE1 data set consists of 200 participants organized in 55 groups. Table 3.1 illustrate the number of groups (with their size) across participating universities. Since the study was implemented twice at TU Delft, within INSTANCE1, the two implementations are referred as *TU Delft1* and *TU Delft2*. The INSTANCE2 data set, consists of 150 participants organized in 41 groups. Table 3.2 illustrate the number of groups (with their size) across participating universities.

The descriptive statistics for the two data sets are provided later in this chapter, in section 3.4.

Table 3.1: INSTANCE1 - Groups statistics

Group size	2	3	4	5	SUM
UNI Leiden	2	2	2	/	6
UNI Klagenfurt	1	1	4	/	6
TU Delft1	1	2	1	/	4
TU Delft2	1	8	14	8	31
TU Wien	2	1	5	/	8
#Groups	7	14	26	8	55
#Participants	14	42	104	40	200

Table 3.2: INSTANCE2 - Groups statistics

Group size	2	3	4	5	SUM
UNI Sarajevo	4	5	10	6	25
TU Wien	2	3	11	/	16
#Groups	6	8	21	6	41
#Participants	12	24	84	30	150

3.3 Derived constructs

In this section, constructs (also referred to as variables) that are derived from the observed (collected) data, and that are used in more than one analysis of the thesis are introduced and defined. The variables are organized in three subsections, according to their specific purpose. The first set of variables describes individual, group-unrelated, implicit travel preferences (also referred to as the travel types or travel factors) of the participants, derived from the 17 Tourist Roles. The second set of variables describes group similarity/diversity, of two dimensions, i.e., explicit preferences and travel types (factors). Finally, the third set of variables measures individual and group performance in the group decision-making task.

3.3.1 Implicit travel preferences - travel types / factors

As we previously introduced, beside the explicit destination preferences, in the pre-questionnaire, with the help of the 30 questionnaire statements we captured information about participants' 17 Tourist Roles [YG92, GY02] - the individual, implicit travel preferences. The 17 Roles are described in Chapter 2, and hereby we provide the questionnaire statements related to the 17 Roles in order to ease the interpretation of the analysis presented in this section.

Sun Lover

TR1 *"When I go on vacation I mostly relax and sunbathe"*

TR2 *"On vacation I go to warm places with lots of sun, sand, and ocean"*

Action Seeker

TR3 *"On vacation I spend most of the day on the beach, go out every night, drink with friends, and do crazy things"*

TR4 *"On vacation I try to meet people of the opposite sex for uncomplicated romantic experiences"*

Anthropologist

TR5 *"I enjoy meeting the local people, trying the food, and speaking the language"*

TR6 *"On vacation I try to get to know the ways of the culture, and generally avoid the regular tourist route"*

Archaeologist

TR7 *"I visit museums which house archaeological artifacts from ancient sites and civilizations"*

TR8 *"Visiting the sites, and studying the history of ancient civilizations have a special meaning for me"*

Organized Mass Tourist

TR9 *"When I go on vacation I leave all the planning, hotel reservations, organized tours, etc., to my travel agent"*

TR10 *"I take packaged vacations and organized tours"*

Thrill Seeker

TR11 *"I participate in activities involving an element of risk such as sky diving, rock climbing or ski jumping"*

TR12 *"I engage in risky/exhilarating activities which provide me with emotional highs"*

Explorer

TR13 *"I go on adventure travel such as a hike down the Grand Canyon, jungle treks, and the like"*

TR14 *"I explore out of the way places and enjoy the challenges and hardships involved in getting there"*

Jetsetter

TR15 *"I go to exclusive night clubs, attend yacht parties, and socialize with celebrities"*

TR16 *"I vacation in elite, exotic, or out of the way world class resorts such as Monte Carlo, Tahiti, or the French Riviera"*

Seeker

TR17 *"For me, vacations are a sort of a spiritual quest in which I try to discover knowledge about my roots, history, or traditions"*

TR18 *"My purpose in travel is to explore the meaning of life and what I can learn about myself"*

Independent Mass Tourist I

TR19 *"I visit regular tourist attractions but I avoid packaged vacations and organized tours"*

Independent Mass Tourist II

TR20 *"While I leave some of my travel arrangements to my travel agent, I plan my own route/destination, make my own hotel reservations, and often play it by ear"*

High Class Tourist

TR21 *"I stay in first class hotels, go to shows and dine at the best restaurants"*

TR22 *"I travel first class, and stay at the best luxury resorts"*

Drifter

TR23 *"I try to make it on my own, living with the local people, and often take jobs to keep myself going"*

TR24 *"I drift from place to place living a hippy style existence"*

Escapist I

TR25 *"On vacation I take it easy getting away from it all"*

Escapist II

TR26 *"I head for places that are quiet and peaceful such as a deserted beach, a cabin in the hills, etc"*

Active Sport Tourist

TR27 *"On vacation I stay physically active engaging in my favorite sports"*

TR28 *"II go on vacation mostly to engage in my favorite sports (e.g. tennis, sailing, golf, skiing, hunting, etc.)"*

Educational Tourist

TR29 *"I participate in planned study programs which may include lectures, workshops, and the like"*

TR30 *"I take educationally oriented vacations that enable me to study and/or acquire new skills and knowledge"*

Clearly, having 17 dimensions to capture implicit preferences can be cumbersome, thus we investigated whether we can compress the 17 Tourist Roles into a model with less dimensions. Hence, with the goal to obtain a more concise, simplified model of implicit travel preferences that we would further use in our analyses, we conducted a factor analysis. Another option to capture implicit travel preferences was to use the model of Neidhardt, et al. [NSSW14, NSSW15], which combines 17 Travel Roles and the Big Five factors, however, in this PhD research we go a step back and evaluate separate effects of Travel Roles and Big Five factors, having that the future plan is to use the combined model.

Factor analysis: The analysis was carried out within the *SPSS* and its *Dimension Reduction - Factor analysis* module. The data from INSTANCE1 and INSTANCE2 were combined, therefore, the analysis was conducted upon 350 data instances.

In the first step, the suitability of the data for the factor analysis was evaluated using the Keiser-Meyer-Olkin measure (KMO) and Bartlett's Test. The KMO measure of Sampling Adequacy is a statistical measure of the proportion of variance in the variables that might be explained by the underlying factors. Values close to 1.0 indicate that a factor analysis could be of use with the data at hand. Bartlett's test of sphericity assesses the hypothesis that the data correlation matrix is an identity matrix, indicating that the variables are unrelated and therefore inadequate for detecting patterns. Values less than 0.05 of the significance level indicate that a factor analysis, again, could be useful with the data at hand. Based on the table 3.3, we can conclude that our data is suitable for the factor analysis.

Table 3.3: KMO and Bartlett's Test for the factor analysis

KMO Sampling Adequacy	.822
Bartlett's Test (Sig.)	.000

In the second step, the Anti-image Correlation matrix (Measure of Sampling Adequacy - MSA) was analyzed in order to determine the subset of 30 questionnaire items that should be used in the final factor model(i.e., entries that score less than .700 on the diagonal should be removed) [DS74]. As a result, TR19 and TR25 questionnaire items were removed from the final factor model. Finally, to build the factor model, PCA (Principal Component Analysis) method was used with the Varimax rotation. The final factor model contains eight components (we select components whose Eigenvalues equal and higher than 1.0, otherwise the factor explains less variance than a single item would explain), and explains 68.548% of the total variance. Table 3.4 illustrates results of the analysis - the left side of the table provides information on the individual factors, their total Eigenvalue, total variance explained by each factor, and the cumulative variance explained by adding factor by factor to the model; the right side of the table provides the information about the rotated factors (factors are now orthogonal to each other, therefore information explained by one factor is independent of the information explained in the other factors), again their total Eigenvalue, variance and cumulative variance. In the right side of the table, factors with Eigenvalue less than 1.0 are excluded.

Since the eight factor model explains nearly 70% of variance, we can accept it as a valid representation of the 30 questionnaire items and the 17 Tourist Roles. Therefore, the model is used throughout the thesis, in various analyses, as the representation of the participants implicit travel preferences (i.e., travel types/factors).

To better understand the meaning of the obtained factor-model, we grouped questionnaire items according to their loadings on the eight factors. The factors are named by interpreting the belonging questionnaire items.

Table 3.4: Total Variance Explained

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.225	25.803	25.803	3.744	13.370	13.370
2	2.821	10.076	35.878	3.062	10.934	24.305
3	2.402	8.579	44.458	2.570	9.178	33.483
4	1.831	6.541	50.998	2.391	8.540	42.023
5	1.522	5.436	56.434	2.296	8.201	50.224
6	1.199	4.280	60.715	1.743	6.225	56.448
7	1.130	4.035	64.750	1.699	6.067	62.515
8	1.063	3.798	68.548	1.689	6.033	68.548
9	.901	3.218	71.766			
10	.895	3.195	74.961			
11	.779	2.783	77.744			

1. ***Carefree elitist*** (TR4, TR15, TR16, TR21, TR22)
2. ***Adventurous thrill seeker*** (TR11, TR12, TR13, TR14)
3. ***Spiritual drifter*** (TR17, TR18, TR18, TR23, TR24)
4. ***Beach and party lover*** (TR1, TR2, TR3)
5. ***Organized archaeologist*** (TR7, TR8, TR9, TR10)
6. ***Educational tourist*** (TR29, TR30)
7. ***Independent anthropologist*** (TR5, TR6, TR9)
8. ***Active escapist*** (TR26, TR27, TR28)

3.3.2 Group diversity

According to [VKS07], diversity is *"a characteristic of social grouping that reflects the degree to which objective or subjective differences exist between group members"*. Similarly, in [Jac91, TKG94, WOI98], diversity is defined as variability between individuals in any attribute that potentially leads to individual perception of difference from another. Group diversity can be conceptualized into three types, a) demographic diversity (i.e., distinction between demographic attributes, e.g., gender, ethnicity, age) [WOI98]; b) informational diversity (i.e., diversity in education, background knowledge, experience, etc.) [Jac91, JCT97, MM96]; and c) diversity in personality, attitudes, and values [BPS00, HPB98, JCT97]. In this thesis the focus is on the third type, i.e., the diversity of group members' attitudes (i.e., explicit preferences), and personality (in terms of travel types/factors, in other words implicit preferences). The reason behind is that the literature in GRSs suggests that group decision-making process and group members' satisfaction might be affected by this type of diversity. However, in our future research we are interested to explore the effect of other types of diversity in the travel-related group decision-making process.

We define two types of diversity: 1) Diversity of explicit preferences (ratings/rankings of the ten destinations); and 2) Diversity of implicit preferences (travel types/factors).

Diversity of explicit preferences: Research on group decision-making process has shown that groups adopt various approaches to reach a collective decision [For18]. The differences in the adopted approaches can be observed with respect to two aspects:

1. During discussion, group members exchange information, preferences and interests - the way these preferences are expressed is known as the *preference disclosure technique.*
2. After the discussion, groups employ a certain *decision-reaching technique* to make the final choice.

Our assumption is that how group members perceive themselves to be similar/diverse to each other in a group decision-making process is influenced, to a great extent, by the flow of their discussion, and the way in which they expressed their individual preferences. For instance, given a set of alternatives (i.e., the choice-set), group similarity might be perceived as high, if group members discussed only their top-choices and found a considerable overlap. However, if they would have discussed the whole choice-set, they might have perceived their group similarity completely differently. Following this concept, and our research presented in [DNW18], we propose two basic approaches to measure group diversity, the first option is to consider the preferences of group members over the *"full choice-set"*, while the second option, would be to consider only a part of group members individual preferences, e.g., individual top choices.

We introduce four measures of group diversity. The first two consider the group diversity on group members' top-choices: 1) Spearman Top-choice Diversity, and 2) Unique Top-choice Diversity; the third on the full choice-set, therefore named 3) Full Choice-set diversity; and, the last one considers the maximum "distance" on group members' top-choices: 4) Max-min diversity. In the following sub-sections, each one is explained in detail.

Spearman Top-choice Diversity (ST_DIV): considers the Spearman foot-rule distance between pairs of group members and their individual top-choices. The method measures the group diversity based on group members' ranks of each others' top-choices. The group diversity is therefore the average of group members' pairwise Spearman foot-rule distances on their individual top-choices. To better explain the diversity measures, an example is illustrated as follows.

Table 3.5: Example rankings

	$r(m_*, i_1)$	$r(m_*, i_2)$	$r(m_*, i_3)$	$r(m_*, i_4)$	$r(m_*, i_5)$
m_1	1	3	1	3	5
m_2	4	3	4	2	1
m_3	1	3	2	1	4

Example: Assume we have a group of three members and a choice-set of five items. Table 3.5 illustrates the individual item rankings of group members.

STEP 1: For each group member and her top-choices calculate the Spearman foot-rule distance to each fellow group member:

$$\underset{TopChoice(m_1)}{Spearman(m_1, m_2)} = \underset{(i_1, i_3)}{Spearman(m_1, m_2)} = \frac{3+3}{2} = 3 \qquad (3.1)$$

The top-choices of member m_1 are i_1 and i_3. Therefore, to calculate the distance between members m_1 and m_2, for the top-choices of member m_1, the ranks for i_1 and i_3 of m_2 are needed. Therefore, the average Spearman foot-rule distance for the two items, between the two members is 3 (as illustrated in equation 3.3.2). The same procedure is then repeated for each group member and her top choices.

STEP 2: Calculate the Spearman Top-choice Diversity at the group level as the average of the previously calculated distances, as illustrated with equation 3.3.2:

$$ST\_DIV = \frac{\underset{(i_1, i_3)}{Spearman(m_1, m_2)} + .. + \underset{(i_1, i_4)}{Spearman(m_3, m_2)}}{6} = 2.25 \qquad (3.2)$$

Equation:

$$ST\_DIV = \frac{1}{n(n-1)} * \sum_{i=1}^{n} \sum_{\substack{j=1 \\ \wedge j \neq i}}^{n} \underset{TopChoice(m_i)}{Spearman} (m_i, m_j) \qquad (3.3)$$

Unique Top-choice Diversity (UT_DIV)**:** measures the number of unique destination occurrences among individual group members' top-choices.

Equation:

$$UT\_DIV = |\{TopChoice(m_i)\}|, i = 1..n \wedge n = GroupSize \qquad (3.4)$$

Spearman Full Choice-set Diversity (SF_DIV)**:** measures average pairwise Spearman foot-rule distances between group members' individually ranked lists. In the first step, absolute values of the pairwise distances over the ten destinations are calculated for each pair of group members. In the second step, the group diversity measure is obtained as the average of previously calculated pairwise distances. We follow the previous example and show how to obtain the Spearman Full Choice-set diversity.

Example: Again, we will use table 3.5 that shows the item rankings provided by the three group members.

STEP 1: Calculate pairwise Spearman foot-rule distances between group members' individual ranked lists, as illustrated in equation 3.3.2 (repeat the procedure for each pair of group members):

$$Spearman(m_1, m_2) = |1 - 4| + |3 - 3| + |1 - 4| + |3 - 2| + |5 - 1| = 11 \qquad (3.5)$$

STEP 2: Calculate the Spearman Top-choice Diversity at the group level as the average of the previously calculated pairwise distances, as shown in equation 3.3.2:

$$SF\_DIV = \frac{Spearman(m_1, m_2) + .. + Spearman(m_2, m_3)}{3} = 8 \qquad (3.6)$$

Equation:

$$SF\_DIV = \frac{2}{n(n-1)} * \sum_{j=1}^{n-1} \sum_{i=j+1}^{n} Spearman(m_j, m_i) \qquad (3.7)$$

Max-Min Diversity on the top-choices (MM_DIV): evaluates the diversity of a group on group members' individual top-choices as well, but it is based on the maximum distance found for each group members' top-choice. To clarify, in the first step, for each group member and her top-choices, the maximum distance to any other fellow group member is identified. In the second step, the group diversity is selected as the minimum of the previously obtained group members' maximum distance scores. Again, we use the previous example to demonstrate how to calculate Max-Min diversity measure.

Example:

Step 1: For each group member and her top choice, find a fellow group member with a maximum distance to those top choices, as illustrated in equation 3.3.2 (repeat the procedure for each group member).

$$\begin{aligned} max_{m_1} &= max(r(m_2, TopChoice_{m_1}), r(m_3, TopChoice_{m_1})) = \\ &= max(r(m_2, i_1), r(m_2, i_3), r(m_3, i_1), r(m_3, i_3)) = \\ &= r(m_2, i_1) = r(m_2, i_3)) = 4 \end{aligned} \qquad (3.8)$$

Step 2: As the measure of max-min group diversity, select the minimum of the previously obtained maximum distances:

$$MM\_DIV = min(max_{m_1}, max_{m_2}, max_{m_3}) = min(4, 5, 4) = 4 \qquad (3.9)$$

Equation:

$$MM\_DIV = \min_{m_i \in g}(rank_{j \neq i}(TopChoice_{m_i})) \tag{3.10}$$

Table 3.6 shows the descriptive statistics of the introduced diversity measures for the two instances. The diversity scores are normalized at the group level (i.e., using the group size). However, the scores are not normalized over the number of items taken into the consideration. Therefore, the Spearman Full Choice-set diversity takes the highest scores simply because it takes all ten destinations into the consideration, which is not the case with other diversity measures. On a larger scale, the normalization at the choice-set size can also be done, but in our case it was not compulsory, as we could still compare the groups of various sizes. The descriptive statistics of the two instances indicate that there are slight differences between the two instances, and our assumption is that this is a result of the two study settings, i.e., in INSTANCE1, the participants (majority) provided rankings of the ten destinations, while in INSTANCE2, the participants rated the ten destinations.

Table 3.6: Descriptive statistics of diversity measures

INSTANCE1						
Measure	**MIN**	**MAX**	**Mean**	**Median**	**StDev**	**Abbr.**
Spearman Top-choice Diversity	.00	15.41	7.41	7.33	3.09	ST_DIV
Unique Top-choice Diversity	1.00	10.00	3.31	3.00	1.95	UT_DIV
Spearman Full Choice-set Diversity	9.33	42.00	29.55	31.00	6.68	SF_DIV
Max-Min Diversity	.00	5.00	1.40	1.00	1.27	MM_DIV
INSTANCE2						
Measure	**MIN**	**MAX**	**Mean**	**Median**	**StDev**	**Abbr.**
Spearman Top-choice Diversity	2.50	20.50	10.68	10.83	4.10	ST_DIV
Unique Top-choice Diversity	2.00	10.00	6.78	3.00	2.75	UT_DIV
Spearman Full Choice-set Diversity	15.00	44.00	30.13	30.50	6.20	SF_DIV
Max-Min Diversity	.00	7.00	1.37	.00	1.99	MM_DIV

Diversity of implicit travel preferences (travel types/factors): We propose another measure of group diversity that captures the diversity of group members' scores

on the travel types/factors (as previously obtained with the factor analysis) which will be referred to as the diversity of implicit preferences (TR_DIV). It is calculated with the Euclidean distance function. Travel types/factors can be interpreted as a multidimensional space, and therefore the user profiles of our study participants as the points in that eight-dimensional space. Then, pairwise differences between group members can be obtained by applying Euclidean distance, and group diversity as the average of pairwise distances (see equation 3.3.2).

Equation:

$$TR\_DIV = \frac{2}{n(n-1)} * \sum_{j=1}^{n-1} \sum_{i=j+1}^{n} Euclid(m_j, m_i) \tag{3.11}$$

3.3.3 Performance in the group decision-making process

To evaluate group performance for a certain task, it is required to define measures that quantify how well the group performed in that task. Therefore, in our case, we need to assess the quality of the group decision-making process, and its outcome. The performance can be measured at the individual, and at the group level.

Individual performance: In the post-questionnaire, we asked about group members' individual satisfaction with the group choice, and how difficult the decision-making process was for them. The two constructs can be used as a decision-making process quality measures at the individual level. Moreover, we introduce another performance measure that is related to the individual preferences, and the actual group choice, i.e., Individual Loss (IL). It quantifies the difference between individual preferences and the group preferences, and it is calculated as the absolute value of the difference between group rank and individual rank of a chosen destination. Thus, this measure can indicate how "persuasive" a group member was when pushing for her own preferences in the group decision-making process. This approach to evaluate individual performance is equivalent to the ones defined by Baltrunas et al. [BMR10], and Pessemier et al. [DPDM14], which measure the efficiency of the group recommendations. Therefore, $IL_1(m_n, G, i_G)$ is the distance between member's m_n preferences and the first group choice i_G selected by group G:

$$IL_1(m_n, G, i_G) = |rank_{m_n}(i_G) - 1| \tag{3.12}$$

Where $rank_{m_n}(i_G)$ is the rank position in the list of member m_n for the first choice of the group G.

Similarly, $IL_2(m_n, G, i_G)$ is the distance of member's m_n preferences and the second group choice i_G selected by group G:

$$IL_2(m_n, G, i_G) = rank_{m_n}(i_G) - 2 \tag{3.13}$$

Where $rank_{m_n}(second\_choice_G)$ is the rank position in the list of m_n for the second choice of the group G.

Group performance: To measure group performance, we can, as well, use satisfaction and difficulty constructs inquired in the post-questionnaire, but aggregated at the group level. Hence, we obtain two group performance measures: 1) Mean value of group members' individual choice satisfaction (*ChoiceSat*), i.e., Mean Choice Satisfaction (*MCS*); and 2) Mean value of group members' perceived difficulty of the decision-making process, i.e., Mean Difficulty of the process (MDiff):

$$MCS(G) = \frac{1}{|G|} \sum_{m_n \in G} ChoiceSat(m_n, G, i_G) \tag{3.14}$$

$$MDiff(G) = \frac{1}{|G|} \sum_{m_n \in G} Diff(m_n, G, i_G) \tag{3.15}$$

In addition, to capture another dimension of the group satisfaction, we measure the difference between maximal and minimal reported individual choice satisfaction in the group, i.e., Difference in Choice Satisfaction (*DCS*), as in equation 3.16.

$$DCS(G) = \max_{user_n \in G} CS(user_n, G, i_G) - \min_{user_n \in G} CS(user_n, G, i_G) \tag{3.16}$$

The second set of group performance measures is based on the individual and group preferences, just like the Individual Loss (*IL*) measure, and is motivated by the work of Nguyen et al. [NRDB19]. We define two measures, 1) The variation in individual's loss within the group, i.e., Mean Individual Loss (MIL), and 2) The difference between the Individual Loss of a group member who is the closest to the group choice (winner) and of a group member who is the farthest from the group choice (loser), i.e., Win-Loss Difference (WLD).

The Mean Individual Loss (MIL) and Win-Loss Difference (WLD) are motivated by the social psychology literature [For18], and the idea of process loss which indicates the decline in performance caused by group settings. In the context of GRSs, this measure is utmost reasonable, since the goal of group recommendations is to satisfy the preferences of all group members, which is hardly as good as recommendations tailored for individual users. Moreover, diverse preferences in the decision-making process often lead to one side winning, and the other side losing. This motivates us to observe the difference in Individual Loss between the "winners" (i.e., those with the lowest Individual Loss) and the "losers" (i.e., those with the largest Individual Loss) of the decision-making process. Given the group G and its first choice i_G, Mean Individual Loss $MIL(G, i_G)$ is calculates as the mean value of Individual Loss of G's group members:

$$MIL(G, i_G) = \frac{1}{|G|} \sum_{m_n \in G} IL(m_n, G, i_G). \tag{3.17}$$

We can consider that the lower the overall loss of the group, the better the performance of the group should be.

Given the group G and its first choice i_G, Win-Loss Difference $WLD(G, i_g)$ is defined as the difference between Individual Loss of the winner and Individual Loss of the loser:

$$WLD(G, i_g) = \max_{m_n \in G} IL(m_n, G, i_G) - \min_{m_n \in G} IL(m_n, G, i_G). \tag{3.18}$$

Descriptive statistics of the performance measures, for the two data sets are provided in table 3.7. We can see that, in general, Individual Loss (IL) in INSTANCE1 was higher than in INSTANCE2, together with Mean Individual Loss (MIL), and Win-Loss Difference (WLD). Again, we believe that the reason behind these differences is the way the participants expressed their individual preferences. For instance, having the absolute rankings of the destinations might result in greater distance between individual and group preferences, in comparison to partial rankings (ratings) as in INSTANCE2. Moreover, the groups from INSTANCE2 were more slightly satisfied in average (and in median) with their choices, and throughout the thesis we will be exploring various factors that influenced the choice satisfaction.

3.4 Descriptive statistics

In this section, the descriptive statistics for the collected data are illustrated, and for the two instances separately.

3.4.1 Basic demographics

Descriptive statistics of the demographic information for the INSTANCE1 and IN-STANCE2 participants is shown in tables 3.8 and 3.8 respectively. Unfortunately, since majority of the participating universities, in INSTANCE1, were technical ones, there is a clear gender imbalance. However, this is not the case for the INSTANCE2 data set, where the ratio between male and female participants is balanced. Moreover, in INSTANCE1, most of our participants were at TU Delft and Uni Leiden, thus, Netherlands is prevailing as participants' country of origin, followed by Austria. Overall 73.5% participants are from the two countries. The homogeneity of participants' country of origin, is even more emphasized in INSTANCE2, where 86% participants are either from B&H or Austria.

Table 3.7: Descriptive statistics of performance measures

INSTANCE1						
Measure	**MIN**	**MAX**	**Mean**	**Median**	**StDev**	**Abbr.**
Individual Loss	.00	16.00	5.35	5.00	3.79	IL
Mean Individual Loss	1.00	9.50	5.18	5.50	2.21	MIL
Win-Loss Difference	.00	15.00	6.50	6.00	4.04	WLD
Mean Choice Satisfaction	3.11	5.00	4.08	4.10	.45	MCS
Difference in Choice Satisfaction	.00	3.67	1.36	1.50	.73	DCS
Mean Difficulty of the process	1.50	2.92	2.29	2.33	.33	MDiff
INSTANCE2						
Measure	**MIN**	**MAX**	**Mean**	**Median**	**StDev**	**Abbr.**
Individual Loss	.00	9.00	2.03	1.00	2.50	IL
Mean Individual Loss	.00	4.25	1.95	2.00	1.32	MIL
Win-Loss Difference	.00	9.00	4.09	4.00	2.83	WLD
Mean Choice Satisfaction	3.92	5.00	4.52	4.56	.30	MCS
Difference in Choice Satisfaction	.00	2.50	.85	1.00	.55	DCS
Mean Difficulty of the process	1.39	3.25	2.31	2.30	.43	MDiff

Table 3.8: INSTANCE1 - Participants demographics

Age	Gender	Country
Min: 17 Median: 21.50 Mean: 22.46 Max: 48	Male: 166 Female: 34	Netherlands: 114, Austria: 31, Spain: 7, China: 4, Russia: 4, Singapore: 4, USA: 4, Other: 32

Table 3.9: INSTANCE2 - Participants demographics

Age	Gender	Country
Min: 19 Median: 24 Mean: 24.51 Max: 48	Male: 75 Female: 75	Bosnia & Herzegovina: 94, Austria: 35, Albania: 3, Other: 18

3.4.2 Personality and travel types/factors

The distribution of the five personality traits for the two instances is illustrated in figures 3.3 and 3.4. The distributions are slightly shifted to the right, with their mean values higher than the middle of the scale (i.e., three). This is even more highlighted for the INSTANCE2 data set, where mean values for personality traits reached almost the score of four.

Figures 3.3f and 3.4f illustrate distribution of the five personality traits mean values, when participants' gender is taken into the account. Interestingly, except for the *Conscientiousness* trait in INSTANCE1, no visible differences between mean values for the male and female participants can be observed. Moreover, the Kruskal-Wallis test showed significant differences ($p = .034$) in distribution of *Conscientiousness* trait for male and female participants.

Figure 3.5, illustrates the frequency of participants with respect to their travel types/factors affinity, for the both instances. The factor with the greatest participants' affinity is *Beach and Party Lover*, followed by *Thrill Seeker*, *Escapist* and *Educational Tourist*, while the factor with the lowest affinity is *Elitist*. To clarify, the travel factor scores have a standard normal distribution with a zero mean, therefore, when a group member has a score for a travel factor larger than zero, it is considered that the group member is inclined towards that travel factor.

3.4.3 Explicit preferences

Figure 3.6 illustrates the distribution of participants' ratings of the ten destinations, in the INSTANCE2 data set. Since the preferences of INSTANCE1 participants were expressed with the ranking lists (with an absolute ranking order), there is no need to show the distribution of rankings, as clearly it is a uniform one.

Figures 3.7 and 3.8 depict the distribution of ranks/ratings (respectively) per destination, for the two instances. In the INSTANCE1 data set, we can see that the most preferred destinations were Rome and London, while the least proffered options were Paris, Berlin and Vienna/Amsterdam. In the INSTANCE2 data set, the most preferred destinations were Porquerolles (Beach & relaxing) and Snaefellsnes (Eco-tourism), while the least

(a) Openness
$(\overline{opn} = 3.88, s = 0.51)$

(b) Conscientiousness
$(\overline{cns} = 3.76, s = 0.56)$

(c) Extroversion
$(\overline{ext} = 3.40, s = 0.73)$

(d) Agreeableness
$(\overline{agr} = 3.76, s = 0.60)$

(e) Emotional Stability
$(\overline{est} = 3.45, s = 0.66)$

(f) Distribution of personality over gender
(Blue-female; Red-male)
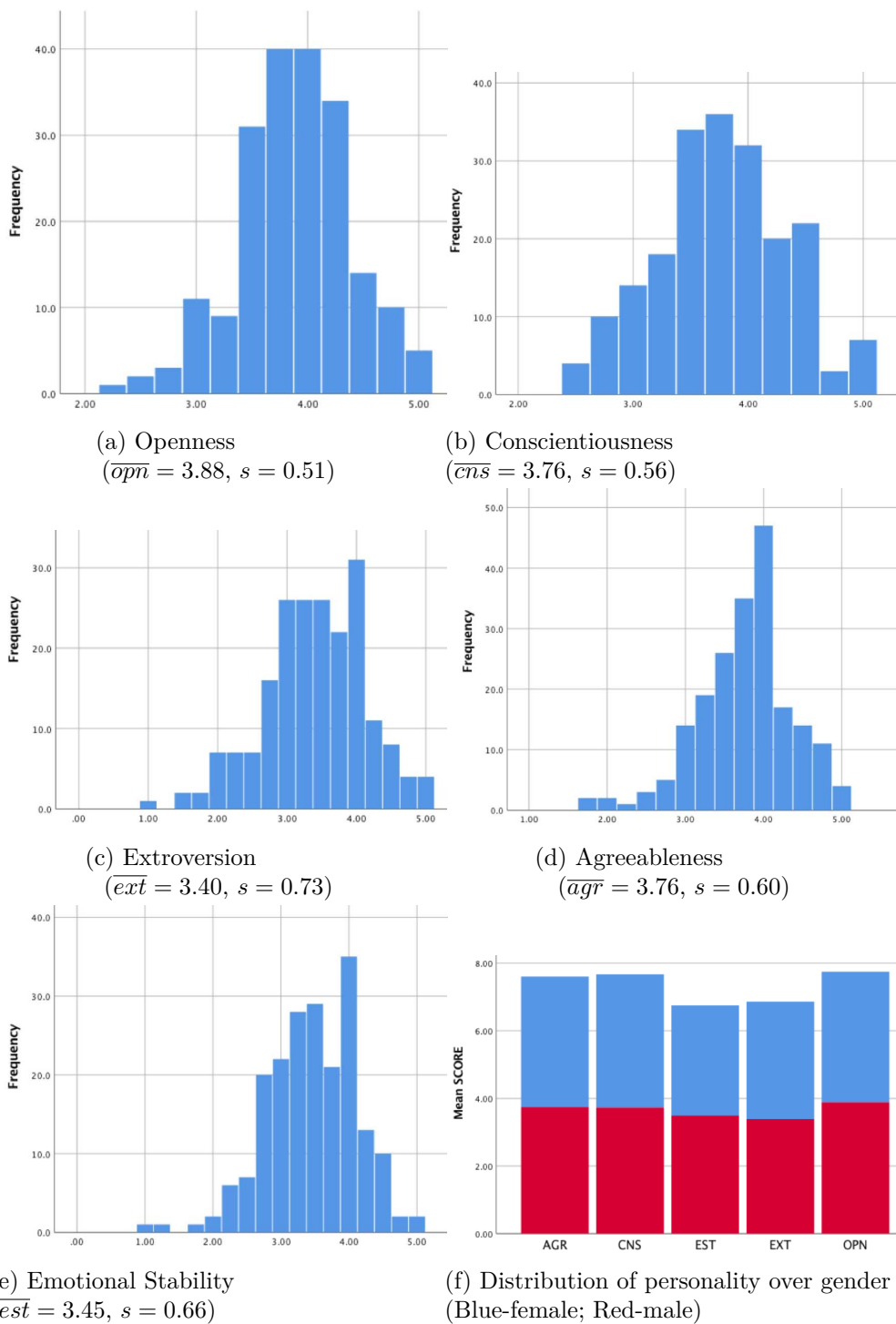
Figure 3.3: INSTANCE1: Personality traits distribution (with mean and standard deviation values)

(a) Openness
($\overline{opn} = 4.08$, $s = 0.51$)

(b) Conscientiousness
($\overline{cns} = 4.04$, $s = 0.57$)

(c) Extroversion
($\overline{ext} = 3.85$, $s = 0.71$)

(d) Agreeableness
($\overline{agr} = 3.98$, $s = 0.60$)

(e) Emotional Stability
($\overline{est} = 3.50$, $s = 0.64$)

(f) Distribution of personality over gender
(Blue-female; Red-male)
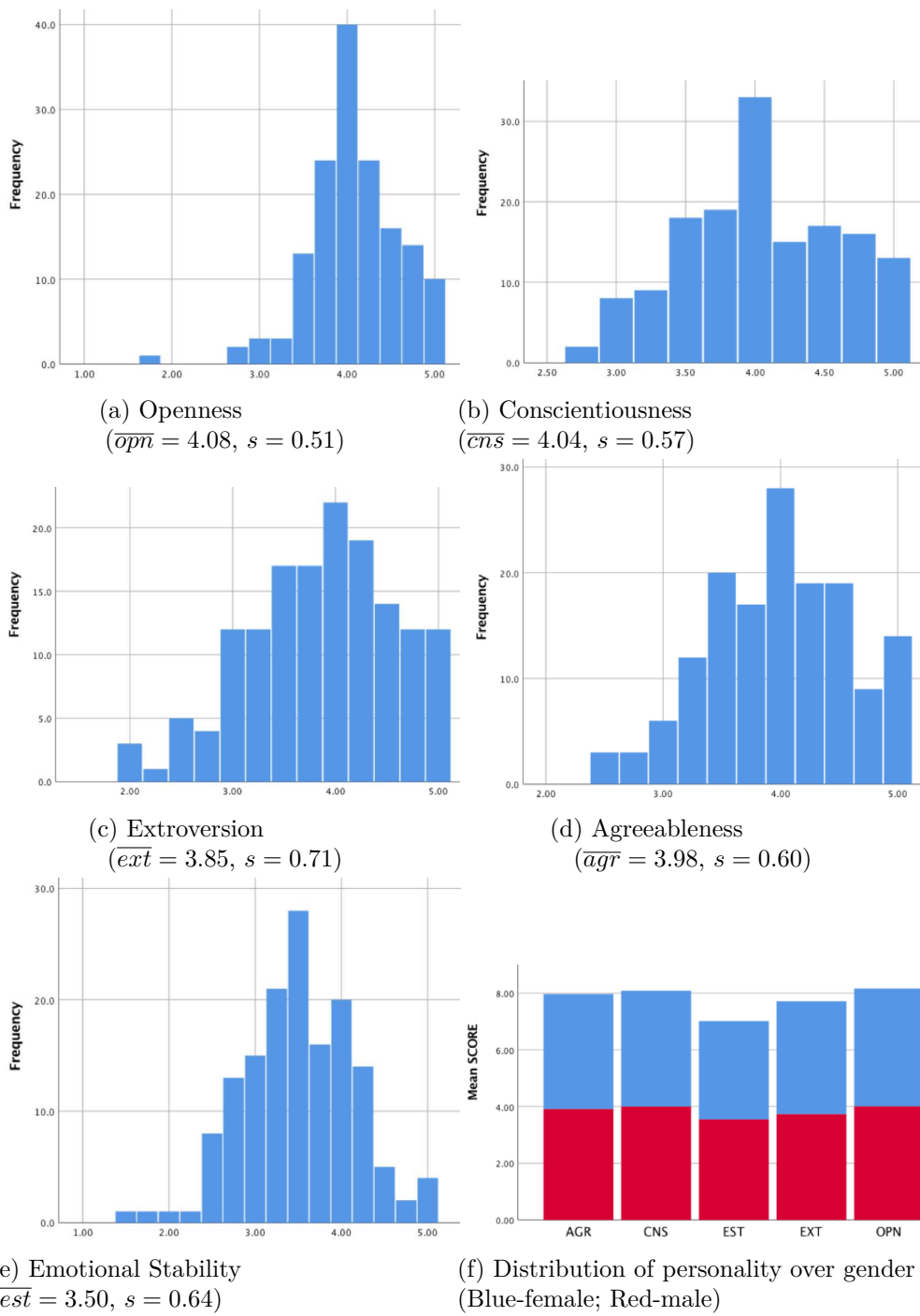
Figure 3.4: INSTANCE2: Personality traits distribution (with mean and standard deviation values)
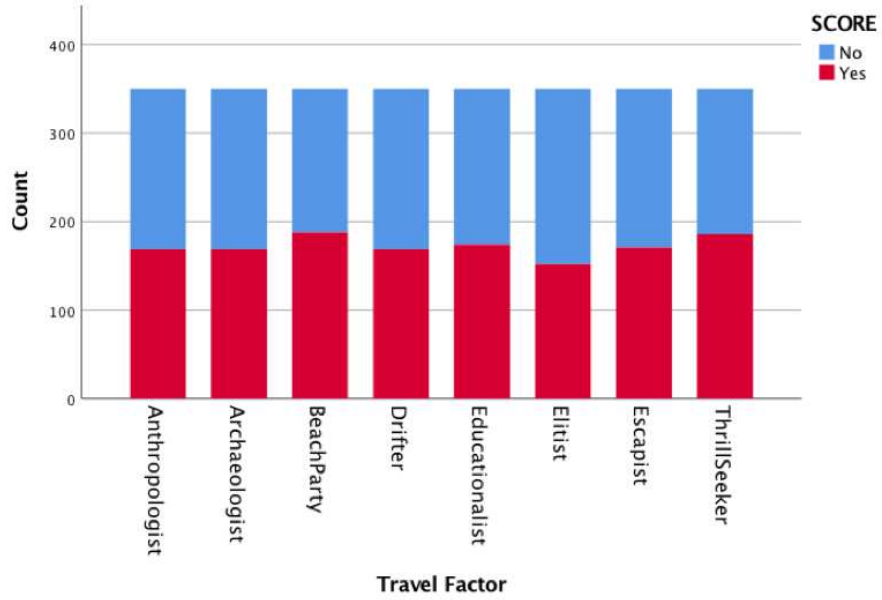
Figure 3.5: Participants' travel types/factors affinity
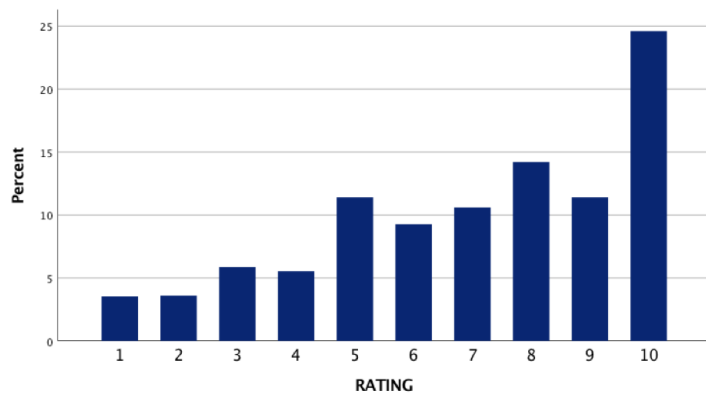
Figure 3.6: INSTANCE2 - Distribution of ratings

preferred destination was Serravalle Scrivia (Shopping). Preferred destinations in IN-STANCE2 data set nicely mirror the travel types/factors affinities that we previously mentioned.
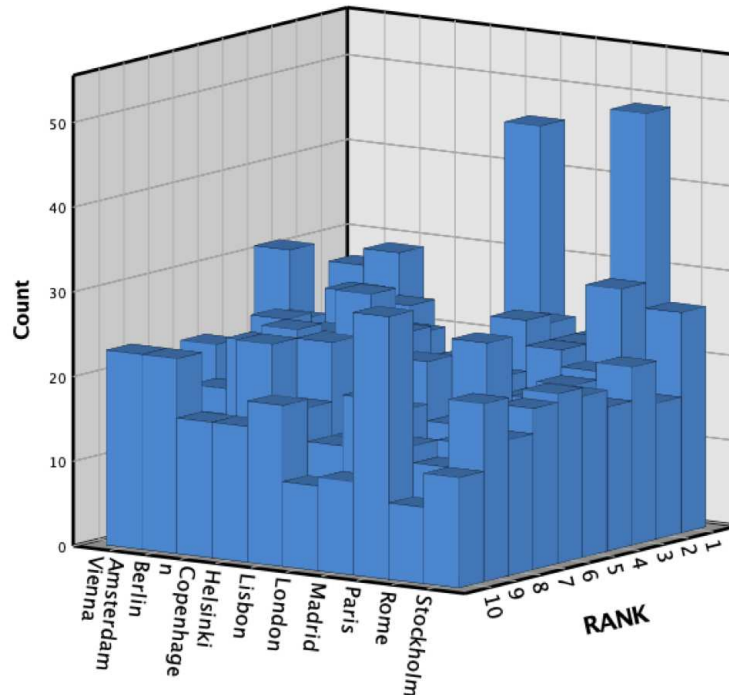
Figure 3.7: INSTANCE1 - Distribution of ranks per city

Figures 3.9 and 3.10 illustrate the frequency of each destination being selected as the first and second group choice. Here, the individually preferred options were in most cases transferred as the group proffered options. Thus, when it comes to the first group choice, in INSTANCE1, Rome was selected in most cases, but Stockholm (not London) had the second highest selection rate. When it comes to the second group choice, interestingly Copenhagen was selected the most often, which does not really reflect individual preferences. In the case of INSTANCE2, Porquerolles and Snaefellsnes were selected as the first group choice in most of the cases. However, for the second group choice, even though Snaefellsnes was selected the most often, the second place was occupied by Girona, which, again, does not really reflect individual preferences.

3.4.4 Experience with ten destinations

Figures 3.11 and 3.12 show the distribution of participants knowledge (i.e., visits) about the ten destinations. For the INSTANCE1 data set, most participants never visited majority of the destinations, nevertheless, none of the participants reported that they never heard about some of the destinations (clearly because the ten destinations were large European cities). However, in the INSTANCE2 data set, in many cases the participants
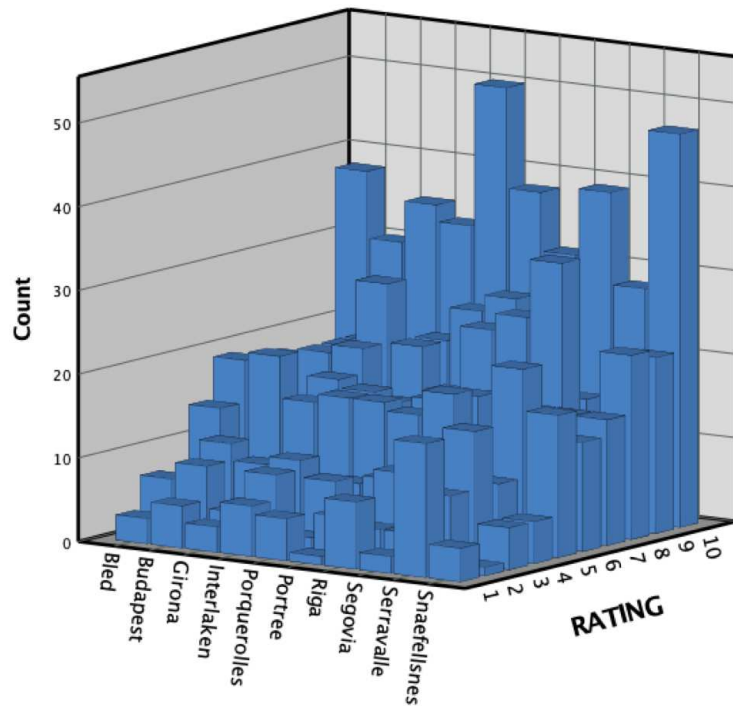
Figure 3.8: INSTANCE2 - Distribution of ratings per city
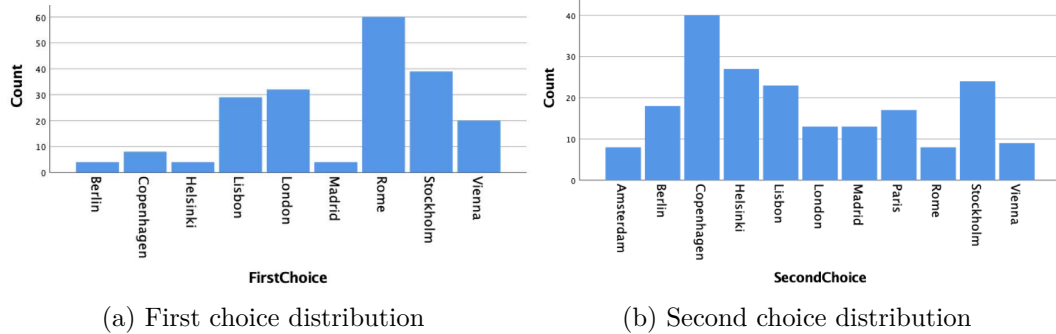
(a) First choice distribution

(b) Second choice distribution

Figure 3.9: INSTANCE1 - First and second choice distribution

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(a) First choice distribution

(b) Second choice distribution
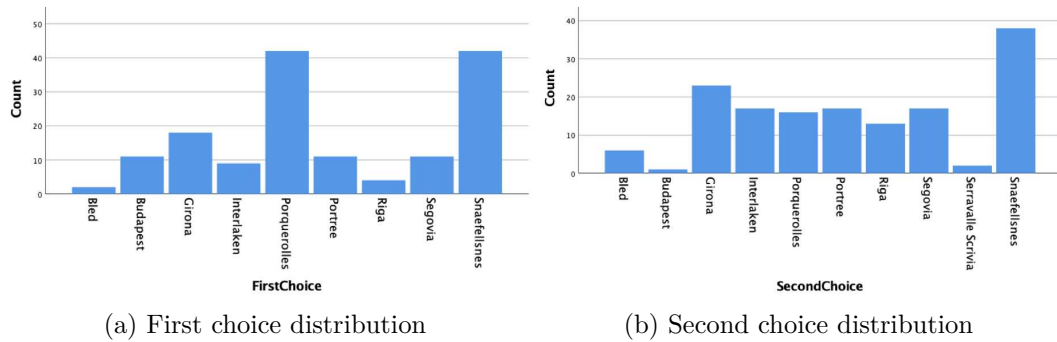
Figure 3.10: INSTANCE2 - First and second choice distribution

reported that they never heard about destinations, therefore the only information they had when they expressed their preferences and discussed different options was what we provided to them in the group decision-making study. Therefore, we can obviously say that participants knowledge about the ten destinations was, undoubtedly, richer in the INSTANCE1 data set.
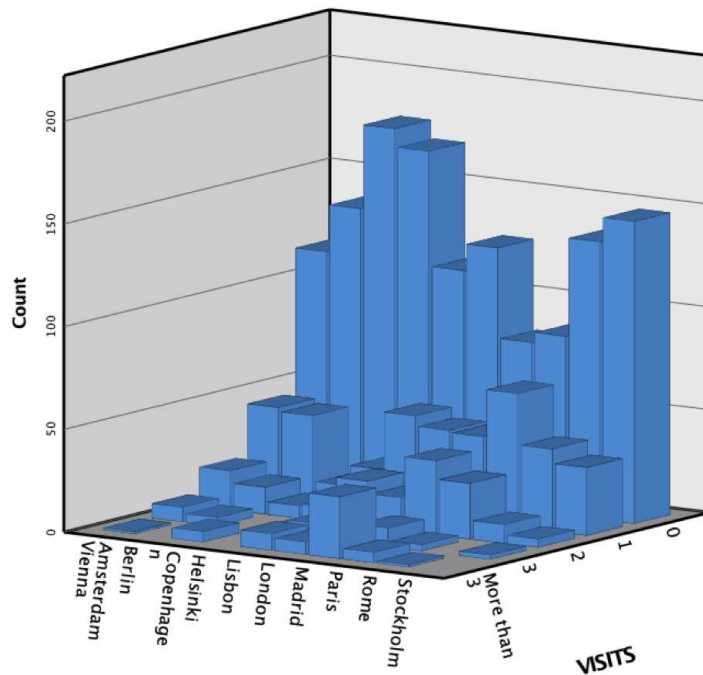
Figure 3.11: INSTANCE1 - Distribution of visits per city
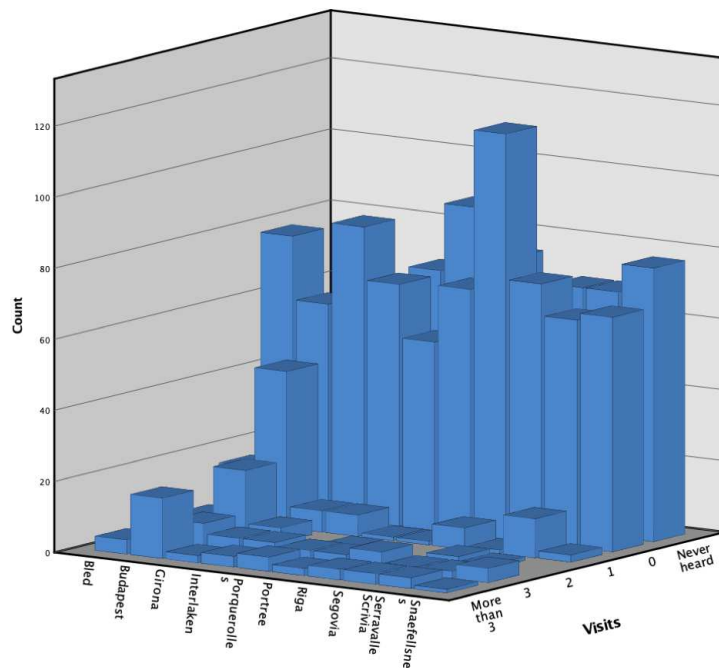
Figure 3.12: INSTANCE2 - Distribution of visits per city

3.4.5 Post-questionnaire constructs

In our analyses, the measurements from the post-questionnaire[1] were aggregated into constructs. Depending on the "direction" of the statement related to the constructs, the

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[1]**Post-questionnaire measurments:**
- **ChoiceSat1** "*I like the destination that we have chosen*"
- **ChoiceSat2** "*I am excited about the chosen destination*"
- **ChoiceSat3** "*The chosen destination fits my preference*"
- **ChoiceSat4** (INSTANCE1) "*I didn't prefer the chosen destination, but it was fair*"
- **ChoiceSat4** (INSTANCE2) "*The chosen destination is a fair choice*"
- **Diff1** "*Eventually I was in doubt between some destinations*"
- **Diff2** "*I changed several times before making the decision*"
- **Diff3** "*I think we have chosen the best destination from the options*"
- **Diff4** "*The task of making this decision was overwhelming*"
- **Diff5** "*To make the decision was easy*"
- **Diff6** "*The decision process was frustrating*"
- **GrIdent1** "*I identify with the other students in my group*"
- **GrIdent1** "*I identify with the other students in my group*"
- **GrIdent2** "*I see myself as a member of this group*"
- **GrIdent3** "*I am glad to be a member of this group*"
- **GrIdent4** "*I feel strong ties with my group*"
- **GrSim1** "*I considered the other members in my group to be similar to each other in terms of their preference*"
- **GrSim2** "*I considered myself similar to the other members in my group in terms of our preferences*"

obtained scores were either reversed or used as they are in the average function. For instance, statement Diff5, contributes to the Diff construct in an opposite direction - it evaluates how easy the group decision-making process was, not how difficult. Therefore, when used in the aggregation function, score five becomes one, four becomes two, and etc. Table 3.10 illustrates descriptive statistics of the obtained constructs. Mean and median values of choice satisfaction, in both data sets, are greater than 4, which indicates that majority of participants were satisfied with the selected options of their group. When it comes to difficulty of the group decision-making process, participants reported low to moderate levels of difficulty, which is slightly higher in the INSTANCE2 data set. Moreover, mean and median values of group identification indicate a quite strong identification of members towards their group. Finally, perceived group similarity, having mean and median values close to 4, as well demonstrate high levels of members' perceived group similarity.

Table 3.10: Descriptive statistics of post-questionnaire constructs

INSTANCE1						
Construct	**Min**	**Max**	**Mean**	**Median**	**StDev**	**Abbr.**
Choice satisfaction	1.75	5.00	4.07	4.00	.733	ChoiceSat
Difficulty	1.00	3.83	2.30	2.33	.641	Diff
Group identification	1.5	5.00	3.85	4.00	.710	GrIdent
Group similarity	1.00	5.00	3.61	4.00	.610	GrSim
INSTANCE2						
Construct	**Min**	**Max**	**Mean**	**Median**	**StDev**	**Abbr.**
Choice satisfaction	2.50	5.00	4.51	4.62	.514	ChoiceSat
Difficulty	1.67	5.00	3.06	3.00	.484	Diff
Group identification	2.25	5.00	4.10	4.00	.647	GrIdent
Group similarity	1.00	5.00	3.77	4.00	.758	GrSim

CHAPTER 4

Preferences and Group Decision-Making Process

Research in RSs, as well as, in GRSs, as discussed in Chapter 1, primarily focuses on the user preferences (implicit or explicit) in order to infer conclusions about user's future decisions and consumptions. In this chapter as the first analysis presented in the thesis, the focal point is on group members' individual, group-independent preferences and their role in the group decision-making process. In this context, we analyse three distinctive aspects:

1. Members' position in the group in terms of preferences, its relationship and impact on the members' individual satisfaction with the group choice;

2. Group diversity in terms of preferences, its relationship and impact on the group members' individual "well-being", as well as, on the group performance in the group decision-making process.

3. Individual preferences (i.e., linear, vs. non-linear), group preferences (i.e., preference network, vs. "flat" preferences), and their impact on the prediction power of the group recommendation approaches.

It is noteworthy, that all the remaining sections of this chapter will be separated according to these three aspects of analysis.

For the first two analyses, both data sets were used, i.e., INSTANCE1 (200 participants in 55 groups), and INSTANCE2 (150 participants in 41 groups). It is noteworthy, that as the input information about group members, we only considered individual preferences reported in the pre-questionnaire and disregarded all the other individual characteristics (i.e., personality, travel types/factors, experience, etc.).

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For the third analysis, however, we used the first data set and only a part of the INSTANCE2 data set. The reason behind was that there was an extremely low variability in the group members' individual preferences - majority of the INSTANCE2 destination were more than appealing to the participants (as can be observed in the descriptive statistics of explicit preferences, in Chapter 3, section 3.4, specifically as illustrated in figure 3.6).

This chapter focuses to answer **research question 1**: *What is the role of the group members' explicit preferences in the travel-related group decision-making process?*, more precisely the first analysis aims to answer question *RQ 1.1 What is the relationship between the match-mismatch between member's individual preferences and the group choice, and the choice satisfaction of that member?*; the second analysis question *RQ 1.2 How does the composition of members' preferences relate to group members' "well-being" and their performance in the decision-making process?*; and the third analysis answers questions *RQ 1.3 Can we use network structures of preferences within the group to better predict the actual group choices?*, and *RQ 1.4 Can we use non-linear transformations of preferences to better predict the actual group choices?*.

4.1 Preferences and choice satisfaction

This analysis aims to bring some light to one of the basic questions about the group decision-making processes, i.e., the role of group members' initial preferences for their level of satisfaction with the final group choice. In the existing research, it is claimed that the answer to this question lies in the extent to which the final group verdict matches (or mismatches) the individual's initial travel preferences. Inspired by behavioral research on group decision-making involving preferences [DDW03, KT04], four theoretical outcomes of group decision-making process are explored: 1) It would make sense for a group member to experience sensation of winning, if someone's favorite, or second favorite destination from a larger list of potential destinations made it as the final group choice - this would render that group member as a "satisfied winner", i.e., pleased with the travel destination that was mutually agreed upon and happened to match the own initial preference; 2) Contrasting this, the group member would probably experience sensation of losing, if the rest of the group collectively rejected his or her favorite travel destination, and, instead, opted for some other travel destination - this could turn that group member into a "dissatisfied loser", not pleased with the mismatch between private and group preference; 3) Less straightforward, someone may have the same preference as most of the group, but not derive satisfaction out of it - this group member would be a "dissatisfied winner", i.e., dispassionate with the, perhaps boring, travel destination; 4) Finally, it makes sense to also consider the possibility of a "satisfied loser" – someone, who failed to convince the other members of the group of his/her favorite destination (or did not even bother), but is nevertheless happy with the end result, perhaps, because each destination was equally (un)attractive or (ir)relevant, and only triggered "choice deferral" [WHH+11]. Therefore, we evaluate whether or not an agreement between individual preferences and the group choice brought satisfaction to group members, or this was not always the case

and other factors should be explored as well. Moreover, we are interested to see how plausible it is to observe a "satisfied loser", and an "unsatisfied winner".

4.1.1 Methodology

We focus on the participants' individual choice satisfaction (ChoiceSat), as reported in the post-questionnaire. For more details about the descriptive statistics of individuals' choice satisfaction, see Chapter 3, section 3.4.

In order to test the dependence of the choice satisfaction upon the individual preference fulfillment with the group choice, we defined two categories of participants: *IN* category - participants whose first or second preferred destination was chosen as the first group choice; and *OUT* category - participants whose neither first nor second preferred destination was chosen as the first group choice (for the distribution of participants across categories, see table 4.1). In table 4.1, label Top-1 indicates whether the first choice of a group member was also selected as the first choice of the group, while label Top-2 indicates whether the first or the second choice of a group member was selected as the first choice of the group.

Table 4.1: Participants with their top choices selected as the first group choice

Instance	#TopChoices	Category	Frequency	Percentage
INSTANCE1	Top-1	OUT	131	65.5
		IN	69	34.5
	Top-2	OUT	103	51.5
		IN	97	48.5
INSTANCE2	Top-1	OUT	83	55.3
		IN	67	44.7
	Top-2	OUT	65	43.3
		IN	85	56.7

Moreover, in this analysis, we also used Individual Loss (IL) in the group decision-making process, which evaluates the match-mismatch between individual preferences and the group choice (for more details see Chapter 3, section 3.3). In this way we were able to quantify the relationship between Choice Satisfaction (ChoiceSat), and Individual Loss (IL), during the group decision-making process.

4.1.2 Results

To summarize, we studied whether or not the group members were satisfied with the outcome of the decision-making process, and we tried to understand the impact of their initial preferences on that satisfaction. Overall, regardless of initial group members' preferences and the final group choice, the vast majority of participants reported a high satisfaction, i.e., in INSTANCE1, 45.5% of participants agreed, and 37.5% strongly agreed that they were excited about the chosen destination (all together 83%); while in INSTANCE2, 34.0% of participants agreed, and even 60.7% strongly agreed with the

statement (all together 94.7%). In a certain way, this indicates that fulfillment of group members' preferences with the group choice is not a critical factor for individuals' choice satisfaction. However, we statistically test this statement further.

In the next step we were interested to see how satisfied the participants were when we consider *IN* and *OUT* categories, with respect to their individual preferred options being chosen as the group choice (for more details about *IN* and *OUT* categories see section 4.1.1). Interestingly, such a high satisfaction with the group choice might simply be explainable by a moderately high fulfillment of members' preferences with the group choice, i.e., for INSTANCE1, 48.5% participants had one of their top choices as the group choice, whilst, for INSTANCE2, this percentage was even increased to 56.7%.

(a) Top-1 ($p = .000$)   (b) Top-2 ($p = .000$)
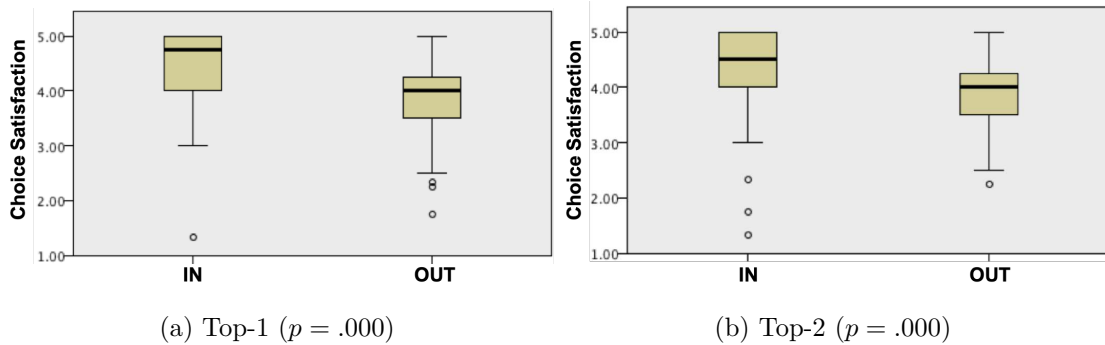
Figure 4.1: INSTANCE1 - Difference in ChoiceSat between the *IN*, and *OUT* categories

Figures 4.1a and 4.1b illustrate the differences in the choice satisfaction distribution between the *IN* and *OUT* categories, for the INSTANCE1 data set. The Kruskal-Wallis test indicates that there are significant differences in these distributions in both cases, with $p = .000$. Group members whose top preferred option was selected as the first group choice are significantly happier.

For the INSTANCE2 data set, although there is even higher percentage of overall "excited" participants, the obtained result show the same: participants who have their first or second preferred option chosen as the first group choice are significantly more satisfied (see figures 4.2a, and 4.2b).

The correlation coefficient between Individual Loss (IL), and Choice Satisfaction (ChoiceSat), for the two data sets, is shown in table 4.2. It indicates that the lower the Individual Loss in the final group choice, the higher the satisfaction of that group member is. However, the correlation, even though significant, is moderate in its magnitude.

Table 4.2: Correlation between Individual Loss and Choice Satisfaction

Instance	Correlation	p-value
INSTANCE1	$-.333$	.000
INSTANCE2	$.-319$	.000

(a) Top-1 ($p = .000$)   (b) Top-2 ($p = .000$)
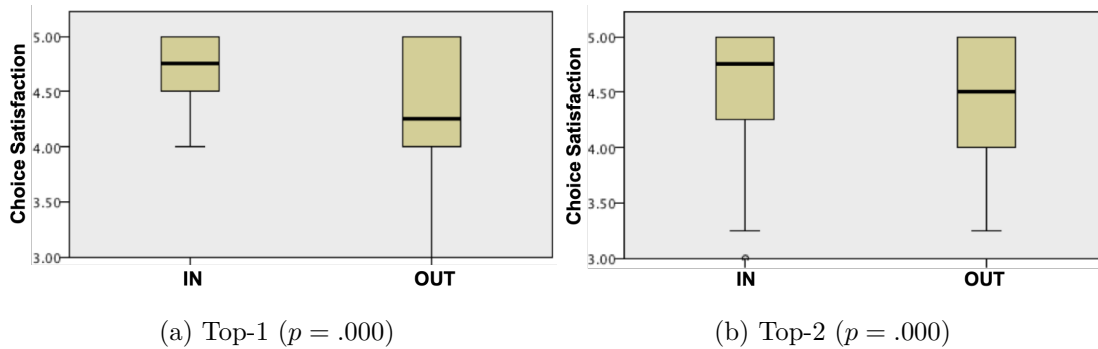
Figure 4.2: INSTANCE2 - Difference in ChoiceSat between the *IN*, and *OUT* categories

4.1.3 Conclusion

With the previously presented results, we can conclude that participants with a match between their individual and group preferences are more satisfied, nevertheless, the majority is not dissatisfied, but on the contrary. Therefore, the match-mismatch between individual and group preferences and the satisfaction with the final group choice, are correlated and dependent, but obviously, individuals' satisfaction is not fully explained nor dependent on the final group choice. Therefore, in the chapters to come, we evaluate other group and individual characteristics and the role that they play for the group decision-making process, and its outcomes (i.e., the actual group choice, as well as, participants' satisfaction with that choice).

4.2 Preferences diversity, "well-being" and performance

The second analysis of this chapter focuses on the relationship between group diversity, in terms of preferences, and the group decision-making process. The motivation for this analysis can be found in the organizational diversity theory, which studies how group diversity impacts group performance, cohesion and social interaction, as well as, group members' individual commitment, satisfaction, etc. (i.e., "well being"). The main challenge for researchers in the organizational diversity theory is to understand which group processes are affected by diversity; how to manage these processes in terms of diversity, with the goal to improve group performance, and individuals' "well being" in general [VKS07]. Moreover, research has shown that group diversity might have positive, as well as, negative effects on the group performance, and group members' individual "well being" in the group decision-making process. In the area of GRSs (as discussed in Chapter 2) only a couple of studies tackled the issue of diversity and its impact on the performance of a GRS. Baltrunas et al. [BMR10] showed that the effectiveness of group recommendations decrease for highly diverse groups in comparison to individual recommendations, while for highly similar groups this is not the case. The same was shown in [DPDM14], and in addition, the authors found that group recommendations for highly similar groups even have the "potential" to outperform the recommendations

for individuals. Moreover, Quijano et al. [QSRGDAJD13] showed that the more diverse a group is with respect to the personality of group members the more accurate their personality-based group recommendations were. Another study [DN17] shows that there is a significant and positive correlation between perceived similarity of group members' preferences and their individual satisfaction with the group choice. In theory, the increase of preference diversity in groups should make it more complicated for a GRS to find an agreeable solution for group members. In the same way, when individuals are found in a group with conflicting preferences, it is natural to assume that it will be harder for them to make a decision, acceptable by all the members. Therefore, we evaluate the impact of group diversity, in terms of preferences, on the group members' "well-being", and their individual and group performance in the decision-making process.

4.2.1 Methodology

To capture diversity of the group members' individual preferences, in this analysis, we use three measures introduced in Chapter 3, section 3.3, i.e., Spearman Top-choice Diversity (ST_DIV), Spearman Full Choice-set Diversity (SF_DIV), and Max-Min Diversity on the top-choices (MM_DIV) (for details see the referenced chapter and section). Secondly, to capture the group members' individual "well-being", we combine three post-questionnaire measures, i.e., choice satisfaction (ChoiceSat), perceived difficulty of the decision-making process (Diff), and group identity (GrIdent). The reason behind is clear, choice satisfaction indicates participants' *individual happiness with the outcome* of the group decision-making process; perceived difficulty indicates whether or not group members were *struggling during the process*; group identity indicates participants' *individual happiness with belonging to a certain group*, and executing a task with that group. Moreover, not a part of the "well-being" construct, but we also consider the perceived group similarity (GrSim) - we are interested to investigate how our defined group diversity measures (considered as measures of the "objective" diversity, since we measure them from data) relate to the perceived group similarity (GrSim) reported by participants in the post-questionnaire (considered as a measure of the "subjective" diversity). Lastly, for the individual and group performance measures we considered: Individual Loss (IL), Mean Individual Loss (MIL), Win-Loss Difference (WLD), Mean choice satisfaction (MCS), and Difference in choice satisfaction (DCS).

To investigate the relationships between diversity and group performance in the decision-making task, first we employ a simple Pearson's correlation analysis. It is noteworthy that with the correlation analysis we identify non-causal relationships at the group level. In the next step, with the Kruskal-Wallis test (i.e., a non-parametric test) we evaluate the effects of group diversity on group performance, as well as group members' individual "well-being". The choice of the test was made based on the results of Shapiro-Wilk normality test, which showed a significant deviation of our measures from the normal distribution.

To employ the Kruskal-Wallis test, we split the data into diverse and non-diverse groups, based on the median score of the specific diversity measure (see equation 4.1). The

data separation is done independently for the two data sets, and independently for each diversity measure. The median is chosen as it represents the middle point the values within a variable, and due to its resilience to the possible outliers (in contrast to the mean value).

$$IS\_DIV = \begin{cases} 1, & SF\_DIV > median(SF\_DIV) \\ 0, & otherwise \end{cases} \quad (4.1)$$

4.2.2   Results

First, we present how group diversity is related, and affects the group performance, and group "well being". Then, in the second part, we present how group diversity affects group members' individual performance, and "well being" in the decision-making process.

Group level

As illustrated in table 4.3, the results of the correlation analysis show several significant correlations. Firstly, Mean Individual Loss (MIL), and Win-Loss Difference (WLD) are positively and strongly correlated with the group diversity, for both data sets. This result is of course expected, i.e., the higher the diversity of preferences in a group, the more likely it is that the group decision will not satisfy everyone equally, i.e., some group members will lose more than the others. However, this result is not captured by all diversity measures that we introduced. Secondly, perceived group similarity at the group level (MSim) is moderately captured by the diversity of group members' top-choices, for INSTANCE1. This result partially confirms our assumption that how group members perceive their group similarity is related to the discussion style that group adopted. Thirdly, even though previous research indicates that choice satisfaction is strongly related to group diversity, the analysis indicates no correlation at the group level at all. The same is observed for the group identity, and perceived difficulty of the decision-making process.

Table 4.4 illustrates significant differences between diverse and non-diverse groups in their group performance, and their group "well-being", identified with the Kruskal-Wallis test. Hereby, the results of the correlation analysis are confirmed, i.e., Mean Individual Loss (MIL) and Win-Loss Difference (WLD) are significantly higher in diverse groups. Also, we can see that perceived group similarity (MSim), for INSTANCE1, is captured by the Spearman Full Choice-set Diversity (SF_DIV), and by the Spearman Top-choice Diversity (ST_DIV). However, for INSTANCE2, only the Max-Min diversity (MM_DIV) captures how the group members perceive their group similarity (MSim). Interestingly, for INSTANCE1, the non-parametric test showed that Mean Choice Satisfaction (MCS) is significantly higher in non-diverse groups, which is in-line with the existing literature [JNN99]. Moreover, for INSTANCE2, the test also showed that members of diverse

INSTANCE1			
Diversity measure	MIL	WLD	MSim
ST_DIV	.566**	.439**	−.339**
SF_DIV	.599**	.502**	-
INSTANCE2			
Diversity measure	MIL	WLD	MSim
ST_DIV	-	.387**	-
MM_DIV	.351*	-	-

ST_DIV: Spearman Top-choice Diversity

SF_DIV: Spearman Full-choice Diversity

MM_DIV: Max-Min Diversity

MIL: Mean Individual Loss

WLD: Win-Loss Difference

MSim: Mean perceived Similarity

Table 4.3: Correlation between diversity and performance at the group level for INSTANCE1 and INSTANCE2

groups perceived the decision-making process as significantly more difficult than those of non-diverse groups.

INSTANCE1				
Diversity measure	Performance & "Well-being"	Diverse group	Non-Diverse group	p
SF_DIV	MCS	3.98	4.17	.043
	MIL	6.55	3.86	.000
	WLD	8.18	4.89	.003
	MSim	3.49	3.74	.041
ST_DIV	MIL	6.43	3.69	.000
	WLD	8.13	4.56	.001
	MSim	3.42	3.86	.002
MM_DIV	MCS	3.88	4.19	.006
INSTANCE2				
Diversity measure	Performance & "Well-being"	Diverse group	Non-Diverse group	p
ST_DIV	MIL	2.48	1.40	.011
	WLD	5.52	2.60	.001
	MDiff	2.45	2.17	.020
MM_DIV	WLD	4.21	4.00	.019
	MSim	3.59	3.93	.042

ST_DIV: Spearman Top--choice Diversity

SF_DIV: Spearman Full--choice Diversity

MM_DIV: Max-Min Diversity

MCS: Mean Choice Satisfaction

MIL: Mean Individual Loss

WLD: Win-Loss Difference

MSim: Mean perceived Similarity

MDiff: Mean Difficulty

Table 4.4: Difference between diverse and non-diverse groups in their group performance and their group "well-being"

Individual level

INSTANCE1 At the individual level, we obtain further insights in differences between diverse and non-diverse groups. Captured with the Spearman Top-choice Diversity, in non-diverse groups, a) group members are significantly more satisfied with the group choice (figure 4.3a); b) they perceive their group similarity as significantly higher (figure 4.3b); c) they are significantly happier with their group - higher group identity (figure 4.3c); and d) they experience significantly lower Individual Loss in the decision-making process (figure 4.3d).

(a) Choice Satisfaction ($p = .002$)   (b) Perceived Group Similarity ($p = .000$)

(c) Group Identity ($p = .006$)   (d) Individual Loss ($p = .000$)
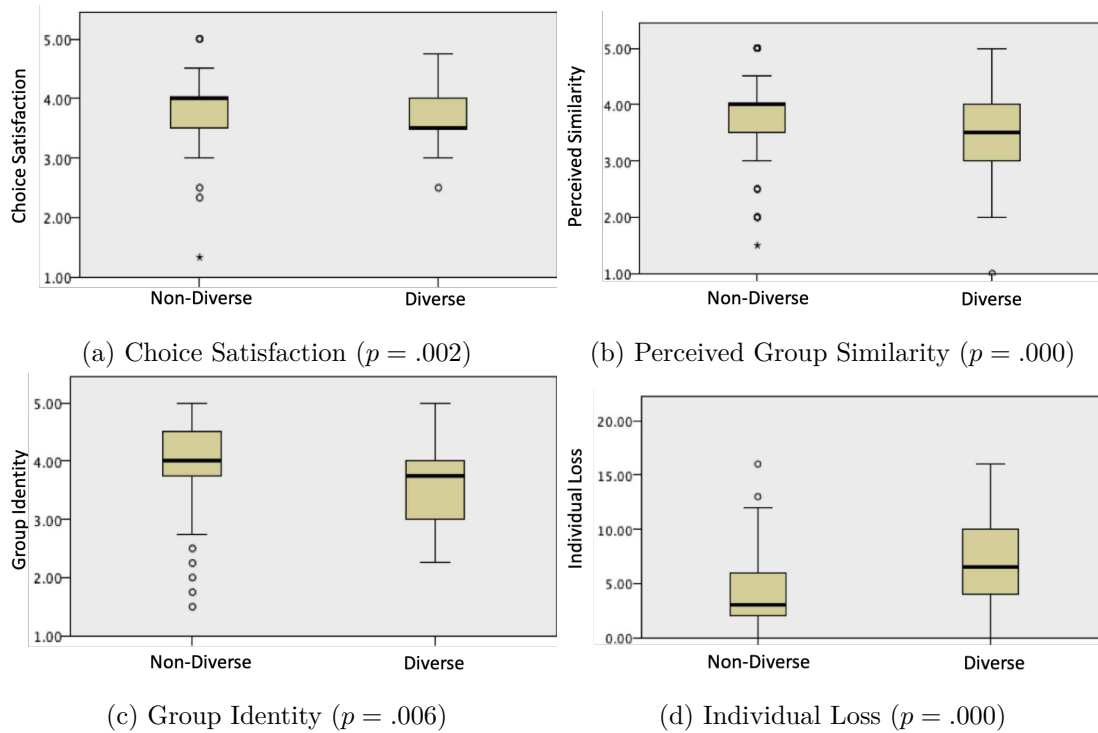
Figure 4.3: INSTANCE1 - Significant differences between diverse and non-diverse groups as captured with the Spearman Top-choice Diversity (ST_DIV)

Similarly, captured with the Spearman Full Choice-set Diversity (ST_DIV), participants in the non-diverse groups are, also, significantly more satisfied (figure 4.4a), they perceive their group similarity as higher (figure 4.4b), and their Individual Loss is significantly lower (figure 4.4c).

Captured by the Max-Min Diversity (MM_DIV), group members were significantly more satisfied with the group choice in non-diverse groups (figure 4.5).

INSTANCE2 In general, patterns observed within INSTANCE1 are confirmed within INSTANCE2. Members of non-diverse groups, as captured by the Spearman Full Choice-set Diversity (SF_DIV), are significantly more satisfied (ChoiceSat) (figure 4.6b).

(a) Choice Satisfaction ($p = .022$)

(b) Perceived Group Similarity ($p = .005$)

(c) Individual Loss ($p = .000$)
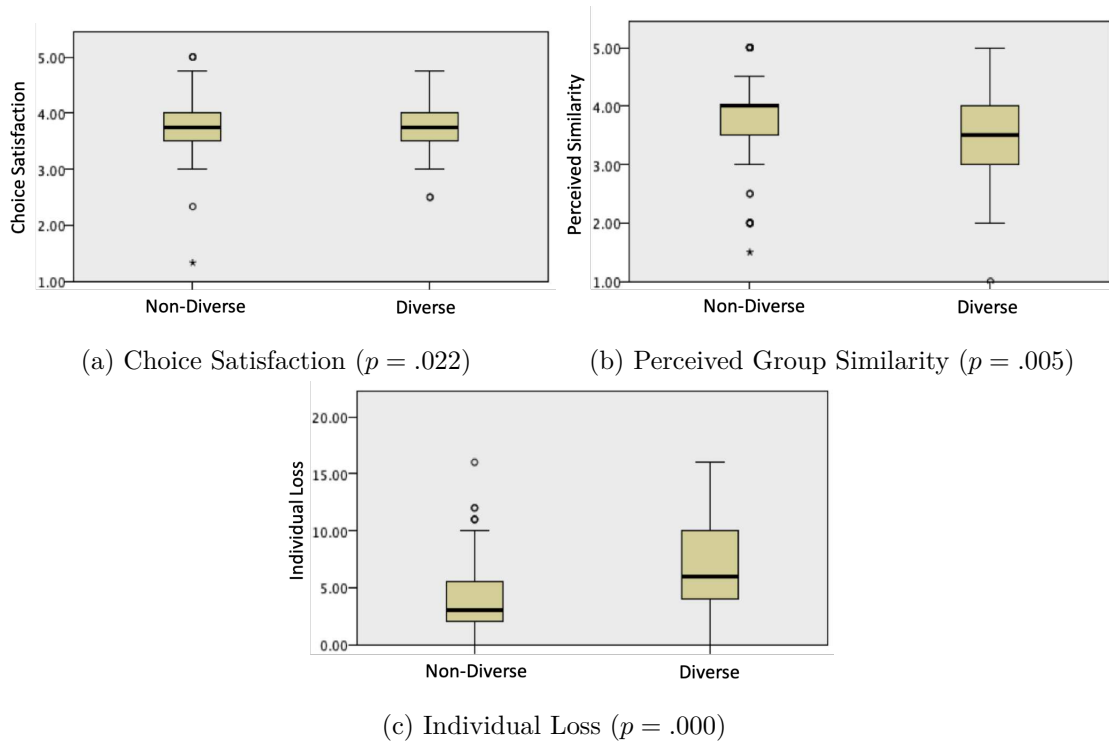
Figure 4.4: INSTANCE1 - Significant differences between diverse and non-diverse groups as captured by the Spearman Full Choice-set Diversity (SF_DIV)
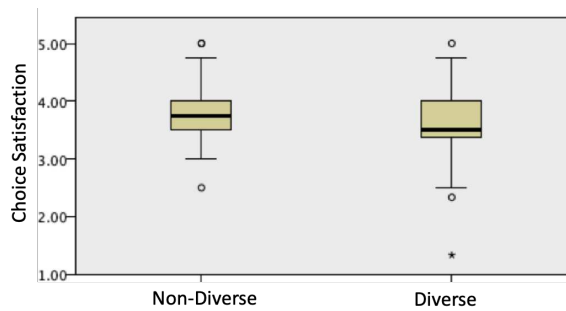
Figure 4.5: INSTANCE1 - Significant differences in Choice Satisfaction between diverse and non-diverse groups as captured by the Max-Min Diversity (MM_DIV) ($p = .013$)

Moreover, captured by both, Sperman Full Choice-set (SF_DIV), and Spearman Top-choice Diversity (ST_DIV), members of diverse groups perceive the decision-making process as significantly more difficult (Diff) (see figures 4.6a and 4.7). Finally, members of non-diverse groups, as captured by the Max-Min Diversity (MM_DIV), had a significantly lower Individual Loss (IL), than members of diverse groups (figure 4.8a). Moreover, as illustrated in figure 4.8b, the distribution of perceived group similarity score (GrSim) in diverse groups has more variance, a larger range and a lower minimum value, than in non-diverse groups, even though the median value is the same for the two categories.

(a) Difficulty ($p = .034$)

(b) Choice Satisfaction ($p = .033$)
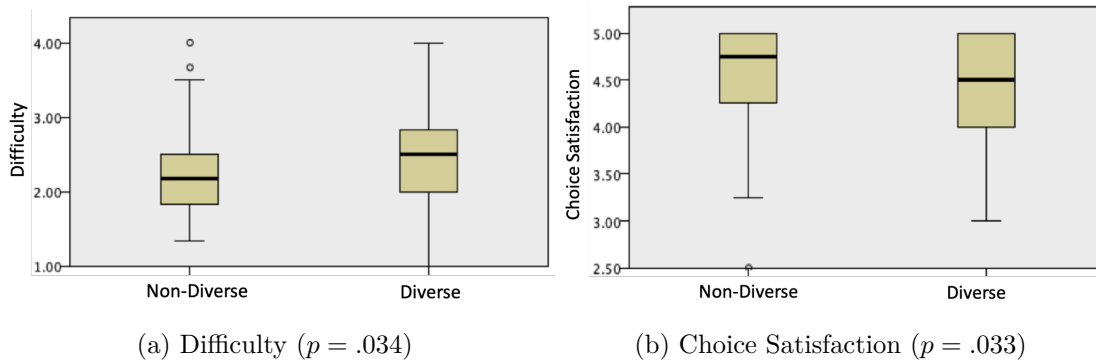
Figure 4.6: INSTANCE2 - Significant differences between diverse and non-diverse groups as captured by the Spearman Full Choice-set Diversity (SF_DIV)
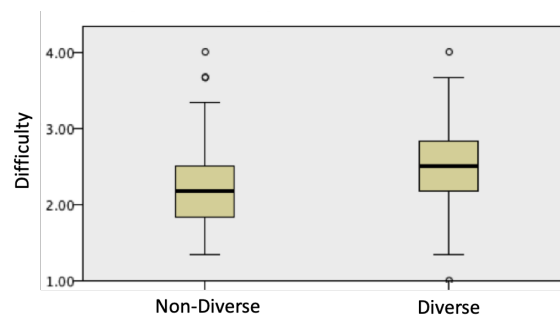
Figure 4.7: INSTANCE2 - Significant differences in Difficulty (Diff) of the decision-making process between diverse and non-diverse groups as captured by Spearman Top-choice Diversity (ST_DIV) ($p = .001$)

4.2.3 Conclusion

To summarize, we have shown that diversity of group preferences (i.e., diversity in values and attitudes as defined by the organizational diversity theory) has a negative effect on the group members' individual "well being":

1. In diverse groups, group members tend to be less satisfied with the group choice.

(a) Individual Loss ($p = .002$) (b) Perceived group similarity ($p = .007$)
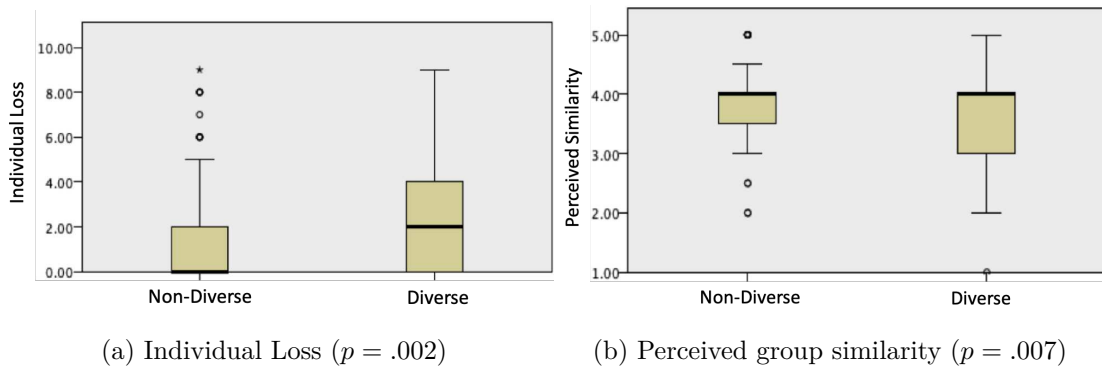
Figure 4.8: INSTANCE2 - Significant differences between diverse and non-diverse groups as captured by Max-Min Diversity (MM_DIV)

2. In diverse groups, group members tend to be less happy with being a part of the specific group (lower group identity).

3. In diverse groups, group members struggle more during the decision-making process (higher difficulty of the decision-making process).

This result is inline with the observations of Jehn et al. [JNN99]. The same was confirmed for group "well being" (i.e., individuals' "well being" constructs aggregated at the group level). Moreover, in terms of Individual Loss, Mean Individual Loss, and Win-Loss Difference, the individual and group performance is deteriorated, which is expected, and inline with the findings of Baltrunas et al. and Pessemier et al. [BMR10, DPDM14].

Now, we will discuss the implications of the presented results. First of all, yes, it is confirmed that group members are significantly more satisfied in non-diverse groups, but the relevant question is: are the group members in diverse groups dissatisfied. If we have a look at figures 4.3a, 4.4a, 4.5, and 4.6b, we will see that the difference in median values of choice satisfaction between diverse and non-diverse groups is significant, but minor in its magnitude. Even more, a case where the median choice satisfaction falls bellow the mid-point of the scale (i.e., on a five-point scale, three is the mid-point) does not exist. This indicates that, even in diverse groups, where some group members will, for sure, experience greater Individual Loss (see figures 4.3d, 4.4c, and 4.8a), their choice satisfaction does not necessarily drop proportionally with the increase of Individual Loss. The same holds for the group identity, i.e., satisfaction with being a part of a specific group.

Furthermore, the results clearly show, that different diversity measures display different effects on the group performance, and group members' individual "well being", for the two data sets. Even though the patterns of the diversity effects are similar, the observed differences deserve a proper discussion.

Firstly, we believe that these differences can be explained by understanding "objective" (i.e., measured over the reported preferences), and "subjective" (i.e., perceived by participants) representations of group diversity, on one hand, and group performance and individuals' "well being", on the other. Namely, Individual Loss, Mean Individual Loss, and Win-Loss Difference are "objective" (i.e., measured over the reported individual and group preferences) indicators of individual and group performance in the group decision-making process. For the INSTANCE1 data set, these performance measures are affected by group diversity when the diversity is captured with the Full Choice-set Diversity, and Top-Choice Diversity, but not with the Max-Min Diversity (see figures 4.4c, and 4.3d, and table 4.4). The probable explanation could be found in the way the group members expressed their individual preferences, i.e., absolute ranks of the ten destinations. Therefore, the "objective" diversity measure, in such a case, should compare individuals' ranking lists, either completely, or at the individual top choices, in order to capture the variations between the individuals' preferences. This is not really what the Max-Min Diversity captures as it overlooks the group members' pairwise diversity (for details see Chapter 3, section 8.1). On the contrary, for the INSTANCE2 data set, the effect of diversity on the Individual Loss is only captured by the Max-Min Diversity (figure 4.8a); on the Mean Individual Loss, and the Win-Loss Difference by the Top-choice Diversity and Max-Min Diversity, but not the Full Choice-set Diversity (see table 4.4). Here, the group members expressed their preferences as the ten-point ratings (i.e., the partial ranks of the ten destinations). If we measure the diversity over the full choice-set, the main differences between individuals' ranking lists might be diminished - multiple destinations can share the same place on the individual's list, and this can decrease the overall group diversity. On the other hand, Max-Min Diversity and Top-choice Diversity can capture exactly the required differences, and disregard all the similarities that might not affect group performance.

Secondly, the constructs of individuals' "well being" are all subjective measures, reported by participants as perceived. Hereby, the group diversity affects individuals' "well being" mostly during the group discussion, more precisely, the group diversity as individuals' perception of the group diversity (i.e., which does not have to be the same [HPGF02]). To explain the detected relationships, we would need to better understand which techniques the groups employed when they exchanged their individual preferences. For instance, if the group members discussed all ten destinations, then we might observe that the Full Choice-set Diversity captured the perceived diversity, and therefore we might find that it affects the group members' individual "well being"; if the group members' discussed only their top choices, then we might expect that the Top-choice Diversity would capture the perceived diversity, thus we might find that it affects their "well being". In Chapter 8, for INSTANCE1, we present an analysis of the group decision-making process, and the approaches the groups adopted to reach their final choice, but we have not yet associated those findings with how the participants perceived their group similarity, nor how it affected their individual well-being, or their performance, which will be a part of our future research.

4.3 Predicting group choice

The third part of this chapter deals with a Group Recommender System (GRS) task, i.e., how to aggregate group members' individual preferences in order to deliver effective recommendations for the group, i.e., recommendations that the group will actually chose and are fair. As Arrow's theorem indicates and the GRSs research has shown, no single, optimal approach to aggregate individuals' preferences exists [Mas15]. Moreover, the classical preference aggregation strategies are not uniformly adopted by groups, i.e., different groups adopt different approaches to reach their decisions [For18]. Hence, having the goal to predict or reconstruct the actual outcome of a group decision-making process, in order to generate more precise recommendations, one has two options. On one hand, machine learning techniques can be used to predict the actual strategy used in a group to aggregate the individual preferences. This prediction task can leverage a number of group and individuals' descriptors, i.e., assuming that the descriptors are predictors of the specific way a group makes a decision. Or, on the other hand, one can try to adapt a general strategy, for instance, the classical average aggregation method, e.g., by weighting the importance of the group members when their preferences are aggregated.

In this analysis, we focus on the second option, and introduce two novel adaptations of general preference aggregation strategies. Firstly, we develop a novel method to weight individuals' preferences in a group preference model before they are aggregated by a standard method. Secondly, we propose and evaluate the effect of a non-linear transformation of the original individual preferences of the group members before they are aggregated in a standard strategy.

In fact, a considerable amount of work has been done in the field of psychology to better understand group behavior in decision-making processes. Among various types of individual, as well as group features that affect group processes [For18, DNN+16, DNR+17, DNNR18], research has shown that these processes are influenced, to a great extent, by certain group structures [For18]. One of the fundamental group structures are connections (relationships) between pairs of group members. In a social grouping, different types of connections can emerge, and therefore different types of group networks, e.g., status networks (i.e., patterns of authority), attraction networks (i.e., patterns of likes/dislikes), communication networks, etc.

Hereby, we observe a specific type of network, namely preference similarity networks, which evolve when individuals with various preferences are placed in a group. We define, in particular, network connections (i.e., edges) on the basis of the group members' pairwise preference agreement derived from the Spearman Footrule Distance (i.e., motivated by the Spearman Full Choice-set Diversity, as introduced in Chapter 3, section 3.3). In general, the centrality of an actor within a certain network plays an important role for the development and outcomes of various processes within that network. Therefore, we hypothesize that, firstly, the centrality of an individual in the group preference network would impact her "weight" (importance) in a discussion and decision-making process. Secondly, we conjecture a method to weight group members' individual preferences based

on their centrality in that network in order to improve the prediction of group choices.

In Recommender Systems (RS), a similar approach has been considered, but in a significantly different setting, and for a considerably different task. Namely, in [MGKM+17], the authors proposed a group formation method based on the pairwise similarity of users' ratings. Then, they employed a weighted group aggregation strategy based on user centrality in the formed group, in order to deliver recommendations for individual users. They showed that their approach, as such, performs better than other aggregation strategies. Clearly, our task is a completely different one - predicting the choices of actual groups, where the groups were formed arbitrarily, as the participants felt like. Moreover, our set of items, used to construct preference network, is a rather short one, compared to MovieLens data set, used in [MGKM+17]. However, Mahyar's, et al., approach has further motivated us to test our hypothesis.

Secondly, we challenge the assumption of linearly discounting lower ranked choice preferences in the preference aggregation strategy used for generating recommendations to a group. Namely, user preferences that are expressed as either ratings or rankings are usually captured in a linear form, e.g., on a scale from 1 to 5. However, user preferences do not necessarily have to be linear. Masthoff [Mas04] has observed that prediction of a group choice is improved when the linear rating scale is transformed into a quadratic one, with negative scores. Moreover, group discussions often evolve around a couple of strongly preferred options and not around the full choice set, where the options at the bottom of the individual preference lists are disregarded already at the beginning of the decision-making process. Moreover, in many cases, humans actually react linearly to an exponential growth of the stimulus. This is the reason why log scales are typically used (e.g., decibel or lumen). For instance, in information retrieval a term, which is occurring ten times more in a document than in another, is considered as only one unit more important in the first document compared to the second. Thus, we assume that a non-linear (exponential) remapping of the originally expressed individuals' preferences can improve the prediction of the group choices.

To summarize, we conjecture two hypotheses:

H1 Transforming the scale of group members' individual preferences from a linear to a non-linear one, improves the prediction of group choices.

H2 Using group members' centrality in a group preference network as weights in a group preference model, improves the prediction of group choices.

The results of experiments show that our first hypothesis is partially confirmed (i.e., non-linear remapping of the original preferences improves the prediction of group choices to some extent), and that our second hypothesis is strongly supported by the obtained results (i.e., the proposed weighting method outperforms the state-of-the-art aggregation methods), which we show in the following sections.

4.3.1 Methodology

Research hypothesis

In this section we present group choice prediction methods, in particular, novel methods that we have designed in accordance to our hypotheses as well as the baselines we used for comparison. The group choice prediction methods are algorithms that, based on the individual preferences of the group members, aggregate these preferences and generate a novel ranking or rating for the options. These ratings or ranking are used to *predict* the actual choice of the group. Note that the individual preferences are expressed before the group discussion and decision-making process take place, in that sense, it can be said that a preference aggregation method/strategy predicts the actual group choice if the group choice matches the top ranked or rated option according to the given preference aggregation strategy.

In our first hypothesis, we conjecture that a non-linear (exponential) remapping of the originally expressed individuals' preferences (ratings/rankings) can improve the prediction of the group choices. To test this hypothesis, we transform the group members' individual preferences, from a linear scale into a non-linear one. We use an exponential function, as shown in equation 4.2:

$$new\_rating = a^{old\_rating} \tag{4.2}$$

where the parameter a is set to 1.5, in order to simulate a mild exponential growth. Within the thesis the effect of different value choices is not evaluated. This is left to a future work.

In the second hypothesis, we conjecture that the prediction of a group choice can be improved by representing groups as networks and using node centrality scores computed on these networks. In particular, we conjecture that the centrality scores of the network nodes (each node represents a group member) can be used for weighting the members in the considered preference aggregation methods/strategies used for predicting the group choices. The hypothesis is guided by one of the key concepts of social network theory, i.e., *"prominent actors"*. A prominent actor in a social network is defined as *"the one who is the object of extensive ties"* [WF94]. The centrality score of a node in a network captures exactly the prominence/importance of the actor in that network. The approach to construct the group preference networks, and to obtain the weights of group members based on their centrality in that network is presented in the next sections.

Preference networks

We now define the network that we have used for determining the relative importance of the group members. For each group, a separate network is considered. The nodes represents group members and the edges represent relationships between them. These relationships are quantified with node-to-node similarities. The similarities are obtained from the Spearman's Footrule Distance function. We were motivated by the previous work of Baltrunas et al. [BMR10], who used this function in an aggregation strategy.

Namely, we introduce the Full Choice-set Distance measure (FullDist), which considers members' preferences for all the options in the choice set (*ChoiceSet*) to compute the distance between two group members u and v. The measure produces an undirected preference similarity relationship between pairs of group members:

$$FullDist(u, v) = \sum_{i \in ChoiceSet} |score_u(i) - score_v(i)| \qquad (4.3)$$

where $score_u(i)$ is: in INSTANCE1 (and INSTANCE2 respectively) the position (rating) of option i, in the personal u ranking (ratings) list of the ten considered options. Hence, this score is in both cases (ranking and ratings) an integer between 1 and 10 in our case.

The above defined pairwise distance between group members is used to construct a preference similarity network for each group. To represent the relationship between two group members u and v as a similarity rather than a distance, we simply subtract the distance score between u and v from the overall maximum distance score, as in equation 4.3.1. Therefore, the preference similarity network is further referred to as FullSim network.

$$FullSim(u, v) = max(FullDist) - FullDist(u, v) \qquad (4.4)$$

The FullSim network is an undirected network, since it is based on an undirected preference similarity relationship between pairs of group members.

Network analysis

Representing the preferences of group members and their relationships in such a manner allows us to apply network analysis methods at the group level. By using these techniques we are able to identify the group members centrality scores. Semantically, a group member with a high centrality score in such a network is a person that shares a great deal of preferences with the rest of the group. This group member could then be seen as more important (or prominent) when she is "positioned" at the intersection of all the group members' preferences.

The degree centrality of a node is the sum of all its links' weights. Although there are other centrality measures [WF94], this is the most obvious choice as we consider rather small, fully connected, undirected, and weighted network.

As it was mentioned previously, we hypothesize that the prediction of the group choice can be improved by weighing more the preferences of group members that have a higher centrality score in the group preference network. In order to implement this idea, the weight w_u of a group member u is calculated by normalizing the centrality score $CS(u)$

of this group member in its group preference network G:

$$
w_u = \begin{cases} 1 & \text{if } \max_G(CS) = \min_G(CS) \\ \frac{CS(u) - \min_G(CS)}{\max_G(CS) - \min_G(CS)} + \beta, & \text{otherwise} \end{cases} \tag{4.5}
$$

where $\max_G(CS)$ and $\min_G(CS)$ are, respectively, the maximum and the minimum node centrality scores within the graph G. Clearly, if the centrality scores of all the group members are equal (i.e., $\max_G(CS) = \min_G(CS)$), their preferences will be considered as equally important in the group preference model. The parameter β controls the relative differences of the group members' weights (larger values will make all the weights ratios closer to 1).

Prediction methods

The prediction of a group choice is performed with preference aggregation strategies. Based on the individual preferences (ratings or rankings) of the group members, these strategies generate either a ranking or a scoring for the available options. Preference aggregation strategies were introduced in Chapter 2. In this analysis, according to the related literature, we will consider average, multiplicative, least misery and Borda count as the baseline methods since these are the methods that were used most often.

Apart from Borda that operates on the rankings, these strategies require, in order to compute the group score, the group members' ratings as the input. As previously mentioned, the two data sets, INSTANCE1 and INSTANCE2, were different in terms of group members individual preferences, i.e., rankings in the first vs. ratings in the second. Hence, to apply the Borda count strategy on the INSTANCE2 data set, we simply mapped the ratings into partial rankings of the options. Furthermore, to apply the average, multiplicative and the least misery approach on the INSTANCE1 data set, we required ratings of the ten destinations. The rankings were mapped to ratings, by applying the following procedure:

1. Given the individual partial rankings calculated for INSTANCE2 (as previously explained), for each ranking position (i.e., $\{1, 2, ..., 10\}$), we calculated the conditional probability for each rating that it will be assigned to the rank at hand.

2. For each group member from INSTANCE1, and for each ranking that she provided, a rating was sampled, according to the previously calculated conditional probabilities.

In order to validate the procedure, we compared the distribution of the original rankings in INSTANCE1 with the rankings obtained from the newly generated ratings, and the two distributions did not differ significantly.

Finally, with the goal to test our research hypotheses, we introduce two categories of preference aggregation strategies, that are compared with the selected baseline methods:

1. The non-linear category including: non-linear Borda (*"Nl-Borda"*), which uses non-linear rankings of the group members; non-linear average (*"Nl-Avg"*), and non-linear multiplicative strategy (*"Nl-Mult"*), which use the non-linear ratings.

2. The weighted category including: weighted average (*"W-Avg"*); weighted Borda count (*"W-Borda"*); and weighted multiplicative (*"W-Mult"*) (group members' weights are calculated according to the equation 4.5).

Example In order to illustrate how the introduced preference aggregation strategies work, in comparison with the selected baselines, we illustrate an example. Let us assume that we have a group of three members (i.e., u_1, u_2, and u_3), and that each of them rated three items (i.e., $r(u_*, i_1)$, $r(u_*, i_2)$, and $r(u_*, i_3)$) as illustrated in the left part of table 4.5. For the given group, and the provided ratings, if we compute the weights for each group member, according to equation 4.5, and $\beta = 1$, we will obtain the following node weights: $w_{u_1} = 1$, $w_{u_2} = 2$, and $w_{u_3} = 1$. Now, in the bottom part of the table, the results of the baseline aggregation strategies, i.e., least misery (msry), multiplicative (mult), and average(avg), together with the weighted average, are presented.

Table 4.5: Baseline and weighted strategies performance on an example

	$r(u_*, i_1)$	$r(u_*, i_2)$	$r(u_*, i_3)$
u_1	10	6	9
u_2	7	8	4
u_3	2	7	7
msry	2	**6**	4
mult	140	**336**	252
avg	6.33	**7**	6.66
w-avg	8.66	**10**	8

To illustrate how the non-linear category of aggregation strategies operate, table 4.6 contains the transformed, non-linear preferences, and the results of the non-linear average and the non-linear weighted average strategy.

Table 4.6: Non-linear strategies performance on an example (a = 1.5)

	$a^{r(u_*, i_1)}$	$a^{r(u_*, i_2)}$	$a^{r(u_*, i_3)}$
u_1	57.66	11.39	38.44
u_2	17.08	25.62	5.06
u_3	2.25	17.08	17.08
nl-avg	**25.66**	18.27	20.19
nl-w-avg	**31.35**	26.57	22.21

To summarize, all the baseline methods choose item i_2 as the best option for the group. Even the weighted average prefers this item, due to the high rating of the member u_2, who

has the largest weight (equal to 2) in the group model. Nevertheless, the weighted average shifts the importance of the items i_1 and i_3, in comparison to the baseline methods, making i_1 the second best option, and i_3 the least preferred option. The non-linear average, on the contrary, chooses i_1 as the best option for the group, placing the i_2 item on the last place. The non-linear weighted average, also chooses i_1 for the group, but does not make i_2 the least desirable option.

Evaluation strategy

To asses the predictive performance of the various aggregation strategies, the baseline ones, and the newly proposed ones, we used precision of the recommendations at top-one (P@1) and top-two (P@2):

$$P@k = \frac{\#CorrectTopkRecommendations}{\#TopkRecommendations} \qquad (4.6)$$

In equation 4.6, the numerator captures the number of group choices that are correctly predicted by the aggregation strategy. The denominator is the number of top-k recommendations generated by an aggregation strategy (i.e., when multiple items obtain the same score they will share the rank in a recommendation list, but the precision score will decreased according to the number of recommendations).

As the weighted aggregation strategies depend on the β parameter (see equation 4.5), we searched for the β value which maximizes the estimated precision of the prediction strategy. To this end, we have split the data into a training set (randomly selected 50% of groups from the combined data set, i.e., INSTANCE1 and INSTANCE2 merged), and a test set (the remaining 50% of the groups). In the training set, the β value, for which the considered weighted aggregation strategy reached its maximum precision score (i.e., the mean value of $P@1$ and $P@2$) was selected. The test set was then used to compare all the proposed methods with the baselines. The procedure of randomly splitting the data was repeated all together ten times and the average performance metrics were computed. In each repetition the optimal β parameter was selected based on the results obtained for the training set.

4.3.2 Results

Non-linear scale

The first hypothesis conjectures that the prediction of the group choices can be improved if group members' individual preferences are transformed with an exponential function, hence are mapped from a linear scale to a non-linear one. This mapping penalizes low rated/ranked items, and emphasizing the importance of highly rated/ranked items.

Table 4.7 shows the precision of the considered strategies, when predicting the two choices of the group with the baseline and non-linear methods. Here, the best scores are highlighted, where the higher is the better. As previously explained, the performance

metrics are computed on a test set formed by a random sample of 50% of the groups, after the weighted methods were trained on the other 50% of the groups for selecting the optimal β value. Since the procedure of randomly selecting a test set of 50% of the groups was repeated ten times, we report the average precision scores over these ten repetitions.

Table 4.7: Non-linear Scaling - Average P@1 and P@2

Aggregation strategy	P@1	P@2
Average	0.458	0.422
Nl-Average	0.518	0.450
Borda	0.550	**0.449**
Nl-Borda	**0.608**	0.445
Multiplicative	0.445	0.426
Nl-Multiplicative	0.458	0.422
Least misery	0.414	0.358

The *P*@1 scores of average and Borda strategies are improved by the exponential (non-linear) mapping of the group members' individual preferences. The improvement of the non-linear Borda in comparison to the baseline Borda is over 5%, while the improvement of the non-linear average strategy is 6%. The non-linear multiplicative also performs better better than its baseline, but only slightly (1.3%). The least misery strategy will not be considered anymore, since in this data set it performs worse than all the other methods. For *P*@2, the proposed non-linear mapping improves only the average strategy, with a slight improvement of 2.8%. The non-linear Borda and multiplicative perform almost the same as their respective baselines.

To better understand the performance of the various aggregation strategies, we made a pairwise comparisons of the new proposed methods with their respective baselines. Namely, tables 4.8 and 4.9, show how many times the P@1/P@2 score, as calculated per group, is better (i.e., higher), worse (i.e., lower), and equal when a strategy noted in column "Method 1" is compared with a strategy noted in column "Method 2". Again, the scores (i.e., "better", "worse", and "equal") are averaged over the above described ten test repetitions.

Table 4.8: Comparison of introduced methods with the baselines in achieving better P@1

Method1	Method2	Better	Worse	Equal
Nl-Avg	Avg	3.7	0.5	35.8
Nl-Borda	Borda	4.0	0.6	35.4
Nl-Mult	Mult	1.5	0.5	38

Table 4.8 clearly illustrates the effectiveness of the non-linear average and Borda strategies, in comparison to their baselines, for the P@1 metric. In average, non-linear Borda

Table 4.9: Comparison of introduced methods with the baselines in achieving better P@2

Method1	Method2	Better	Worse	Equal
Nl-Avg	Avg	8.2	4.1	27.7
Nl-Borda	Borda	4.1	4.1	31.8
Nl-Mult	Mult	4.0	5.8	30.2

performs better on 4.0 of 40 groups in total, while looses on only 0.6 groups; non-linear average wins on 3.7 groups, and looses on 0.5 groups; and non-linear multiplicative shows small improvement also analysing its win-lose performance.

For P@2, table 4.9 illustrates that the non-linear average performs the best in comparison to its respective baseline i.e., it wins on 8.2 groups, and loses on 4.1 groups. However, the non-linear Borda and multiplicative perform equal and worse (respectively) than their baselines.

To summarize, the non-linear Borda performs particularly better than the baseline Borda with respect to the P@1 metric, but this does not hold for P@2. However, the non-linear average strategy obtains better results in both cases. As for the non-linear multiplicative strategy, a clear improvement is not achieved for both precision metrics.

Centrality-based weighting

In the second hypothesis we conjecture that weighting group members according to their centrality in the group preference network can improve the precision of a preference aggregation strategy prediction of the group choices, in comparison to the corresponding baseline strategy that does not use this weighting schema.

Table 4.10: Centrality-based weighting - Average P@1 and P@2

Aggregation strategy	P@1	P@2
Average	0.458	0.422
W-Average	0.523	0.438
Borda	0.550	0.449
W-Borda	**0.603**	**0.455**
Multiplicative	0.445	0.426
W-Multiplicative	0.525	0.454

For P@1 the weighted average performs better than the baseline average, and even better than the non-linear average (see table 4.10). However, table 4.11, actually shows that the weighted average has almost the same number of wins and losses occurrences against its baseline, even though it achieves better P@1 score. Nevertheless, the higher P@1 score indicates that when the prediction is correct, the weighted average has less false positives placed at the same rank position as the true positive, in comparison to its

Table 4.11: Comparison of introduced methods with the baselines in achieving better P@1 for the ten trials

Method1	Method2	Better	Worse	Equal
W-Avg	Avg	6.2	5.1	28.7
W-Borda	Borda	3.1	2.0	34.9
W-Mult	Mult	6.2	4.1	37

Table 4.12: Comparison of introduced methods with the baselines in achieving better P@2 for the ten trials

Method1	Method2	Better	Worse	Equal
W-Avg	Avg	12.5	10.3	17.2
W-Borda	Borda	6.4	4.6	29
W-Mult	Mult	9.1	7.8	23.1

baseline. The weighted Borda strategy achieves the second best P@1 result of all the aggregation strategies (only after Nl-Borda), and has 3.1 wins and 2.0 loses, in average, against the baseline (table 4.11). The weighted multiplicative strategy, as well, preforms better than its baseline, even by 7% (table 4.10), having 6.2 wins, and 4.1 losses.

For $P@2$, the improvement of the weighted methods is more noticeable. The weighted average is again better than the baseline average, the weighted Borda is the best performing strategy in this case, but only slightly better than the baseline, and the weighted multiplicative, makes more than 3% improvement, in comparison to its baseline, (table 4.10).

To summarize, the weighted aggregation strategies perform consistently better than their respective baselines, achieving better P@1 and P@2 score, in average.

4.3.3   Conclusion

In this section we discuss the implications of our results. To test the first hypothesis we evaluated the performance of certain preference aggregation strategies when the group members' preferences are transformed from a linear scale to a non-linear one using an exponential function. The hypothesis is motivated by the fact that, in many situations, human react linearly (with the given rating or ranking) to an exponential growth of the stimulus (attractiveness), as described in section 4.3. In other words, we assume that for a certain option to be one level better than another option it must have a score that is larger than the other by a multiplicative factor. The results we obtained partially support this hypothesis. The P@1 metric has clearly improved for all the evaluated strategies when considering a non-linear scaling of the preferences, while the P@2 metric has only improved for the non-linear average strategy. Consequently, based on the current results, we can conclude that our *first hypothesis is only partially supported*. Certainly, the performance of the non-linear strategies is influenced by the selection of the parameter

a (i.e., the base of the exponential function, see equation 4.2), which we set to 1.5 in the current analysis. For the future work, we would like to evaluate the effect of the *a* parameter, and optimize it.

In the second hypothesis, we conjecture that representing groups in a network structure and using the degree centrality of the nodes to weight the respective members in a preference aggregation strategy will improve the precision of the group choices prediction. Such an approach is used in group dynamics theory [For18, KOT97, KM90, Lat96], and has recently been evaluated for the group formation problem [MGKM$^+$17]. However, to our best knowledge, such an approach has not yet been attempted in GRSs, even though it is an intuitive step towards understanding group behavior. According to our results, this *hypothesis is supported and improvements can be achieved when using the weighted strategies instead of their respective baselines.* This is true for both precision metrics (P@1 and P@2), having that the weighted strategies are better than the corresponding baselines (see table 4.12).

The performance of the weighted strategies is highly dependent on the proper selection of the β parameter (it controls the relative differences of the group members' weights -larger values will make all the weights ratios closer to 1, see equation 4.5). In our approach, for each training set, the best performing β was selected. Clearly, the larger the training set, the greater the confidence to select β. However, it is worth noting, that our data set comprises of only 79 instances. 50-50 split of the data results in 39/40 training instances only. We could have used a different splitting ratio (e.g., 70-30), but in that case the number of groups on which we test the performance of the aggregation strategies becomes severely limited (e.g., containing only 23/24 groups).

Clearly the size of the data set is a limitation of this analysis, nevertheless, showing that our methods perform on average better than the baselines, strongly support the validity of our second hypothesis. Therefore, the approach to construct group preference networks and weight group members based on their centrality (i.e., importance) in those networks, should be considered in group recommendation tasks.

The presented analysis focuses on comparing the non-linear and weighted strategies with their respective baselines. Even though we do show that our proposed methods work better on average, tables 4.9 and 4.12 indicate that there are situations in which the baseline aggregation strategies actually perform better. To this end, one goal of our future work will be to identify group characteristics that determine which aggregation strategy should be used in a particular case, therefore adapting the aggregation strategy to the specific contextual situation and the group at hand.

CHAPTER 5

Personality, Travel Types and Group Decision-Making Process

The goal of this chapter is to explore the role of personality, and travel factors in the group decision-making process. More precisely, to investigate 1) whether the members' individual satisfaction with the group choice depends on their personality and their inclination towards certain travel factors, and 2) whether the group performance, as defined in section 3.3.3, varies across groups with different compositions of personality types.

Firstly, the hypothesis is that the likelihood of a person being satisfied after the tourism-related decision-making process depends, not only upon the group choice and whether their individual preferences are fulfilled through that choice, but that it also depends upon their personality. It is specifically explored that the satisfaction level of the individual group member with the final group choice is under the influence of a) personality differences (i.e., the Big Five factors), b) the individual's general inclination towards competitive-collaborative interaction with other people (i.e., the Thomas-Kilmann Conflict Resolution Styles), and c) the individual's higher or lower general interest in particular tourism-related activities (i.e., the implicit travel preferences - travel types/factors).

Secondly, as shown in Chapter 4, section 4.2.2, performance of the group in the decision-making process is, of course, related to the group structure in terms of preference diversity, i.e., as the preference diversity in the group increases, the Mean Individual Loss (MIL) of the group follows that increase. It was also demonstrated, that individual choice satisfaction is related with the preference diversity. Hereby, it is conjectured that group structure in terms of personality also relates to the performance of the group in the decision-making process. For instance, if group members are collaborative in the decision-making task, they might find a more suitable solution for a group as a whole (thus,

decreasing their Mean Individual Loss), than a group that is not really collaborative in their nature.

Behavioral research on group decision-making maintains that individuals often arrive at group decisions that are satisfactory for most group members [Gor14, DMM10]. Often observed in that respect is a process, in which the individual preferences within a decision-making group lead to a consensus via social 'sharedness' - that is, the option that is most commonly shared within the group will become the final group decision. This situation is often referred to as a majority/plurality-wins model, which nicely captures why many group members are typically satisfied with decisions made in a group setting [KT04]. The shared consensus choice is the response option that matches most of the individual group members' personal preferences, causing high satisfaction levels within the group. On the other hand, participants of a group decision-making process can also fall victim to dissatisfaction [DDW03]. Well-documented in that respect is the dissatisfaction that the most extreme participants in group decision-making experience, when their individual preference does not make it as the final group decision. The least central member within the group, indeed, often loses out against the majority/plurality, and is forced to comply with a mismatching decision, which leads to feelings of dissatisfaction [KT04]. Anecdotal evidence exists even for the so-called 'Abilene paradox', an extreme situation, in which group members collectively arrive at a joint decision that is dis-satisfactory to most (if not all) individuals within the group [Har88, For18].

It makes sense to assume that the likelihood that the person will experience (dis)satisfaction with the outcome of the decision-making process also depends on trait-specific characteristics of the individual group member, and the trait-specific structure of the group.

In this chapter, therefore, we aim to answer **research question 2:** *What is the role of personality, and travel types in the group decision-making process?*, together with question *RQ 2.1 How is the personality, and the travel type of a member related to her satisfaction with the group choice?*, and *RQ 2.2 How does the group personality composition relate to the performance of that group in the decision making-process?*.

5.1 Methodology

The general objective of this chapter, as previously mentioned, is to examine the influence of personality in individual satisfaction and group performance in the travel-related group-decision making task. Understanding the dynamics underlying such processes is highly relevant for the design and the development of e-tourism RSs [WASC+15].

The analysis is structured in two parts, the first one deals with group members individually, and their individual choice satisfaction, while the second part deals with the group as a whole and its performance - both exploring the impact of personality. Therefore, the first part is further referred to as individual level, and the second part as group level analysis.

Overall, the analysis was performed on the INSTANCE1 data set, with its 200 participants and 55 groups. For more information about the data set, see section 3.4. For the future

work, the plan is to validate the presented results on the second data set that we collected (i.e., INSTANCE2).

5.1.1 Individual level

Hereby, the goal is to identify the differences between highly satisfied and not so satisfied participants of the study. Therefore, the first step was to define high and low satisfied participants.

High and low choice satisfaction. A participant was considered to be highly satisfied ($IS\_SAT = 1$) with the group choice when his or her satisfaction score ($ChoiceSat$) was higher than, or equal to the median satisfaction score across the data set; and was considered to be unsatisfied ($IS\_SAT = 0$) with the group choice, if the satisfaction score was lower than the median (see equation 5.1). Table 5.1 illustrates the distribution of highly satisfied and unsatisfied group members.

$$IS\_SAT = \begin{cases} 1, & ChoiceSat \geq median(ChoiceSat) \\ 0, & otherwise \end{cases} \tag{5.1}$$

Table 5.1: Distribution of high and low satisfied participants

# of High satisfied	# of Low satisfied
124 (# of = median: 33)	76

In the next step, as we were interested to further analyse reasons of satisfaction/dissatisfaction of the participants, we explored whether or not winning/losing in the group decision-making process determines the satisfaction level. In Chapter 4, the correlation between Individual Loss (IL) and choice satisfaction (ChoiceSat) is presented, i.e., a moderate and significant correlation might imply that other factors, besides to winning/losing effect might play an important factor of satisfaction. Hereby, we define *"winners"* and *"losers"* of group decision-making process.

Winners and losers. To determine whether an individual group member was a winner or a loser in the group decision-making process, the Individual Loss (IL), as defined in 3.3.3 was used. As a reminder, Individual Loss represents the actual match or mismatch between the favourite destination(s) as submitted by an individual prior to the group decision-making process, and the destination that was chosen by the group after that group decision-making process. To operationalize, the absolute value of the difference between group rank and participant's individual rank of the chosen destination is considered. A group member with the Individual Loss lower than the median Individual Loss was considered a winner ($IS\_WIN = 1$), and a loser ($IS\_WIN = 0$) otherwise (see equation 5.2). Table 5.2 illustrates the distribution of winners and losers across the data sample.

$$IS\_WIN = \begin{cases} 1, & IL < median(IL) \\ 0, & otherwise \end{cases} \tag{5.2}$$

Table 5.2: Distribution of winners and losers

# of Winners	# of Losers
99	101

Since the overall goal of the chapter is to investigate the influence of group members' personality on their choice satisfaction, the following personality models were used.

The Big Five factors. As described in section 2.5, personality of participants was captured with the Big Five factors model. To recall, the Five Factors are Openness to new experience, Conscientiousness, Extroversion, Agreeableness and Emotional stability.

Thomas-Kilmann conflict resolution styles. When individuals engage in decision-making in a group setting, conflict is bound to arise [For18]. The Thomas-Kilmann Conflict Mode Instrument was developed to address the potential conflict resolution styles group members adopt, by distinguishing between high and low cooperation and high and low assertion. It focuses on the interaction between users rather than on characteristics of individual users. Therefore, in this chapter, we are also evaluating the effect of group members' conflict resolution styles on their experienced choice satisfaction. To this end, as the Thomas-Kilmann Conflict Mode Instrument was not a part of our questionnaires, we followed the existing literature [WB08] to derive participants' individual conflict resolution styles from their Big Five factors scores. In essence, the goal is to represent assertiveness and cooperativeness with the Big Five factors. Hence, according to Wood and Bell's procedure, someone with a high score on Agreeableness (i.e., higher than the median Agreeableness score (3.75) in the sample) and with a high score on Extroversion (i.e., higher than the median Extroversion score (3.50) in the sample) can be considered as Collaborating (COLL, $N = 45$); a person with a low score on Agreeableness and a low score on Extroversion can be called Avoiding (AVOID, $N = 72$); a person with a high score on Agreeableness and a low score on Extroversion can be regarded as Accommodating (ACOM, $N = 48$); and, finally, a person with a low score on Agreeableness, but a high score on Extroversion can be considered as Competing (COMP, $N = 35$). In this case the median score was selected due to its properties. First of all, by its definition, the median represents the midpoint of a frequency distribution of the observed values, therefore all the values above median can be considered as high, and all the values bellow the median can be considered as low. Furthermore, the groups that we obtain with the median split are of similar sizes (depends on the number of variables falling exactly on the midpoint), which is a valuable feature to have when evaluating differences between two groups of instances. Finally, as the range of the personality variables is $[1, 5]$, then the mean value differs from the median only marginally, however, the mean split would produce more imbalanced groups of instances which we were trying to avoid.

Implicit travel preferences (travel types/factors). Having that the implicit travel preferences represent the short-term travel related interests and behavioral patterns, these preferences can be regarded as participants' travel-related personality types. The procedure of obtaining the implicit travel preferences, i.e., the eight travel factors is described in section 3.3.1. To recall, the eight travel types/factors are: Carefree elitist, Adventurous thrill seeker, Spiritual drifter, Beach and party lover, Organized archaeologist, Educational tourist, Independent anthropologist, Active escapist.

5.1.2 Group level

In this part of the analysis, the objective was to evaluate the impact of "group personality" on the group performance in the decision-making process. Therefore, the first step was to define the concept of group personality, and here we will focus on the Thomas-Kilmann conflict resolution styles. The reason for our choice is two-folded. Firstly, Thomas-Kilmann Conflict Mode Instrument aims to characterize individuals when in a conflicting situation, and most importantly, in a group setting. Therefore, for us, and the group decision-making task, it makes sense to characterize group personality in this way. Secondly, we believe that it might be more intuitive if the group personality is characterized over two dimensions (i.e., assertiveness and cooperativeness), as a combination of Extroversion and Agreeableness, instead over the five dimensions as it is case with the Big Five factors.

Group personality types. The starting point to define the concept of group personality is the Thomas-Kilmann conflict resolution style at the individual level. To assign a group to a specific conflict resolution style, the fraction of participants that belong to a specific style was considered: a group is assigned to a specific conflict resolution style when 50% or more of its members belongs to that style; a group is assigned to a mixed type, if there is no majority that is assigned to a single conflict resolution style, or when 50% of participants belong to one conflict resolution style and the other 50% belong to another style. Therefore, five group personality types are obtained: 1) Collaborative (COLL, $N = 8$), 2) Accommodating (ACOM, $N = 9$), 3) Avoiding (AVOID, $N = 18$), 4) Competing (COMP, $N = 5$), and 5) Mixed (MIX, $N = 15$).

Group performance. The group performance measures that were used in this analysis are Mean Individual Loss (MIL), Win-Loss Difference (WLD), Mean Choice Satisfaction (MCS), and Difference in Choice Satisfaction (DCS), defined in Chapter 3, subsection 3.3.3

In Chapter 4, the relationship between group diversity and group performance was assessed. Therefore, to control for the effect of diversity when evaluating the impact of group personality on the group performance, we analyse separately diverse from non diverse groups. In this manner, we avoid the possibility of obtaining the results that actually show indirect effect of group diversity on the group performance. To this end, diverse and non-diverse groups are defined.

Diverse and non-diverse groups. To measure the group diversity Spearman Full Choice-set Diversity (SF_DIV), as defined in Chapter 3, subsection 3.3.2 was used. Moreover, to make a distinction between diverse from non-diverse groups, the median-split approach is again employed (see equation 5.3).

$$IS\_DIV = \begin{cases} 1, & SF\_DIV > median(SF\_DIV) \\ 0, & otherwise \end{cases} \tag{5.3}$$

5.2 Results

5.2.1 Individual level

In order to get the first feeling about the relationship between choice satisfaction level of group members and their personality traits scores, we conducted a correlation analysis. It turned out, that the significant correlations were found for the Conscientiousness trait (.212, $p < .01$), Openness to new experiences (.185, $p < .01$), and Emotional stability (.183, $p < .01$). All three correlations are clearly low in their magnitude, but nevertheless significant.

To answer what is the role of group members' personality for their choice satisfaction when a group decides on a travel destination to visit together, the differences in individual group member's characteristics (i.e., Big Five Factors and eight travel types/factors) between highly satisfied and unsatisfied participants were analyzed. A Kruskal-Wallis test revealed that the highly satisfied participants were more Open to new experiences, Agreeable, less neurotic (i.e., more Emotionally stable), and they scored higher on the Beach and Party Lover travel factor, than the unsatisfied participants. With respect to the Thomas-Kilmann conflict resolution styles, the participants with a more collaborative personality were generally more satisfied with the group decision (i.e., lower value of the Thomas-Kilmann Mode variable indicates more collaborative behaviour). Finally, highly satisfied participants perceived the group decision process as easier, the group similarity as higher, and their identification with the rest of the group as stronger. Table 5.3 illustrates significant differences (i.e., the median scores) between highly satisfied and unsatisfied group members.

Table 5.3: Significant differences between high and low satisfied participants

Variable	Low satisfied (76)	High satisfied (124)	$p-value$
Openness	3.75	4.00	0.031
Agreeableness	3.75	4.00	0.019
Emotional Stability	3.25	3.50	0.001
TK Mode	3.00	2.00	0.025
Beach and Party Lover	-0.574	0.093	0.001

Next, given that the correlation coefficient between choice satisfaction and Individual Loss (IL) was moderate in its magnitude (as indicated in Chapter 4), the "losers" of the group interaction were studied to explore the differences between those satisfied and unsatisfied. The test indicated that satisfied "losers" were also more Open to new experiences, Agreeable, Emotionally stable, and in addition they were also more Extroverted. This finding was consistent with the direction suggested in the Big Five factors, in the sense that only those "losing" participants with a stronger social orientation were capable of maintaining a sense of satisfaction with the final group decision despite their loss. Hence, these outcomes are consistent with general theorizing on the Big Five factors model of personality, but as well with the theorizing on the tourist roles [DOBL06, MC87, MJ92, WB08], i.e., the satisfied "losers" still scored significantly higher on the Beach and Party Lover travel factor (see table 5.4).

Table 5.4: Significant differences between high satisfied and low satisfied losers

Variable	Low satisfied (48)	High satisfied (53)	$p-value$
Openness	3.75	4.00	0.015
Agreeableness	3.75	4.00	0.032
Extroversion	3.25	3.50	0.015
Emotional Stability	3.25	3.75	0.018
Beach and Party Lover	-0.646	0.040	0.028

Finally, it was explored in what way individual differences in conflict resolution style impacted the satisfaction-levels of the respective "winners" and "losers" in the group decision-making process. Existing research suggests that conflict resolution styles not only are related to the self-reported satisfaction of the individual group member, but, as such, also exert an influence on the actual outcome (i.e., the final choice) of the decision-making process in a group [For18]. To explore this possibility, the individual "winners vs. losers" in the group decision-making process, and their potential "high vs. low satisfaction level" were juxtaposed with the final outcome to arrive at: 1) high satisfied winners, 2) high satisfied losers, 3) low satisfied winners, and 4) low satisfied losers. Next, a contingency table was created to understand the relations between the four respective Thomas-Kilmann conflict resolution styles and our four possible outcomes (see table 5.5).

Table 5.5 nicely shows that those individuals who actively dealt with the potential conflict arising from different preferences within the group regarding the final travel destination in a cooperative fashion (i.e., by engaging in a collaborative resolution style) often became highly satisfied winners. Given their active cooperation with the other members of the group (which can be understood in terms of "teamwork" [For18]), they also often were highly satisfied even when they lost in the end (i.e., 35 of 45 collaborative participants ended up being satisfied, and 21 of them even "winning" the group decision making process). Obviously, the latter pattern was not observed for individuals with a competing conflict resolution style, who only were satisfied when they won – that is, if they managed

Table 5.5: Contingency table: Thomas-Kilmann conflict resolution styles and Outcome

TK Mode / Outcome	COLL	ACCOM	AVOID	COMP	SUM
High Sat. Winners	21	18	23	13	75
High Sat. Losers	14	15	15	9	53
Low Sat. Winners	5	4	10	5	24
Low Sat. Losers	5	11	24	8	48
SUM	45	48	72	35	200

to do so in the first place. From table 5.5, it also becomes evident that matters were more complicated for so-called avoiders – i.e., those participants who took a more passive role in the group negotiations. On the one hand, their avoiding conflict resolution style paid off in terms of satisfaction levels when they were among the "winners". On the other hand, however, they fell particularly hard into low satisfaction when they lost. Clearly, the share of low satisfied losers exceeded the expected value based on the overall distribution – an effect that is even more pronounced when aggregated for all categories ($Chisquare = 5.373$, $df = 1$, $p = .02$; see table 5.6).

Table 5.6: Contingency table: Aggregated Thomas-Kilmann styles and Outcome

TK Mode / Outcome	Avoiding	Not avoiding	SUM
Other outcome categories	48	104	152
Low Sat. Losers	24	24	48
SUM	72	128	200

This seems to suggest that individual group members who play an active role in group negotiations in terms of conflict resolution style are less likely to be dissatisfied "losers" as opposed to those qualified as avoiders according to the Thomas-Kilmann conflict resolution styles. The implications for e-tourism, especially in regard of the development of interactive tools for group travel, will be discussed in section 5.3, in conjunction with the other findings of this study.

5.2.2 Group level

In the second part of results, the impact of group composition in terms of Thomas-Kilmann conflict resolution styles on group performance in the decision-making process (i.e., Mean Individual Loss (MIL), Win-Loss Difference (WLD), Mean Choice Satisfaction (MCS), and Difference in Choice Satisfaction (DCS)) is presented. First, we investigated the effect without controlling for the preference diversity of the group, but simply explored whether or not there are significant differences in group performance between the five group personality types that we previously introduced (i.e., Collaborative (COLL), Accommodating (ACOM), Avoiding (AVOID), Competing (COMP), and Mixed (MIX)).

Kruskal-Wallis Independent Samples test showed significant differences in distribution of the Mean Individual Loss (MIL) across the five personality types (see figure 5.1, sub-figure 5.1a), indicating that groups with a majority of participants assigned to the competing conflict resolution style achieve the lowest Mean Individual Loss (MIL), followed by mixed and collaborative groups. While, the greatest Mean Individual Loss appears in groups with a majority of participants assigned to the accommodating and avoiding conflict resolution styles. Moreover, the test also showed that the distribution of Win-Loss Difference (WLD), varied across the five group personality types (see figure 5.1, sub-figure 5.1b), indicating that the lowest WLD score occurred in mixed groups, followed by collaborative and competing ones, while the highest score was obtained for accommodating and avoiding groups, again.

(a) Mean Individual Loss   (b) Win-Loss Difference
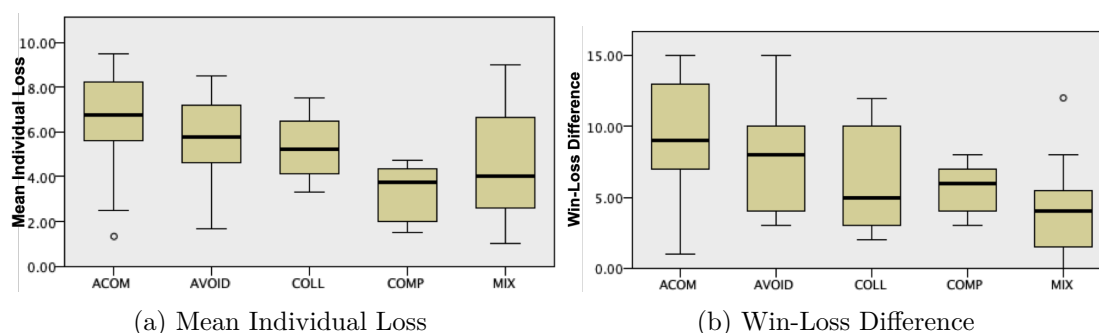
Figure 5.1: Differences in Mean Individual Loss and Win-Loss Difference scores distributions across the five personality categories

However, not controlling for the group diversity might lead to wrong conclusions. For instance, perhaps a majority of groups in the competing category are at the same time the non-diverse groups, which is not improbable, especially if we consider the number of groups in this category ($N = 5$). As shown in Chapter 4, subsection 4.2.2, group diversity is significantly and strongly related with the Mean Individual Loss. Therefore, controlling for group diversity is essential.

As suspected, all groups assigned to the competing category are, as well, non-diverse with respect to group members' individual preferences. Therefore, whether or not the previous output holds can only be confirmed if the same pattern is found for the non-diverse groups. The Kruskal-Wallis Independent Samples test showed no significant differences, and the Mean Individual Loss scores across the five group personality categories did not follow the previously observed pattern, as illustrated in figure 5.2, subfigure 5.2a. Thus, we do not have enough evidence that groups with competing conflict resolution style achieve significantly lower Mean Individual Loss.

On the other side, the Win-Loss Difference scores across the five categories (as shown in figure 5.2, subfigure 5.2b) do resemble the ones shown in figure 5.1, subfigure 5.1b - mixed groups do have the lowest median score of the Win-Loss Difference, but the collaborative groups, here, achieve the second lowest median score. However, again the

illustrated differences are not significant.

(a) Mean Individual Loss

(b) Win-Loss Difference
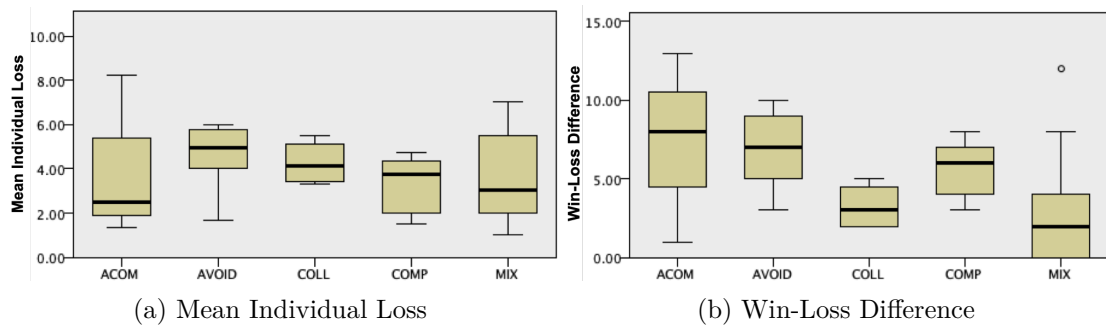
Figure 5.2: Differences in Mean Individual Loss and Win-Loss Difference scores across the five personality categories for non-diverse groups

After the groups were split to the diverse ($N = 28$) and non-diverse ($N = 27$) ones, we further explored differences in distribution of group performance variables across the five group personality categories. However, due to the size of the sample, after the splitting, and having in mind even five group personality categories, the tests were applied in the *"one category against all the others"* manner; for instance, test for differences between mixed groups against all the other types of groups.

Interestingly, for both, diverse and non-diverse cases, mixed groups obtained significantly lower median score for Win-Loss Difference, compared to groups belonging to other personality types (see figure 5.3).

(a) Diverse groups

(b) Non-diverse groups
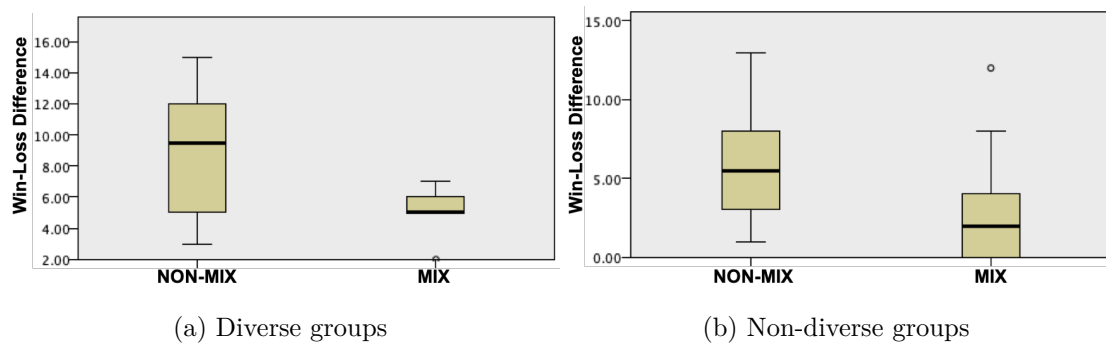
Figure 5.3: Variations in Win-Loss Difference scores between mixed and non-mixed groups

Furthermore, we found out that for diverse groups, the Difference in Choice Satisfaction (DCS) is significantly higher for avoiding compared to non-avoiding groups (see figure 5.4). Which was also shown in the previous section - the results at the individual level.

Other differences between the five group personality categories were not found.
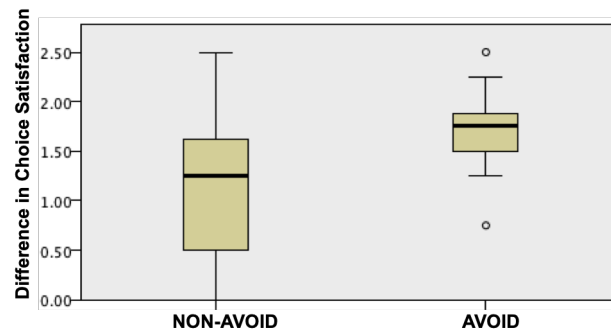
Figure 5.4: Variations in Difference in Choice Satisfaction (DCS) between avoiding and non-avoiding groups

5.3 Discussion

The first part of the study was set up to explore the satisfaction levels of individual group members with the final group decision about a joint travel destination. The obvious assumption was confirmed, i.e., individual group members were highly satisfied with the outcome of group negotiations when the final group decision matched their own initial preferences. The theoretical perspective of the five-factor model of personality (The Big Five) and travel types was taken to explore differences in satisfaction levels, and two contributions stand out.

First, the results showed that highly satisfied participants overall were more open to new experiences, agreeable and emotionally stable than unsatisfied participants. An important additional insight was that group members, when they lost their position to a different group travel decision, nevertheless maintained a sense of satisfaction when they were blessed with a positive personality profile (i.e., more open towards unusual experiences and in favor of cooperation). This finding is consistent with theorizing on the five-factor model of personality [DOBL06, MC87, MJ92], but especially also confirms a large portion of behavioral research into social dilemmas that emphasizes the distinct responses of individuals with a more cooperative (pro-social rather than competitive) orientation towards group members in face of disagreement [VL99, VLBPVV14]. The travel factor that was rendered most salient in face of disagreement and potential loss was Beach and Party Lover – a role that taps into relaxing, sunbathing, partying and enjoying with friends (see section 3.3.1). In other words, the personality and attitudinal effects that were observed in the present study on satisfaction levels consistently emphasize the need to account for a pro-social value orientation in individual group members engaged in the collective task to decide on a joint travel destination for tourism.

Second, the results showed a major difference in experienced satisfaction with the final travel destination submitted by the group for individuals as a function of their active (not avoiding) or passive (avoiding) position during the group negotiations. Passive players were highly satisfied with the final travel destination when it matched their own initial

preference, but were extremely dissatisfied with the collectively chosen travel destination in case of a mismatch with their initially disclosed preferences.

At the group level, we learned that when groups were mixed with respect to their members' conflict resolution styles, they managed to achieve the best performance, in terms of Win-Loss Difference, in the group decision-making process. The result indicates that mixed groups managed to come to an agreement that satisfies almost all the group members equally, and they managed to decrease the discrepancy between those who won the most and those who lost the most in the decision-making process. Moreover, the results obtained for the individual group members were as well confirmed at the group level. Namely, only for avoiding types of groups we observed significantly higher Difference in Choice Satisfaction between the most and the least satisfied group member, in comparison to the non-avoiding groups. The reason behind might be that the avoiding groups failed to communicate their preferences and to come to an agreement that decreases differences in choice satisfaction among group members. This result is yet another opportunity for an automated system (e.g., a group recommender system) to help group members to reach better decisions, decisions that will equalize group members' satisfaction levels.

5.4   Conclusion

The present study aimed to answer how individual and group personality affects the choice satisfaction and group performance in the group decision-making process on a joint travel destination. Using an experimental paradigm with group members interacting with each other in real-time and in a face-to-face manner, it was found that satisfaction levels of group members were generally influenced by their respective Big Five characteristics and a travel factor/type in ways that were consistent with existing theorizing. However, our study also made clear that a big difference in experienced satisfaction existed when the individual had taken an active (not avoiding) or passive (avoiding) position during the group negotiations. Especially passive players experienced dissatisfaction with the travel destination that was collectively chosen.

At the group level, we also obtained intriguing results, i.e., mixed groups, with respect to Thomas-Kilmann conflict resolution styles of individual members, perform the best in the group decision-making process, in terms of making an agreement that satisfies everybody almost equally. Namely, they manage to obtain significantly lower Difference in Choice Satisfaction of the most and least satisfied group members. Moreover, the result about the passive and active players was again confirmed at the group level.

Social Relationships and Group Decision-Making Process

This chapter is motivated by yet another aspect of group dynamics that showed to be a significant indicator of team performance, i.e., social relationships within groups. We showed, as literature suggests, that the aggregation of preferences and decision-making in a group setting cannot be considered as a function of individuals' preferences only, but also a function of inter-subjects' relations [DNN+16]. Moreover, group decisions are often not rational, they cannot always be deduced from group members' individual preferences, and they are not always a result of a majority opinion [For18]. Especially, individual satisfaction with the group choice is strongly related with personality and group behavioral attitudes (i.e., Thomas-Kilmann conflict resolution styles [KT77]) [DNN+16, DNR+17], as shown in Chapter 5. In this chapter, the objective is to explore the role of social relationships within a group, in the same context as previously, i.e., when the group is faced with a travel-related decision task.

There has been an increasing interest in studying social relationships in teams as it has proven to lead to relevant insights. Various studies have identified a positive impact of social relationships on collaboration and performance in a number of domains, e.g., academic output and interdisciplinary work [GUSA05, UMSJ13, LHC14], viability and dynamics of virtual teams in organizations [BH06, MC00], success in sports and e-sports [DWA10, PNCMW13, NHC15, MHN+19] as well as satisfaction and perception of students [BBJ97].

In Chapter 2, studies concerning with social relationships in GRSs are presented in detail. Here, as a reminder and a motivation for the presented analysis, we summarize the most relevant works. Quijano-Sanchez et al. [QSRGDAJD13] used group members' personality and social trust between the pairs of members to address influence in groups. They showed that the performance of a group recommender was significantly improved when accounting

for both personality and social trust, but aggravated when the model included only social trust. In [ACS14], Alina and Schiaffino showed that the best results are obtained when a group model constitutes three social *"factors"* that capture social influence, i.e., 1) Social trust between pairs of members (as reported by the group members); 2) Social similarity between the pairs of members (i.e., shared interests, extracted from a social network - Facebook); and 3) Social centrality of each group member (extracted from a social network - Facebook). Moreover, even when separately used, the improvement of recommendation accuracy was evident, where social trust outperformed social centrality, and social centrality outperformed social similarity. Finally, in Gartrell et al.[GXL$^+$10], three *"group descriptors"* were used to determine the best preference aggregation approach for a given group, 1) Social descriptor (i.e., frequency of contact and type of relationship); 2) Expertise descriptor (i.e., the number of item-ratings the group members provided for the pre-selected set of items); and 3) The dissimilarity descriptor (i.e., average pairwise dissimilarity of group members' item-ratings). The authors concluded that the best aggregation strategy for a) groups with strong social relationships was the most pleasure strategy; b) groups with medium strength social relationships was the average strategy; and c) groups with weak or no social relationships was the least misery strategy.

In our study, we focus on closeness of the group, as the characteristic of a group, and social centrality as the characteristic of group members, and how these constructs relate to the group decision-making process. We obtain the social relationships explicitly with a questionnaire, therefore, we believe a more accurate representation of within group relations is captured. Hereby, we introduce several hypotheses that deal with different aspects of the group decision-making process, that we are testing throughout the chapter. Hence, we aim to answer research question 3, *What is the role of the social relationships within the group for the group decision-making process?*, and each group of hypotheses is related to one of the sub-questions of the research question 3.

First of all, we are guided by one of the key concepts of social network theory, i.e., the identification of prominent actors in a social network. Based on the characterization of a *"prominent actor"* in a social network: *"the one who is the object of extensive ties, focusing solely on the actor as a recipient"* [WF94], we derive the following two hypotheses, related to research questions 3.1 and 3.2 *Are socially central members of the group perceived as more influential in the decision-making process?*, *Are socially central members of the group actually more influential in the decision-making process?*:

Hypothesis I: Socially central members of the group are *perceived as more influential* in the decision-making process.

Hypothesis II: Socially central members of the group *are more influential* in the decision-making process, thus they have their individual preferences closer to the final group choice (i.e., lower Individual Loss (IL)).

Secondly, previous research has pointed out that group identity, as an indicator of group members' happiness with being a part of a certain group can compensate for "loosing" in a decision-making process, and nevertheless make the group member satisfied with the

group decision. Therefore, an important question is whether or not we can capture group identity with the help of social relationships. To this end, and based on the definition of group identity we derive the following hypotheses, related to research question 3.3 *Can we use social relationships within the group as an indicator of the members' level of identification with the group (i.e., group identity as defined by the social identity theory)?*:

Hypothesis III-A: Socially central members of the group report higher group identity.

Hypothesis III-B: Members of socially close groups report higher group identity.

Next, in Chapter 4, we have demonstrated how group diversity affects group decision-making process, in particular, group members' individual "well-being", and group performance. Moreover, we distinguished between *perceived* diversity (i.e., group preference similarity as reported by participants) which is directly related with individuals' choice satisfaction [DN17], and *actual* diversity as measured over group members' individual ratings, which directly affects group decision-making process. In addition, the principle of *"homophily"*, indicates that *"people's personal networks are homogeneous with regard to many sociodemographic, behavioral, and intra-personal characteristics"* [MSLC01]. Also, social influence indicates that change in opinions, attitudes, behaviors of an individual occurs as a result of the tendency to match opinions, attitudes and behaviors of those from the social environment [Tur91]. So, it is natural to assume that closely related groups perceive and have higher group similarity. Therefore, we derive the following hypotheses, related to research question 3.4 *Is the social structure of the group related to the group members' perception of their preference similarity?*:

Hypothesis IV-A: Socially central members of the group perceive their groups as more similar with respect to preferences.

Hypothesis IV-B: Members of socially close groups perceive their groups as more similar with respect to preferences.

Hypothesis IV-C: Members of socially close groups have lower preference diversity.

Consequently to the previously introduced hypotheses, we assume that those in closely related groups will have a more satisfactory experience in the decision-making process, therefore, the following hypotheses are derived, related with research question 3.5 *Are socially central members of the group, and socially close groups happier with the outcomes of the decision-making process?*:

Hypothesis V-A: Socially central members of the group report higher choice satisfaction.

Hypothesis V-B: Members of socially close groups report higher choice satisfaction.

Lastly, according to the research on team performance and the effects of social relationships, we assume that closely related groups will perform better in the decision-making process, and we derive the following hypothesis:

Hypothesis VI: Closely related groups perform better in the group decision-making process.

For the analysis in this chapter, INSTANCE2 data set was used, i.e., containing information about 150 participants organized in 41 groups. The reason behind is that for the INSTANCE1 data set we did not collect information about social relationships within groups.

6.1 Methodology

In this section we present the various measures used in the analysis, and the approach we employ to test the presented hypotheses, and answer the stated questions. First of all, we introduce social relationship variables, i.e., the closeness of the group as a group characteristic; and the centrality of members within the group as a characteristic of individuals. Then we specify variables that capture aspects of the group decision-making process that we are interested in, according to our hypotheses.

6.1.1 Networks' construction

Based on the social relationships data from the pre-questionnaire a *social network* was built for each group. Since the participants provided answers for each fellow group member, where two members might have reported different levels of social closeness to each other, the networks are directed. Moreover, each edge between two members is weighted according to the average value of the answers provided for the three social-relationship questions, i.e., Duration of the relationship, Frequency of the contact, and Emotional proximity (for details see Chapter 3, sections 3.1 and 3.2). An illustrated example of a group social network is shown in Figure 6.1a. Each node represents a group member, the nodes are sized (and numbered) according to their In-Degree Centrality, and the edges are thickened according to the weights assigned to them.

(a) Social network

(b) Influence network
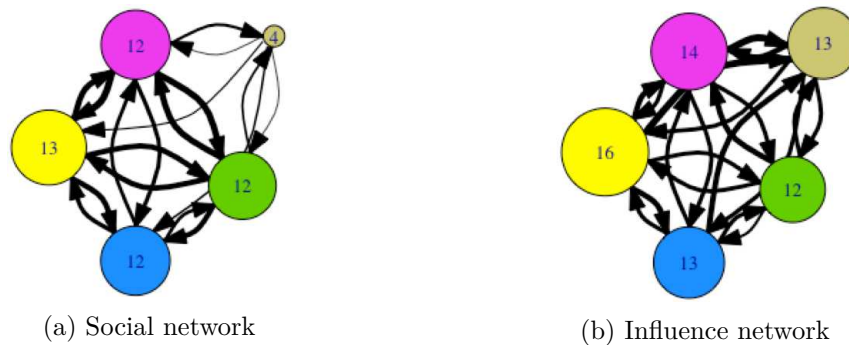
Figure 6.1: Social and influence network example for a group

Moreover, another network was constructed based on perceived influence acquired in the post-questionnaire, i.e., *"To what extent did each of your group members influence your acceptance of the final group choice?"* (for details see Chapter 3, sections 3.1 and 3.2), which we will refer to as the *perceived influence network*. Again, participants were

asked about the level of influence that each fellow group member exerted on them, and of course, two members might have reported different levels of influence between each other, therefore this network is also directed. Moreover, the edges between members are weighted according to the reported level of influence. For the same group as in the previous example, the perceived influence network is illustrated in Figure 6.1b. Each node represents a group member, the nodes are sized according to their Out-Degree Centrality, and the edges are thickened according to the weights assigned to them.

6.1.2 Variables definitions

In the next step, we define different types of variables required to test our hypotheses.

Network variables. From the social networks and the perceived influence networks of the groups, basic weighted network measurements were calculated. Therefore, two levels were considered, i.e., the individual level, capturing each group member separately, and the group level, capturing the group as a whole. In Table 6.1 the resulting network variables for the two networks are listed, and in the following they are explained in more detail.

Table 6.1: Network variables

Variable	Definition
InDegree	Normalized In-Degree Centrality score from the social network
InDegreeCentral	$\begin{cases} 1, & \text{InDegree} > median(\text{InDegree}) \\ 0, & \text{otherwise} \end{cases}$
OutDegree	Normalized Out-Degree Centrality score obtained from the social network
Degree	Normalized Degree Centrality score obtained from the social network
DegreeCentral	$\begin{cases} 1, & \text{Degree} > median(\text{Degree}) \\ 0, & \text{otherwise} \end{cases}$
PageRank	Page-Rank Centrality score obtained from the social network
Closeness	Normalized degree score for the group as a whole obtained from the social network
CloseGroup	$\begin{cases} 1, & \text{Closeness} > median(\text{Closeness}) \\ 0, & \text{otherwise} \end{cases}$
Influence	Normalized Out-Degree Centrality score obtained from the perceived influence network
Influential	$\begin{cases} 1, & \text{Influence} > median(\text{Influence}) \\ 0, & \text{otherwise} \end{cases}$

The *In-Degree Centrality* of a group member measures a member's prestige in the group. It indicates how a member is perceived by her fellow group members and what status that member has in the group. The In-Degree Centrality is calculated as the sum of the weights of all in-links, i.e., the edges directed to the node.

The *Out-Degree Centrality* of a group member measures how a member perceives others in her group, in the sense of how close she feels to them. The Out-Degree Centrality is calculated as the sum of the weights of all out-links, i.e., the edges from the node directed to the others.

The *Degree Centrality* of a group member in a directed graph is the combination of the In-Degree and Out-Degree scores, and represents the overall status of a member in the group (i.e., how she feels about the group, and how the group feels about her). The Degree Centrality is therefore calculated as the sum of In-Degree and Out-Degree scores.

The *Page-Rank Centrality* is another measure of a member's prestige in the group. The Page-Rank Centrality score of a node is not only determined by its number and weights of in-links but also by the Page-Rank Centrality scores of all nodes pointing at it [PBMW99]. Thus, it extends the concept of In-Degree centrality by also taking the prestige of the connections into account, i.e., a node can have a high prestige either because it has many in-links, or because nodes with a high prestige themselves are pointing at it, or both.

Clearly, the centrality measure scores that a group member can achieve depend on the group size (i.e., the larger the group, the more edges there will be in the network). Therefore, to be able to compare members belonging to groups of different sizes, the centrality scores, were normalized accordingly (i.e., the centrality scores were divided by $n - 1$ where n is the size of the group). Page-Rank Centrality is exempted from this normalization procedure, as it is already normalized during the calculation process.

Furthermore, in order to capture the social closeness of the group as a whole, we define a *Closeness* score at the group level as the mean value of the weighted edges in the network.

Individual performance variables. As explained in Chapter 3, section 3.3, and as already used in other analyses presented in the thesis, Individual Loss (IL) is characterized as the difference between individual preferences and the group preferences (i.e., the group choice). For more details, see the referenced chapter and section. Here we use IL_1, as the Individual Loss with respect to the first group choice, as well as, IL_2, as the Individual Loss in terms of the second group choice.

Moreover, again, we define "winners" in the group decision-making process, as an indicator of whether or not the preferences of a group member were close to the group choice or not. Those whose preferences were close we call *Winners* of the decision-making process.

To summarize, the set of variables that capture group members' individual performance in the group decision-making process is shown in Table 6.2.

Diversity variables. To evaluate the link between social relationships and the "objective" (i.e., measured over the explicit preferences of group members) group diversity, in terms

Table 6.2: Individual loss variables

Variable	Definition
IL_1	Absolute difference between group rank and individual rank of the first group choice
IL_2	Absolute difference between group rank and individual rank of the second group choice
WINNER	$\begin{cases} 1, & IL_1 < median(IL_1) \\ 0, & \text{otherwise} \end{cases}$

of group members' individual preferences, we used diversity measures also introduced in Chapter 3, section 3.3. More specifically, in the current analysis, we use Spearman Full Choice-set Diversity (SF_DIV), and Unique Top-Choice Diversity (UT_DIV). The details about the diversity measures can be found in the referenced chapter and section.

To summarize, the set of variables that capture diversity of the group in terms of preferences is given in Table 6.3.

Table 6.3: Diversity variables

Variable	Definition
SF_DIV	Spearman Full Choice-set Diversity
SF_Diverse	$\begin{cases} 1, & SF\_DIV > median(SF\_DIV) \\ 0, & \text{otherwise} \end{cases}$
UT_DIV	Unique Top-Choice Diversity
UT_Diverse	$\begin{cases} 1, & UT\_DIV > median(UT\_DIV) \\ 0, & \text{otherwise} \end{cases}$

Group performance variables. Finally, to analyze the effects of social relationships on the group performance in the group decision-making process, we use a set of group performance measures as introduced in Chapter 3, section 3.3, i.e., Mean Individual Loss (MIL), Win-Loss Difference (WLD), Mean Choice Satisfaction (MCS), and finally Difference in Choice Satisfaction (DCS). For more details, see the referenced chapter and section.

Pre and post-questionnaire variables. Clearly, group members' individual choice satisfaction, reported group identity and perceived group similarity were used as obtained form the post-questionnaires (for details see Chapter 3, sections 3.1 and 3.2).

To test our hypotheses the non-parametric, Kruskal-Wallis test was used. The choice was made based on the results of Shapiro-Wilk normality tests of our variables, which indicated a significant deviance of the variables from the normal distribution. Moreover,

non-parametric tests are more advisable in smaller data samples, therefore, in either case the non-parametric test seem more applicable.

6.2   Results

For the sake of clarity, Table 6.4 shows which set of variables were used to test which hypotheses.

Table 6.4: Hypotheses and variables

Variables	Hypothesis									
	I	II	III-A	III-B	IV-A	IV-B	IV-C	V-A	V-B	VI
Centrality	✓		✓		✓			✓		
Influence	✓	✓								
Group diversity	✓	✓					✓			
Ind. performance		✓								
Group identity			✓	✓						
Group closeness				✓		✓	✓		✓	✓
Perceived similarity					✓	✓				
Choice satisfaction								✓	✓	
Group performance										✓

Hypothesis I: Are socially central members perceived as more influential? Kruskal-wallis test showed no significant difference in perceived influence between socially central and non-central members of the group. However, a significant and positive correlation was found between social centrality (i.e., the In-Degree Centrality) and perceived influence ($r = .307^{***}$, $p < .001$). Interestingly, significant correlation was also found with the Degree Centrality ($r = .248^{***}$, $p < .001$), but not with the Out-Degree Centrality.

This result indicates that our hypothesis is partially supported. To this end, we decided to further analyze the issue. Clearly, groups that are diverse with respect to their preferences might need actors with stronger influence to come up with the final group choice. Therefore, the same hypothesis was tested for the set of groups who do have diverse preferences as captured with the Spearman Full Choice-set Diversity (i.e., SF_Diverse = 1), and with the Unique Top-Choices Diversity (i.e., UT_Diverse = 1).

No significant differences were found for diverse groups in terms of Spearman Full Choice-set Diversity. However, for the Unique Top-Choice Diversity, intriguing results were obtained. Namely, no significant differences were found when the centrality was measured by the In-Degree, nor the Out-Degree Centrality, however, when we considered the Degree Centrality, central group members were perceived as significantly more influential ($p = .042$), see Figure 6.2. Therefore, as for the hypothesis I, we can say that central group members are perceived as more influential in the group decision-making process.
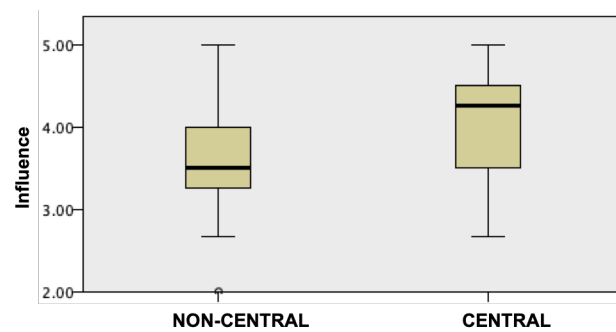
Figure 6.2: Differences in distribution of perceived influence for socially central and non-central members (Degree Centrality) of diverse groups

Hypothesis II: Do socially central members get their way more? Kruskal-Wallis test indicated no evidence that socially central group members have their individual preferences closer to the first group choice (i.e., their ranking of the first group choice is not lower in their individual list than of those who are not socially central), therefore they do not have lower Individual Loss (IL_1). However, in contrast to what was expected, a significant and positive, but low correlation was found between the Page-Rank Centrality and group members' Individual Loss (IL_2) in terms of the second group choice ($r = .163^*$, $p < .05$). Meaning that central group members as captured by the Page-Rank Centrality, had even greater Individual Loss (IL_2), instead of lower.

As for the previous hypothesis, again we were interested if socially central members of the diverse groups would have lower Individual Loss. Here, even though we did confirm that socially central members of diverse groups are perceived as significantly more influential, the test did not show any difference with respect to group members' Individual Loss (IL_1). However, the correlation between the Page-Rank Centrality and group members' Individual Loss with respect to the second group choice was (IL_2) was even emphasized now ($r = .374^*$, $p < .05$) for diverse groups as captured with the Unique Top-Choices Diversity (i.e., UT_Diverse = 1).

Additionally, we also tested whether or not those who were perceived as influential had lower Individual Loss in the group decision-making process. The Kruskal-Wallis Test showed that influential group members, as they were perceived, did not have lower Individual Loss, not for the first group choice (IL_1), nor for the second group choice (IL_2). In conclusion, the tests show no evidence that hypothesis II can be confirmed.

Hypothesis III-A: Do socially central members identify stronger with their groups?

The test clearly demonstrated that socially central group members do report significantly higher group identity ($p = .001$), see Figure 6.3a. Interestingly, this was true for all three centrality measures, i.e., In-Degree, Degree, and Out-Degree Centrality. Hence, we can confirm hypothesis III-A, socially central group members do identify stronger towards

their groups.

Hypothesis III-B: Do members from socially close groups identify stronger with their groups? The Kruskal-Wallis test again indicated that members from socially close groups do report significantly higher group identity ($p = .000$), than the members of non-close groups, see Figure 6.3b. Therefore, also hypothesis III-B can be confirmed, members of socially close groups do identify stronger with their groups than the members of socially non-close groups.

(a) Central group members   (b) Members of close groups
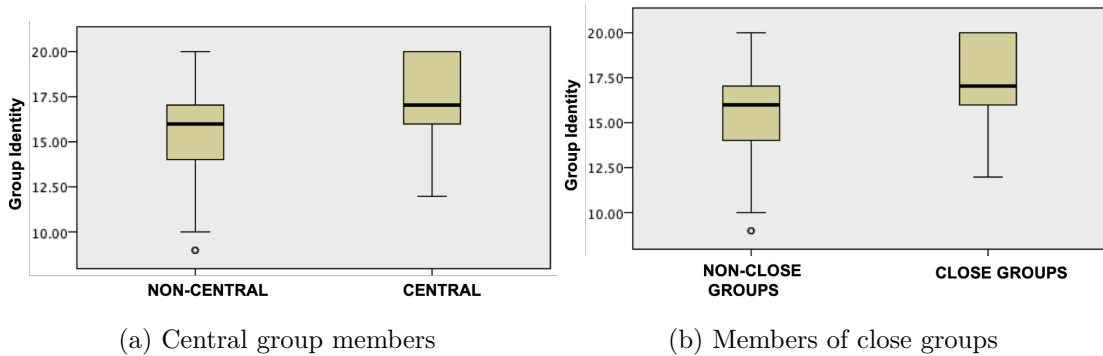
Figure 6.3: Differences in distribution of the group identity for central group members, and members of socially close groups

Hypothesis IV-A: Do socially central group members perceive their groups as more similar? The test showed that socially central group members (i.e., as captured with the Degree Centrality) do perceive their group similarity significantly differently than the non-central group members ($p = 0.008$), see Figure 6.4b. For the other two centrality measures, In-Degree and Out-Degree centrality, the test showed no difference in preference similarity perception. Figure 6.4b does not actually indicate that central group members, nor that members of socially close groups, perceive their group similarity as higher in average (nor that the median score is higher), however, it does indicate that the minimum score, and the score at the first quartile of the perceived group similarity are significantly higher for them.

Hypothesis IV-B: Do members of socially close groups perceive their groups as more similar? Members of the socially close groups perceive their groups similarity significantly differently from the members of socially non-close groups ($p = .019$), see Figure 6.4a.

In conclusion for hypotheses IV-A and IV-B, the test did show significant differences, but we cannot confidently claim that socially central group members, and members of socially close groups perceive their group similarity as higher.

Hypothesis IV-C: Do members from socially close groups have more similar preferences? Kruskal-Wallis test indicated no significant difference of the group diversity as captured by the Spearman Full Choice-set Diversity (SF_DIV), between socially close

(a) Central group members

(b) Members of close groups
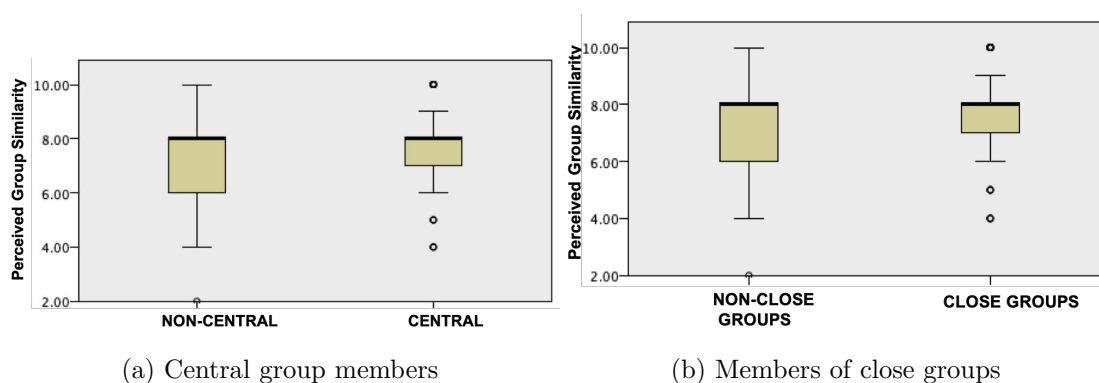
Figure 6.4: Differences in distribution of the perceived group similarity between central and non-central members, and socially close and non-close groups
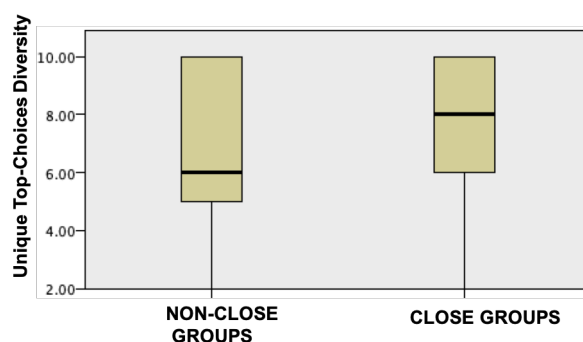
Figure 6.5: Differences in distribution of group preference diversity for socially close and non-close groups

and non-close groups. For the Unique Top-Choices Diversity measure, the test did show significant difference ($p = .036$) between socially close and non-close groups, see Figure 6.5. However, in contrast to what we hypothesized, socially close groups had significantly higher group diversity, when diversity was measured with the Unique Top-Choices Diversity. Furthermore, to bewilder the situation even more, a significant and negative correlation was identified between the social closeness of the group and the group diversity, as captured with the Spearman Full Choice-set Diversity measure (SF_DIV) ($r = -.278 **$, $p < .01$). The result indicates that in our data sample, the phenomenon of "homophily" is not found when it comes to group members explicit preferences over the ten destinations.

Hypothesis V-A: Are socially central group members more satisfied? The test showed that socially central group members are significantly more satisfied ($p = 0.011$), see Figure 6.6a. This was true for all centrality measures (i.e., In-Degree, Out-Degree, Degree and Page-Rank Centrality). Moreover, the test ($p = .032$) also showed that

this was true even for those group members who *"lost"* in the decision-making process according to their Individual Loss in terms of the first group choice (i.e., WINNER = 0), see Figure 6.6b. Therefore, we can conclude that hypothesis V-A can be confirmed, socially central group members are significantly more satisfied with the group choice than the non-central members.

(a) All participants   (b) Members who "lost"
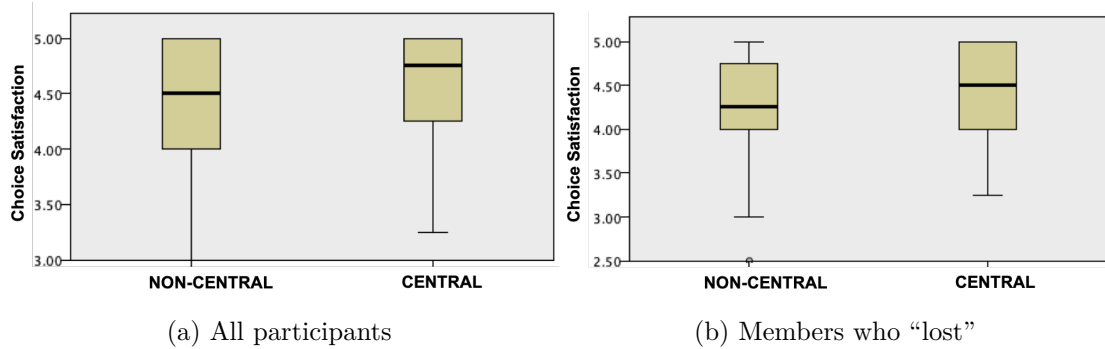
Figure 6.6: Differences in distribution of choice satisfaction for central and non-central group members

Hypothesis V-B: Are members from socially close groups more satisfied? The test showed no significant difference of the group members' individual choice satisfaction between the socially close and non-close groups.

Hypothesis VI: Do socially close groups perform better in the group decision-making process? Finally, we found that significant differences in group performance exist between socially close and non-close groups. Namely, socially close groups achieve significantly higher Mean Choice Satisfaction (MCS) (see figure 6.7a), and significantly lower Difference in Choice Satisfaction (DCS) (see figure 6.7a), but no difference was found for Mean Individual Loss (MIL), and Win-Loss Difference (WLD). This result indicates that the socially close groups tend to take care about each other more, in terms of their feelings, than the non-close groups, i.e., they experience the same amount of loss in the group decision-making process, but they end up being happier.

Table 6.5 summarizes the obtained results and illustrates whether or not the formulated hypotheses were confirmed or not.

6.3   Discussion

Numerous directions and theories in the area of social network analysis have introduced different implications of the network structures for social systems. However, the common thread that unites these theories is that a set of relationships among a set of actors will explain different outcomes better than individual or group attributes [BBJ97]. Our first and second hypotheses were derived from the elementary concepts of social network theory. Social centrality, specifically the In-Degree Centrality is, by its definition, the measure of

(a) Mean Choice Satisfaction

(b) Difference in Choice Satisfaction
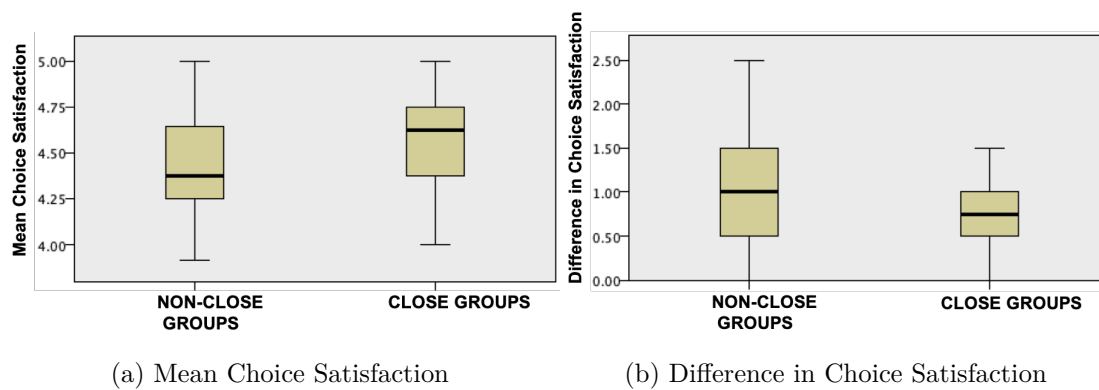
Figure 6.7: Differences in Mean Choice Satisfaction, and Difference in Choice Satisfaction scores between socially close and non-close groups

Table 6.5: Summary of the results

	Hypothesis	**Confirmed**
I:	Socially central members of the group are *perceived as more influential* in the decision-making process.	Yes
II:	Socially central members of the group *are more influential* in the decision-making process	No
III-A:	Socially central members of the group report higher group identity.	Yes
III-B:	Members of socially close groups report higher group identity.	Yes
IV-A:	Socially central members of the group perceive their groups as more similar with respect to preferences.	No evidence
IV-B:	Members of socially close groups perceive their groups as more similar with respect to preferences.	No evidence
IV-C:	Members of socially close groups have lower preference diversity.	No
V-A:	Socially central members of the group report higher choice satisfaction.	Yes
V-B:	Members of socially close groups report higher choice satisfaction.	No
VI:	Closely related groups perform better in the group decision-making process.	Partially

a subject's prominence or prestige in the network. Moreover, the motivation can also be found in GRSs research, even though in a low number of studies [ACS14, GXL$^+$10]. Our results indicate that socially central group members are perceived as significantly more influential, especially in groups that are diverse in terms of group members' preferences. Nevertheless, socially central group members, even though perceived as more influential, did not have their way more often, their Individual Loss, in terms of the first group choice (IL_1), did not differ from the non-central group members. Moreover, to our great surprise, central-group members lost even more in the group decision-making process when it comes to the second group choice, i.e., the more central group member was, the greater the Individual Loss with respect to the second choice (IL_2) was.

Obviously this was not expected, and it raises a question about the meaning of social relationships and social centrality in such intra-group social networks. In a group decision-making process, a group member can behold various types of roles [For18], either a *"task role - performs behaviors that promote completion of tasks"* (e.g., leader, expert, organizer) or a *"relationship role - performs behaviors that improve the nature and quality of interpersonal relations among members,"* (e.g., coordinator, supporter, energizer). Therefore, socially central group members could have been perceived as more influential due to their role in the decision-making process, e.g., an organizer, a coordinator, or a supporter, but in essence their individual preferences were not closer to the group preferences.

This brings us to the second part of our analysis (Hypotheses III to VI), where the focus is more profound, i.e., the meaning of the social relationships for other group related concepts that, as research showed [For18, DN17, BMR10], are of great importance for GRSs as well. The results indicate that social relationships, as captured with the pre-questionnaire, are a useful measure of the group identity level that members feel about each other. Moreover, we observed that social closeness of the group is significantly related with members' perceived group similarity. Nevertheless, the results about "objective" (i.e., measured over the explicit preferences of group members) group diversity and social closeness of the group is, at the very least, baffling. On the one hand, when group diversity was measured with the Unique Top-Choices Diversity, we showed that socially close groups were significantly more diverse than the non-close groups. On the other hand, when group diversity was measured with the Spearman Top-Choice Diversity, we showed that the more socially close the less diverse the group was. This result, perhaps, illustrates how different diversity measures can indicate different things, and therefore, should be used accordingly. We are aware that according to the theory of *"homophily"*, and social influence, socially close groups are supposed to have less diverse preferences, but in our data sample, and for the particular topic, we cannot really claim that.

Going further, we provide evidence that social centrality plays an important role for group members' individual choice satisfaction. This is even true for those who have *"lost"* in the decision-making process. Finally, socially close groups do perform better in the group decision-making process, specifically in terms of their group level satisfaction, and how they manage to decrease the difference between the most and least satisfied

group member. This indicate that socially close groups took care of each other, making sure that nobody gets too dissatisfied with the group choice, which made them better decision-makers than the non-close groups.

6.4 Conclusion

In this chapter the connections between social relationships, social centrality and different aspects of the group decision-making process were analyzed. The analysis clearly indicated that socially central members of the group are perceived as more influential in the group decision-making process, but they do not get their way more often. Moreover, social relationships can be used to grasp the level of group identity that members feel about each other. Also, we demonstrate that socially central group members are significantly happier with the final group choice, even when they are the *"losers"* in the decision-making process. Finally, it is demonstrated that socially close groups reach better group decisions.

In terms of GRSs our results indicate how important it is to include social relationships in group preference models. Indeed, we did not provide evidence that social centrality should be used, for instance, to generate weights assigned to group members in the group preference model. Nevertheless, choice satisfaction is one of the crucial outputs of the group decision-making process, and it should be addressed in a GRS as such. To this end, it is clear that social relationships can be used to predict individual group members' choice satisfaction as well as the overall group satisfaction (i.e., happines with belonging to a certain group - group identity). In this way, social centrality and social closeness can be used as a measure of group members' resilience to dissatisfaction. For example, we can define a constraint interval in which the distance between individuals' preferences and the group recommendation should reside, based on group members' social centrality and social closeness of the whole groups.

In our future work, we plan to further investigate other types of networks that occur in small groups, and their usability in GRSs. For instance, in [KOT97] the authors have shown a strong relationship between centrality in the socio-cognitive network of the group and the influence that a group member has on the final outcomes of the decision-making process. Potentially we can make a socio-cognitive network from the group members' experiences about the ten destinations that they discussed. Thus, the edges between pairs of group members would be formed based on the similarity in experience that members have about the ten destinations. Then we can test whether or not we can better predict group choice by using the information about the group members' centrality in such socio-cognitive network. Moreover, such information can be used in the same manner as in this chapter, to evaluate the effects of group members' position and group closeness in such networks on the group decision-making process.

Putting it All Together

The main task of a GRS is to predict the best option for a group at hand, by combining individual preferences of the group members, and making sure that none of them is dissatisfied with the suggestion. We know that a single perfect method that accomplishes this in any given situation comprehensively well, does not exist, and different methods should be employed according to the contextual information (as we show in Chapter 8). GRSs research often overlooks, or disregards the importance of the group members' individual satisfaction with the group choice - not in a sense that group members' satisfaction is not measured in the experiments, but in the way that the research objective is never to identify what actually determines this satisfaction. However, by ignoring these determinants, we cannot build user models, nor group models that will be able to predict whether or not individuals are happy with the suggestions made by the system. This is especially true for the group settings where the behavior of individuals is not only influenced by their own personal characteristics, but by the other group members, and their characteristics as well.

As it was shown throughout this thesis, a satisfactory option for a group might not be the "middle ground" one. As a matter of fact, the problem is much more complicated than simply aggregating group members' individual explicit preferences. Therefore, the goal of this Chapter is to investigate how well the previously individually analysed characteristics of groups, group behavior, and group decision-making process fit together in a single model for predicting group members' individual choice satisfaction.

Furthermore, research in GRSs invests a great amount of effort to identify users of greater influence, with the goal to weight their preferences more in the group preference models. Such an approach was also developed by ourselves, and presented in Chapter 4, section 4.3. In our study setting, we conjectured that group members of greater influence can be defined as those who lost the least in the decision-making process (i.e., the loss, as introduced in Chapter 3, section 3.3, was operationalized with the Individual Loss variable). To this end, we are as well interested in determinants of group members'

Individual Loss - we are exploring whether there are certain characteristics of group members that seem important for navigating the decision-making process, and therefore the decision itself.

In this chapter, we use the Conditional Process Analysis [Hay17], a variant of the regression analysis used for modeling mediation and moderation effects together with the direct effects (explained in detail in section 7.1). The assumptions of our model are motivated with the results presented in previous chapters. Therefore, firstly, we summarize the results that serve as an input for the current analysis, and we motivate our hypotheses.

We start with the hypotheses related to the Individual Loss, since the Individual Loss itself will also be considered as a predictor of individuals' choice satisfaction.

7.0.1   Predicting individual loss

It is important to note that, in this chapter, we evaluate the effect of different aspects (i.e., personality, preferences, social relationships, etc.) when combined in a single model. Therefore, even though we motivate aspect by aspect individually according to our previous results, the goal is to evaluate the joint effect in a single model. Hypotheses conjectured for the individual loss are illustrated in figure 7.1, and elaborated as follows.
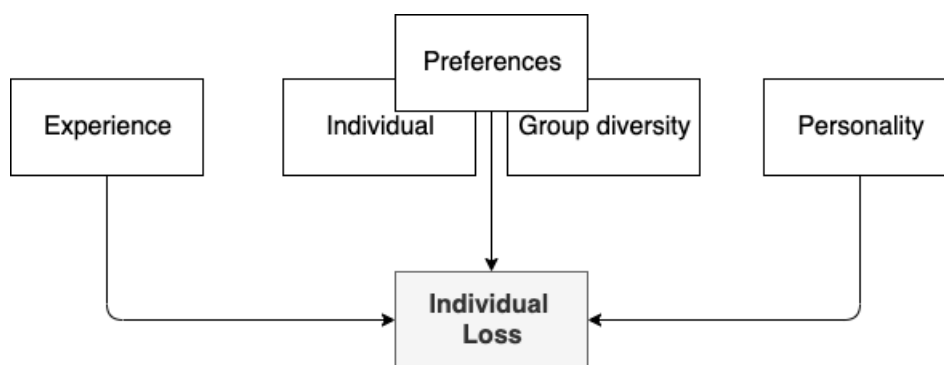
Figure 7.1: Illustration of the Individual Loss hypotheses

Preferences

In Chapter 4, section 4.2.2, we investigated how the composition of group preferences relates to the group choice, as well as, group and individual performance in the decision-making process. We showed that the group diversity, as expected, is related with the Individual Loss, and the Mean Individual Loss in the group. Consequently, our first model hypothesis is:

IL-H1 Greater diversity of group members' preferences leads to greater Individual Loss.

Secondly, in the same chapter, section 4.3, the group members' centrality in the group preference network was used as a weighting scheme of the group members' importance in

the preference aggregation strategies in order to predict the actual choices of the groups. The results suggested that the performance of the aggregation strategies is improved when the group members' weights were adjusted to their centrality in the group preference network. Accordingly, we conjecture the second model hypothesis:

IL-H2 The higher the centrality of a group member in a group preference network, the lower her Individual Loss in the decision-making process will be.

Personality

The relationship between group members' personality and their Individual Loss in the decision-making process was not explored in this thesis. Nevertheless, according to the Big Five Factor model theory we hypothesize that Conscientiousness can be used when predicting the Individual Loss. Namely, individuals scoring high on the Conscientiousness trait are characterized as efficient and organized, with a desire to accomplish a given task well, they are self-disciplined, responsible and reliable. In comparison to the other personality traits, Conscientiousness seems to be, in a way, task oriented. To this end, we conjecture the following hypothesis:

IL-H3 An individual scoring high on the Conscientiousness trait will have a need to organize and navigate the decision-making process, and therefore decrease her Individual Loss, especially in the highly diverse groups, therefore the effect of group diversity for conscientious group members will be decreased.

Hence, we do not assume a direct connection between group members' Individual Loss and their Conscientiousness score, but we rather see the Conscientiousness trait as a moderator variable on the direct effect of the group preference diversity (moderating effect in the Conditional process analysis is explained in detail in section 7.1).

Social relationships

As we did not find any link between social relationships, i.e., members' social centrality within the group, nor the social closeness of the group as a whole, and the Individual Loss (see Chapter 6), we do not assume any link here either.

Experience

Finally, it is reasonable to assume that the more experience/knowledge a person has about a destination (or in general the item-set), the more likely it is that this person will influence the decision-making process, and its outcomes. As described in Chapter 3, one of the questions in the pre-questionnaire, for the participants was to rate their experience/knowledge about each of the ten predefined destinations. The ratings were from 0 - "Never heard about it", to 4 - "Visited more than three times". In this way we obtained group members' individual experience with the given destinations, and we conjecture:

IL-H4 The more experience a group member has about the ten destinations, the less Individual Loss that person will have in the group decision-making process.

This hypothesis is also motivated by the work of Gartrell et al. [GXL⁺10], who use group members' knowledge about the pre-selected set of movies to determine the weights that a member will have in the group preference model.

7.0.2 Predicting choice satisfaction

Now we list our model hypotheses related to the group members' individual choice satisfaction. These hypotheses are illustrated in figure 7.2, and elaborated as follows.
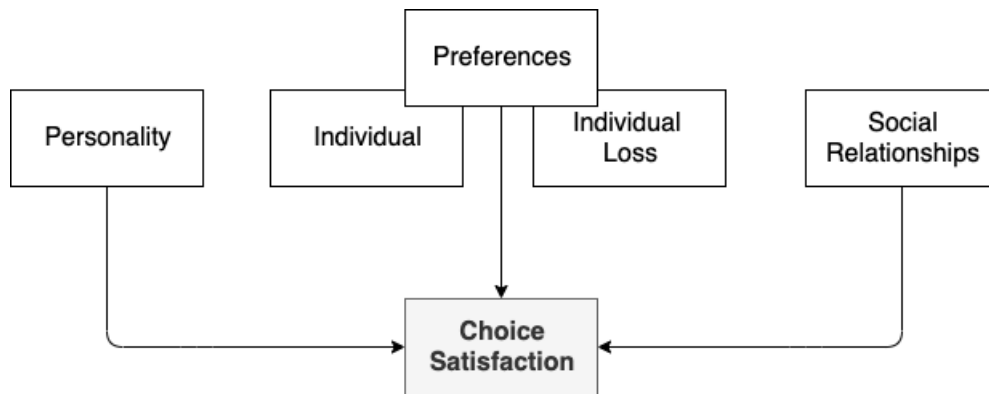
Figure 7.2: Illustration of the Choice Satisfaction hypotheses

Preferences

In Chapter 4, section 4.3, we have illustrated that fulfilment of group members' individual preferences within the group choice is significantly related to the choice satisfaction, i.e., the closer the group choice is to group member's individual preferences, the higher the choice satisfaction is. That fulfilment was measured with the Individual Loss variable. Hence, we conjecture the following hypothesis:

CS-H1 The higher the group members' Individual Loss in the decision-making process the lower the choice satisfaction will be.

Secondly, as previously mentioned, and demonstrated in section 4.3, predicting the first group choice is improved (in terms of precision) if members' centrality in the group preference network is considered. Having this in mind it is valid to assume that more central group members, whose opinion counts more in the group preference model, should be, at the end of the process, more satisfied with the group choice. Therefore, we conjecture the following:

CS-H2 The more central a group member is in the group preference network, the more satisfied that member will be with the group choice.

Personality

In Chapter 5, we evaluated the relationship between group members' personality traits and their choice satisfaction. First, with the correlation analysis, we identified the relationship between choice satisfaction, on the one hand, Conscientiousness, Emotional stability and Openness to new experienced on the other. Secondly, with the Kruskal-Wallis tests, we showed that even the "losers" of the group decision-making process were happy when they had a "positive" personality. Therefore, we assume only the direct effect of the personality traits on the choice satisfaction, and we conjecture the following model hypotheses:

CS-H3 The more conscientious a group member is, the higher the satisfaction with the group choice of that member will be.

CS-H4 The more emotionally stable a group member is, the higher the satisfaction with the group choice of that member will be.

CS-H5 The more open to new experiences a group member is, the higher the satisfaction with the group choice of that member will be.

Social relationships

According to our findings in Chapter 6, the closer the group is, in terms of group members' social relationships, the happier the group members will be regardless of the decision they make. Moreover, we have shown that group identity, as defined with the social identity theory, is a well enough indicator of the group social closeness. Therefore, having in mind that for the INSTANCE1 data set, we did not collect explicit social relationships within groups, for the purpose of this analysis we can use the reported group identity. Thus, we conjecture:

CS-H6 The stronger the group identity of a group member towards her group is, the less important her position in the group preference network will be for her choice satisfaction.

Here, we are assuming that group identity has a direct effect on the choice satisfaction, but as well that it moderates the effect of the group members' preference centrality on the choice satisfaction, i.e., if the group is socially close, the position of the group member in the group preference network (hypothesis **CS-H2**), will not be relevant for her choice satisfaction.

According to the introduced hypotheses that cover preferences, personality, and social relationships together with the outcomes of the group decision-making process, this chapter aims to answer research question 4, *How can we model the combined effect of the preferences, personality and social relationships on the group members' satisfaction with the outcome of the group decision-making process?*. Moreover, as the research questions 1-3, *RQ 1 What is the role of the group members' explicit preferences in the travel-related group decision-making process?*, *RQ 2 What is the role of personality in the group decision-making process?*, and *RQ 3 What is the role of the social relationships within the group for the group decision-making process?*, evaluate the individual effects

of these constructs, we hope that the Conditional Process Analysis will provide more insights into these research questions as well.

7.1   Methodology

In this section, we will introduce the Conditional Process Analysis (CPA), its equivalent regression models, and the effects that are modeled using the CPA, i.e., the moderating and mediating effects. Moreover, at the end, we introduce the models that represent the explained hypotheses individually, as well as, the single model that combines those individual models.

7.1.1   Conditional Process Analysis (CPA)

"*Is used when the analytical goal is to describe and understand the conditional nature of the mechanism or mechanisms by which a variable transmits its effect on another.*" [Hay17]. The goal of the conditional process analysis is to estimate direct and indirect; conditional and unconditional effects that one variable exerts on another variable, where the estimation is based on two types of analysis, 1) the mediation analysis; and 2) the moderation analysis. In our case, we even have a multi-dimensional space - we are evaluating the combined effect of multiple input (independent) variables, on the output (dependant) variable, and hereby we will use the CPA and its moderating and mediating effects to model these multi-dimensional relationships.

Mediation analysis

The mediation analysis tries to answer *how* an independent/antecedent variable X transmit its effect on a dependent/consequent variable Y. Moreover, the goal is to determine *what* is the mechanism through which X influences Y.

A wonderful example of the mediation effect is the analysis of the difference between gain versus loss framing messages in influencing human behavior [OJ07]. For instance, assume that we are interested in exploring what type of messages have a greater influence on smokers to quit smoking. The first type of messages, formed in terms of gains contain all the positive outcomes that a person will experience if he/she stops smoking. The second type of messages, framed in terms of losses will contain all the negative consequences that a person might experience if he/she doesn't quit smoking. The research has indicated that a message framed in terms of gains are more effective in influencing people. The reason behind was that loss framed messages, among other things, were more likely to prompt anxiety in participants, which then reduced the persuasiveness of the message, and resulted in weaker influence on the human behavior. The example of a mediating effect in this case, is the anxiety prompted by the loss framed messages.

Accordingly, a conceptual diagram of the basic mediation model is illustrated in figure 7.3, where as previously, X is an independent, antecedent variable, M is a mediator, and Y is a dependent, consequent variable. The pathway that connects X and Y, without

crossing M, is the direct effect of X on Y. While the second pathway that connects X and Y through M is considered as the indirect effect of X on Y. This indirect effect "*represents how Y is influenced by X through a causal sequence in which X influences M, which in turn influences Y*" [Hay17].
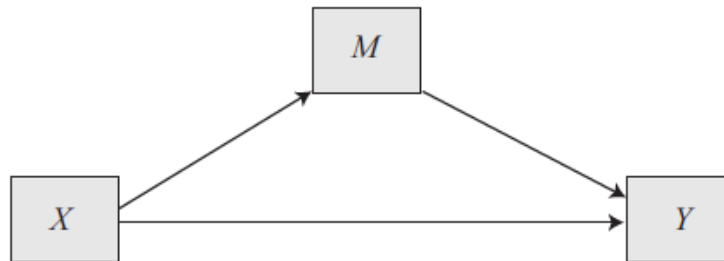
Figure 7.3: Mediation model - conceptual diagram (figure from [Hay17])

The conceptual diagram of the mediation model, requires two equations (equation 7.1 and 7.2) - linear models, due to the two consequent variables [Hay17].

$$M = i_M + aX + e_M \tag{7.1}$$

$$Y = i_Y + c'X + bM + e_Y \tag{7.2}$$

Where i_M and i_Y are regression constants, e_M and e_Y are regression errors, and a, b and c' are regression coefficients. The total effect of the influence that X has on Y is the sum of the direct and indirect effects.

Moderation analysis

The moderation analysis is suitable when we are trying to estimate, whether or not a certain variable moderates the effect of one variable on another. We say that the effect of the independent/antecedent variable X on the dependent/consequent variable Y is moderated by W, if the size, sign or the strength of the effect can be predicted from W. Then, W is called a moderator of the X's effect on Y.

Referring to the previous example, take for instance that there is a difference in reaction to the gain and loss framed messages between male and female smokers. If we would find out that female smokers in our data sample reacted better to the selected messages than the male smokers, then we would say that variable sex is the moderator (W) that influence how the messages (X) will affect the behavior change (Y) [OJ07].

The conceptual diagram of the basic moderation model, with the previous annotation is illustrated in figure 7.4. It is important to note, that one should not assume that W is not an antecedent of Y just because the conceptual diagram does not show the arrow between

the moderator W and the consequent variable Y. In contrast to the conceptual diagram of the mediation model, the conceptual and statistical diagrams of the moderation model are considerably distinctive.
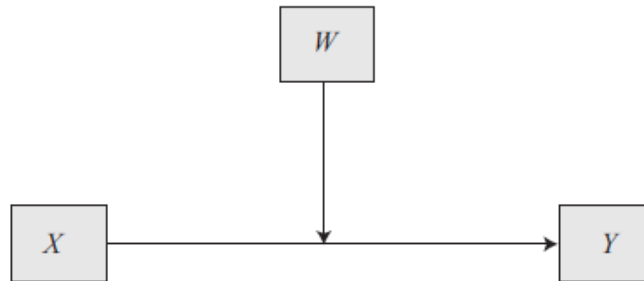
Figure 7.4: Moderation model - conceptual diagram (figure from [Hay17])

The conceptual diagram of the moderation model is equivalent to equation 7.3, and to the statistical diagram illustrated in 7.5.

$$Y = i_Y + b_1 X + b_2 W + b_3 XW + e_Y \tag{7.3}$$

Where i_Y is the regression constant, e_Y the regression error, b_1, b_2 and b_3 are regression coefficients, and XW is the formulation of how W moderates the effect of X on Y.
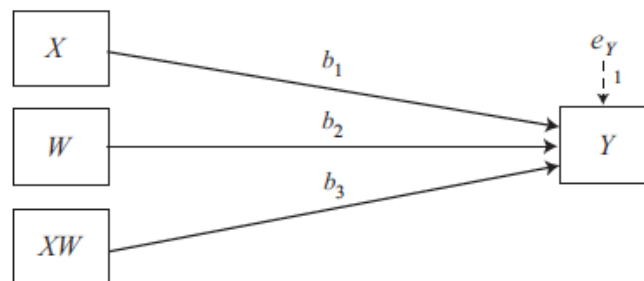
Figure 7.5: Moderation model - statistical diagram (figure from [Hay17])

7.1.2 Representing hypotheses with the CPA

Hereby, we will combine hypotheses for Individual Loss and choice satisfaction, in order to obtain a single model. In all of the illustrations, the Individual Loss and choice satisfaction boxes are highlighted to note that these are the dependent variables in the model. Moreover, each illustration also indicates the general constructs that the particular variable is measuring.

First of all, as defined in the introduction section of this chapter, hypotheses IL-H2 (i.e., group members' centrality in the group preference network is related to group members' Individual Loss), CS-H2 (i.e., group members' centrality in the group preference network is related to their choice satisfaction), and CS-H1 (i.e., group members' Individual Loss is related to their choice satisfaction) are interrelated, and can be represented with a simple mediation model, as illustrated in figure 7.6, with its corresponding equations 7.4 and 7.5. To measure the members' centrality in the group preference network, further referred to as preference centrality (PrefCent), we used the same approach as in Chapter 4, section 4.3.1, i.e., the degree centrality in the FullSim preference network. The strength of connections between group members in the FullSim network is calculated based on the group members' pairwise preference similarity over the full choice set (i.e., ten destinations), for more details see Chapter 4, and section 4.3.1).
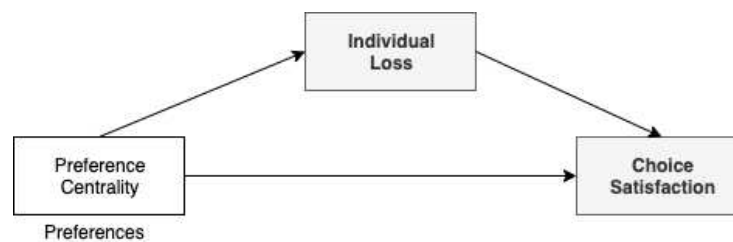
Figure 7.6: Mediation model: Preference Centrality - Individual Loss - Choice satisfaction

$$IL = i_{IL} + aPrefCent + e_{IL} \tag{7.4}$$

$$CS = i_{CS} + cPrefCent + bIL + e_{CS} \tag{7.5}$$

Secondly, hypotheses IL-H1 (i.e., Group diversity is related to group members' Individual Loss), and IL-H3 (i.e., High Conscientiousness trait in group members will decrease their Individual Loss especially when in a highly diverse group) are as well interconnected, but in this case we model them with a moderation effect, as depicted in figure 7.7, with its corresponding equation 7.6. To capture the group diversity Spearman Top-Choice Diversity measure was used. The reason behind was that this diversity measure managed to capture the most differences in individual and group performance in the group decision-making process, as shown in Chapter 4, section 4.2.

As previously mentioned, it is important to note that the moderating effect does not exclude the direct effect of the moderating variable on the dependent variable (even though the conceptual model does not show it). Hereby the moderating effect was chosen as we assume that conscientious group members will "navigate" the group decision-making process more than less conscientious group members, but that this effect will be even more emphasized in diverse groups.
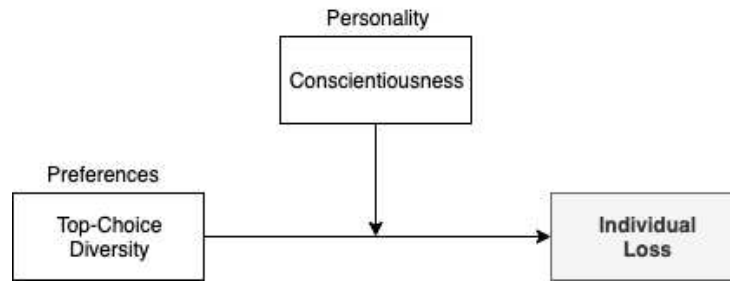
Figure 7.7: Moderation model: Group diversity - Conscientiousness - Individual Loss

$$IL = i_{IL} + a_1 ST\_DIV + a_2 CNS + a_3 CNS * ST\_DIV + e_{IL} \tag{7.6}$$

Finally, we can also illustrate the connection between hypotheses CS-H2 (i.e., Group members' position in the group preference network is related to their choice satisfaction), and CS-H6 (i.e., The effect of the group members' position in the group preference network on the choice satisfaction is moderated with the strength of group identity) with a moderation model, as shown in figure 7.8, and its corresponding equation 7.7.
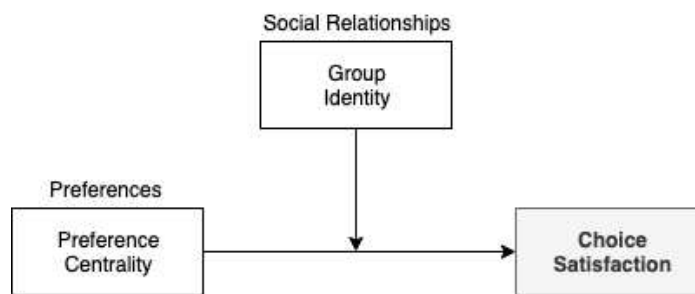
Figure 7.8: Moderation model: Preference Centrality - Group Identity - Choice Satisfaction

$$CS = i_{CS} + b_1 PrefCent + b_2 GrIdent + b_3 PrefCent * GrIdent + e_{CS} \tag{7.7}$$

The rest of the hypotheses (i.e., the relationship between the experience and the Individual Loss, and the relationship between the personality and the choice satisfaction) that we introduced are only considered as direct effects. The final, overall model, that we will evaluate in this chapter is illustrated in figure 7.9, and equations 7.8 and 7.9.

$$IL = i_{IL} + aPrefCent + a_1 ST\_DIV + \\ + a_2 CNS + a_3 CNS * ST\_DIV + a_4 EXP + e_{IL} \tag{7.8}$$
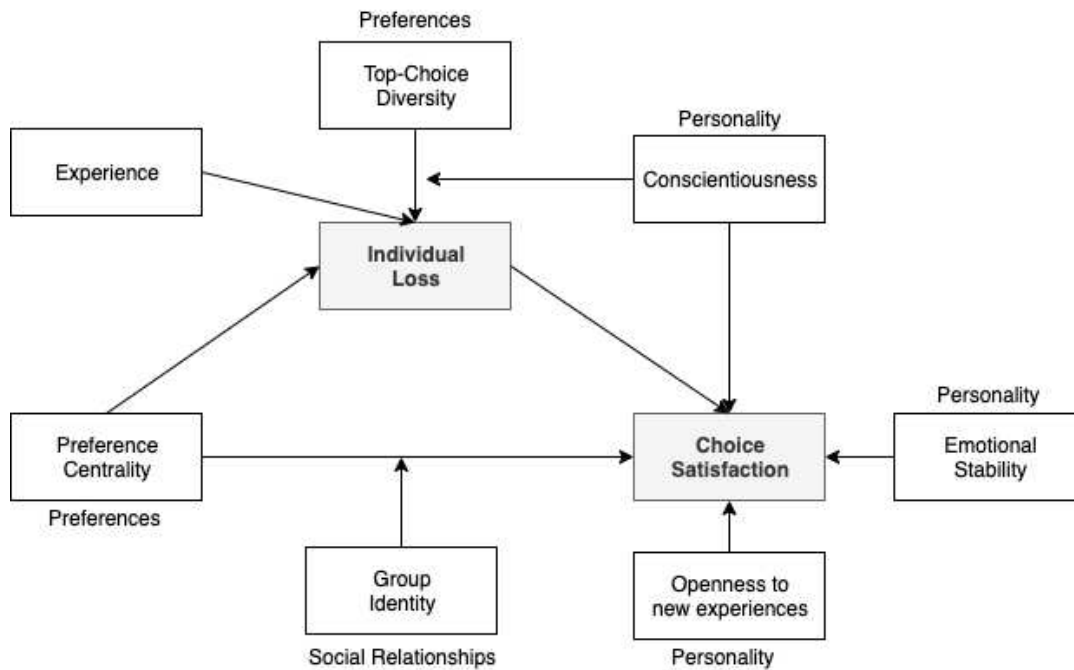
Figure 7.9: Overall model

$$CS = i_{CS} + bPrefCent + b_1 GrIdent +$$
$$+ b_2 PrefCent * GrIdent + b_3 IL +$$
$$+ b_4 OPN + b_5 CNS + b_6 EST + e_{CS} \quad (7.9)$$

Where i_{IL} and i_{CS} are intercepts, e_{IL} and e_{CS}, regression errors, and $a, a_1, ..., a_4$ regression coefficients for Individual Loss, and $b, b_1, ...b_6$, regression coefficients for choice satisfaction.

The model fit will be evaluated with two SPSS modules, the PROCESS module (implemented by Andrew F. Hayes) and the simple Linear Regression module. Since the PROCESS module only evaluates the effect of one antecedent variable on one consequent variable (with various mediation and moderation effects), it is clear that we cannot represent our whole model in it. Therefore, the PROCESS module will be used to evaluate parts of our model, that include the mediation and moderation effects that we defined previously, while the Linear Regression module, will be used to evaluate the overall model, with all of its direct, indirect, conditional and unconditional effects.

7.2 Results

7.2.1 Individual loss

Firstly, we present the results concerning the Individual Loss, specifically, the moderation model illustrated in figure 7.7, and summarized in equation 7.6. Then, with the simple linear regression, the results for the overall model that predicts Individual Loss, as in equation 7.8.

Tables 7.1, 7.2, and 7.3 demonstrate the output of the PROCESS module, for the moderation model, having the group preference diversity (ST_DIV) as the antecedent variable, Individual Loss as the consequent variable and the Conscientiousness personality trait as the moderator. Table 7.1 shows that a) Diversity of group members' preferences relates to the Individual Loss in the decision-making process; b) Conscientiousness is not related to the group members' Individual Loss directly; but c) Conscientiousness is a moderator of the group diversity effect on the Individual Loss. Table 7.1 represents the model summary, while table 7.3 is an extension of the standard regression model output, and it describes the moderating effect of the Conscientiousness trait. It indicates that the effect of the group diversity on the Individual Loss was significant and positive for lower values of the Conscientiousness trait, but it became insignificant for the higher values of the trait. Therefore, the effect of group diversity on the Individual Loss ceases for group members scoring high on the Conscientiousness trait. Moreover, when the Conscientiousness trait was included as a moderator, the variance explained by the model was increased by 2.04%.

Therefore, we can say that the following hypotheses are significant:

IL-H1 The greater the diversity of group members' preferences, the greater their Individual Loss is in the decision-making process.

IL-H3 Conscientiousness is related to the group decision-making process, i.e., group members' scoring high on the trait manage to decrease their loss in the decision-making process in the highly diverse groups in terms of preferences.

Table 7.1: Performance of the moderation model: Group diversity - Conscientiousness - Individual Loss

	Coeff.	Standard error	$p - value$
i_{IL}	-7.823	5.581	0.162
ST_DIV	1.833	0.688	0.008
CNS	2.676	1.455	0.067
CNS*TOP_DIV	-0.375	0.177	0.035

The final model for predicting Individual Loss (see figure 7.10) also includes group members' centrality in the group preference network (i.e., Preference Centrality), and group members' experience with the ten destinations (EXP) as the "direct" predictors. The results are shown in tables 7.4 and 7.5. Here, the percentage of variance explained

Table 7.2: Moderation model performance summary for the: Group diversity - Conscientiousness - Individual Loss

MSE	R	R^2	$p-value$
13.019	0.3280	0.1076	0.0001

Table 7.3: Conscientiousness as a moderator of the group diversity effect on Individual Loss

CNS	Effect	Standard error	$p-value$
3.2500	0.617	0.1382	0.000
3.7500	0.423	0.090	0.000
4.4600	0.156	0.140	0.264

by the model is increased by almost 5%, in comparison to the previous one. According to the output from table 7.4, we can say that the other two hypotheses, with respect to Individual Loss, are as well significant:

IL-H2 The more central a group member is in the group preference network, the less Individual Loss that group member will experience in the decision-making process.

IL-H4 The more experienced/knowledgeable a group member is about the choice set (i.e., destinations at hand), the less Individual Loss that person will have in the group decision-making process.
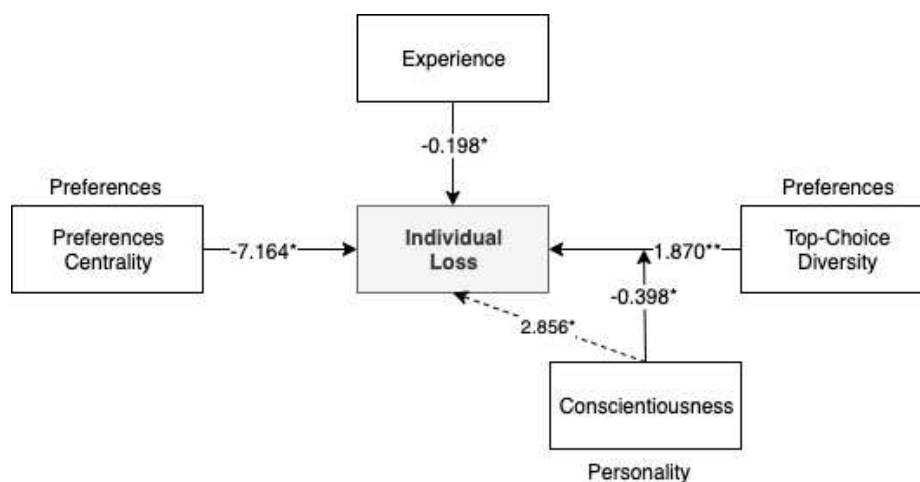
Figure 7.10: Overall model for the Individual Loss

Table 7.4: Performance of the overall model for Individual Loss prediction

	Coeff.	Standard error	$p-value$
i_{IL}	-5.395	5.540	0.331
PrefCent	-7.164	2.973	0.017
ST_DIV	1.870	0.676	0.006
CNS	2.856	1.430	0.047
CNS*TOP_DIV	-0.398	0.174	0.024
EXP	-0.198	0.094	0.036

Table 7.5: Model summary performance for Individual Loss prediction

MSE	R	R^2	$p-value$
12.547	0.386	0.149	0.000

7.2.2 Choice satisfaction

The hypotheses related to the choice satisfaction are evaluated with two models. The first one (see figure 7.11, for the sake of simplicity further referred as model1), combines the mediation model, i.e., the direct and indirect effect of the Preference Centrality through the Individual Loss on the choice satisfaction; and the moderation model, i.e., the group identity as a moderator of the Preference Centrality effect on the choice satisfaction. This model is evaluated with the PROCESS module, having that Preference Centrality is a single antecedent variable, and the choice satisfaction is the single consequent variable, while Individual Loss is a mediator, and group identity a moderator. The second model (see figure 7.12, for the sake of simplicity further referred as model2), combines model1 with the direct effects of personality traits.
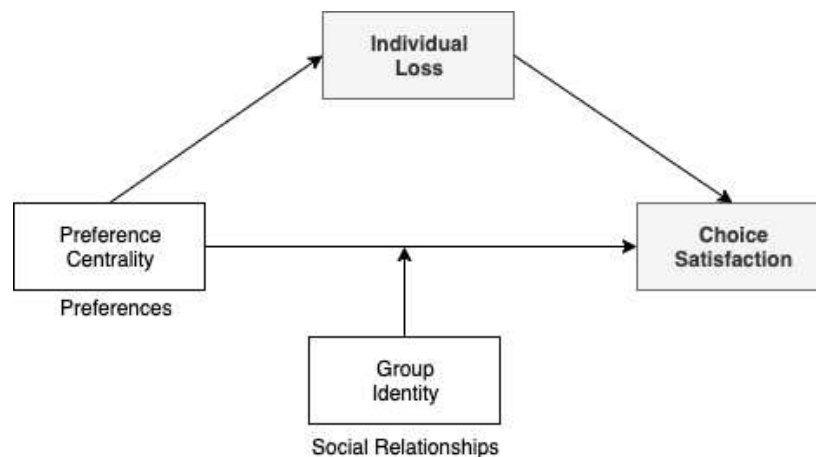
Figure 7.11: Model1 conceptual diagram

Table 7.6: PROCESS module output for model1

	Coeff.	Standard error	$p-value$
i_{CS}	0.4168	0.7997	0.6028
PrefCent	8.810	2.319	0.000
IL	-0.052	0.012	0.000
GrIdent	0.9478	0.200	0.000
PrefCent*GrIdent	-2.040	0.595	0.000

Table 7.7: Model1 performance summary

MSE	R	R^2	$p-value$
.4487	0.4899	0.2400	0.0000

Table 7.8: Group identity as the moderator of the Preference Centrality effect on the choice satisfaction

GrIdent	Effect	Standard error	$p-value$
3.000	2.6903	0.7289	0.0003
4.000	0.6502	0.5796	0.2633
4.500	-0.3699	0.7103	0.6031

Tables 7.6,7.7, and 7.8 illustrate the output of the PROCESS module for the conceptual diagram of model1 (figure 7.11). Based on these results, we can see that all the proposed variables have a significant impact on the group members' individual choice satisfaction, i.e., Preference Centrality, and the group identity have a positive effect, while Individual Loss has a negative effect. Table 7.8 explains in more details the moderating effect of the group identity on the relationship between the Preference Centrality and the choice satisfaction. Namely, group members' centrality in the group preference network has a significant and positive effect on their choice satisfaction when their group identity is low, but the centrality becomes insignificant when the group identity is high. As for the mediation part of the model, as previously explained, group members' Preference Centrality is a significant predictor of their Individual Loss, and hereby we can see that Individual Loss is a significant predictor of the choice satisfaction. This result supports the mediation hypothesis. Moreover, the PROCESS module estimates that the magnitude of the indirect effect of the Preference Centrality on the choice satisfaction through the mediator - Individual Loss, is equal to 0.4359. In conclusion we can say that the following hypotheses are as well significant:

CS-H1 The higher the group members' Individual Loss in the decision-making process the lower the choice satisfaction of that member is.

CS-H2 The more central a group member is in the group preference network, the more satisfied that member will be with the group choice, also due to the fact that central

members decreased their Individual Loss in the decision-making process.

CS-H6 The stronger the group identity of a group member towards her group is, the less important her position in the group preference network will be for her choice satisfaction.
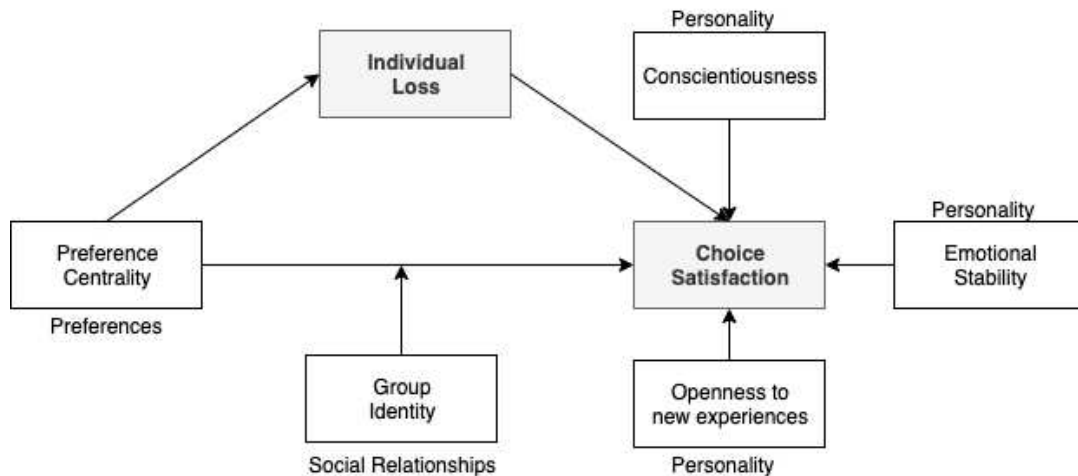
Figure 7.12: Model2 conceptual diagram

Finally, the results for the overall model for predicting the choice satisfaction (i.e., model2) are presented in tables 7.9 and 7.10. Table 7.9 shows that, actually, Openness to new experiences and Conscientiousness are not significant predictors of the choice satisfaction, while the Emotional stability trait is a significant predictor. The rest of the model variables have not changed much in comparison to model1. To this end, we can say that one of the three hypotheses related to the personality traits and choice satisfaction is significant:

CS-H4 The more emotionally stable a group member is, the more she will be satisfied with the final group choice.

7.3 Conclusion

To summarize, in this chapter, motivated by the results obtained when evaluating the effects of preferences, personality, and social relationships individually, on the group decision-making process (i.e., mainly on the group members' individual satisfaction with the group choice), we were interested to understand the joint effect that these different aspects exert on the group members' choice satisfaction when brought together in a single model.

To this end, according to previous results, we conjectured two models. In the first one, we proposed to predict Individual Loss based on the group preference diversity, group

Table 7.9: Linear regression module output for model2

	Coeff.	Standard error	$p-value$
i_{CS}	-0.355	0.877	0.686
OPN	0.088	0.097	0.364
CNS	0.154	0.088	0.082
EST	0.144	0.073	0.050
PrefCent	7.666	2.429	0.002
IL	-0.056	0.013	0.000
GrIdent	0.819	0.214	0.000
PrefCent*GrIdent	-1.864	0.631	0.004

Table 7.10: Model2 performance summary

MSE	R	R^2	$p-value$
0.663	0.516	0.267	0.0000

members' score on the Consciousnesses trait, and their experience/knowledge about the ten destinations. As illustrated in the summary figure 7.13 (the upper part), we came to the following conclusions:

1. The more knowledgeable the group member is, the more she will manage to decrease her Individual Loss in the group decision-making process.

2. The higher the preference diversity in the group, the greater losses group members will experience in the decision-making process.

3. Conscientious members manage to decrease their Individual Loss, especially in diverse groups.

In the second model, we proposed to predict group members' choice satisfaction based on a) members' centrality in the group preference network; b) members' Individual Loss in the group decision-making process; c) members' personality scores on the Openness to new experiences, Emotional Stability and Conscientiousness traits; and d) members' strength of group identification. The results, presented in the lower part of figure 7.13, indicated the following conclusions:

1. The more central a group member is in the group preference network the more that member will manage to decrease her Individual Loss in the decision-making process, and therefore will increase her satisfaction with the group choice.

2. The stronger the identity a group member has to her group the more satisfied she will be with the group choice, regardless of her centrality in the group preference network.

3. The more emotionally stable a group member is, the more satisfied she will be with the group choice.
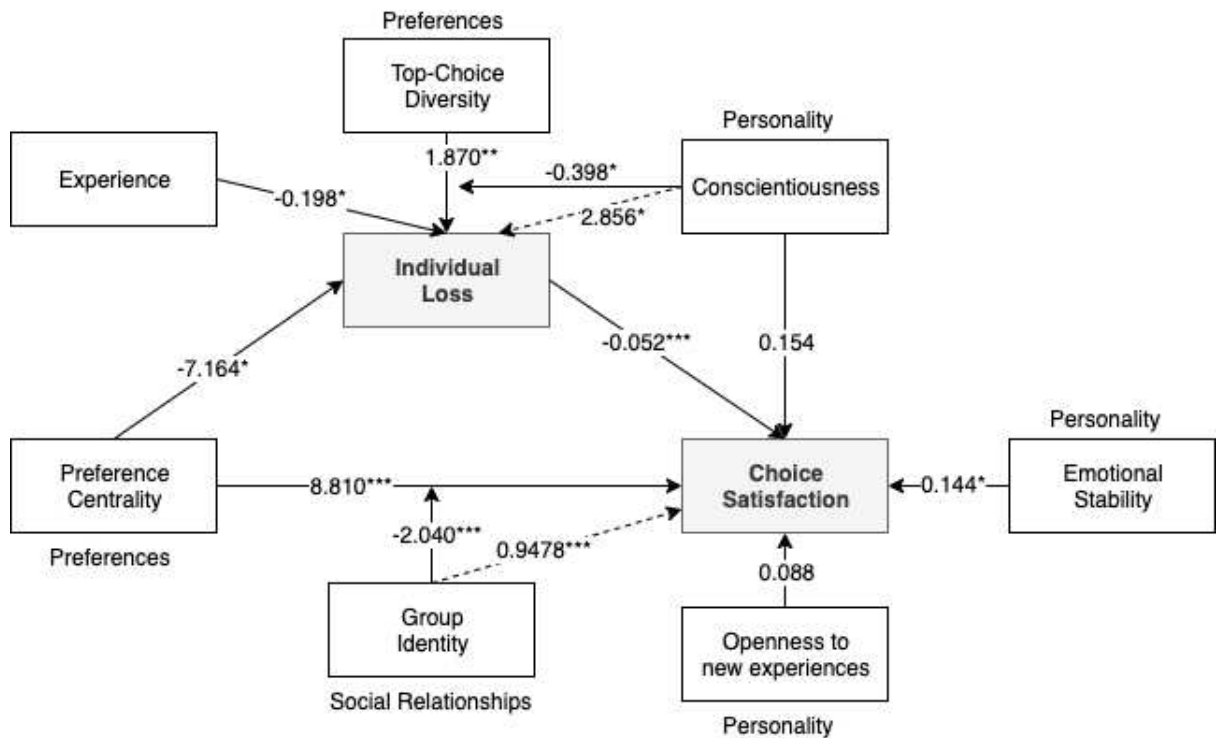
Figure 7.13: Overall model results

The purpose of this study was to show that various individual and group characteristics are related to the group decision-making process and the group members' satisfaction with the final group choice. The results of this analysis can be employed in the design of future GRSs - by accounting for different aspects that were shown to be relevant for the individuals' satisfaction, we can better predict items that would be acceptable by a group at hand, and accordingly generate group recommendations. This analysis was conducted on the INSTANCE1 data set, and in the future we plan to validate the results on the INSTANCE2 set.

A Look at the Process itself

The goal of this chapter is to investigate the group decision-making process itself, while previously we were investigating the attributes of groups and group members and their effects on the outcomes of the decision-making process. In essence we aim to identify group and individual aspects that can help us predict how a group would reach their final decision.

According to Jameson [Jam04], the fourth challenge for GRSs is how to support a group in their group decision-making process and in reaching a final decision. Hereby, we intent to show the importance of studying and addressing this challenge as one of the crucial tasks of GRSs.

The role of decision support has been acknowledged in the literature before. RS, in essence, should ease the decision-making process for their users and help them make better choices [JWF+15]. This is even more true for GRSs, since making decisions in a group of people becomes even more complex [Mas15]. Several studies in GRSs dealt with decision support as one of the core functions of a GRS, such as *Travel Decision Forum* [Jam04], *Collaborative Advisory Travel System* (CATS) [MSC+06], *CHOICLA* [Ste14], *STSGroup* [NR17a] (for more details see Chapter 2).

However, in this chapter, we start one step earlier and analyze real, face-to-face group decision-making process. Thus, we aim to explore the variations in the approaches adopted by different groups, and to relate those variations to the characteristics of the groups (i.e., group level variables) and characteristics of the individuals forming those groups (i.e., individual level variables). Overall, the goal is to learn how a GRS could adapt the decision support approach according to the group at hand. We argue that not only the final recommendations should be the focus of personalization but also the decision support provided by the GRS should be personalized according to specific characteristics of the respective group.

In the work of Stettinger et al. [Ste14], the system enables the configuration of the decision support approach based on the type of decision task that a group is facing (e.g., choosing a restaurant or deciding what candidate to employ for a job, are examples of different decision task types). In our work, on the other hand, we assert that different groups should be supported differently in their decision-making process even when faced with the same decision task.

In this chapter we provide empirical evidence for our claim. To this end, three types of analyses were conducted on the INSTANCE1 data sample. The main contributions of this chapter are:

- Categorization of group decision-making process across several dimensions focusing on various decision process aspects. This contribution was a result of a qualitative analysis of textual descriptions of the decision-making processes as reported by the study participants.

- Identification of relationships between the group decision-making process, on the one side, and characteristics of the group and individuals in that group, on the other side. This contribution was achieved with the help of several non-parametric hypotheses tests.

- Identification of the group characteristics that influence how the group will reach their final decision for the analyzed decision task. This contribution resulted from a discriminant analysis.

This chapter answers research question 5, *How do the group characteristics influence the group decision-making process?*, and each step of the analysis is related to one of the following questions *RQ 5.1 How can we characterize group decision-making process?*; *RQ 5.2 Is there a relationship between group characteristics and the characteristics of the group decision-making process?*; and *RQ 5.3 Which group characteristics can be used to predict a decision-reaching approach that a group adapts?*.

8.1 Methodology

In the presented analysis, two types of variables were used. The first type are the variables that describe participants individually, i.e., the individual level variables, and the second type describes groups as a whole, i.e., the group level variables.

Individual level variables

The individual level variables are selected from pre- and post-questionnaires. The Big Five factors, i.e., Openess to new experiences (OPN), Consciousnesses (CNS), Extroversion (EXT), Agreeableness (AGR), and Emotional Stability (EST), were used as the characteristics of the individuals, and in order to evaluate whether the group decision-making process itself differs when group members of various personality types "design" it. The choice satisfaction (ChoiceSat), and difficulty of the decision-making process (Diff), as

measures collected in the post-questionnaire, after the discussions, represent the outputs of the process, and hereby it would be appealing to see whether certain characteristics of the process affect these measures. The group identity (GrIdent) was selected as it represents a measure of members' happiness with belonging to a certain group, and also as a measure of group closeness. The previous research in group recommender systems, for instance [GXL+10], has shown that groups of different closeness levels are best served with recommendations produced by different aggregation strategies. Hence, studying whether groups with different closeness levels make their decisions differently would bring valuable insights into the issue. Finally, as group diversity is an important factor in group processes, we were also interested to understand whether the members' individual perceived group similarity (GrSim) play a role in the decision-making process. For more details on the measurements see section 3.2.

Group level variables

Table 8.1: Group level variables

Abbreviation	Description	Range
gOPN, gCNS, gEXT, gAGR, gEST	Group score on the Big Five factors	$[0, 1]$
gGrIdent	Group score for group identity	$[0, 1]$
SF_DIV	Spearman Full Choice-set Diversity	$[6.3, 15.6]$
TR_DIV	Implicit Travel Preferences Diversity	$[1.7, 5.3]$
ST_DIV	Spearman Top-choice Diversity	$[0.3, 4.5]$

To derive variables at the group level from the individual level variables an aggregation strategy was applied. The Big Five factors scores, and the group identity score at the group level were obtained with the normalized multiplicative strategy. Therefore, the group score for a variable is calculated as follows:

$$gSCORE = \frac{1}{\max_{1 \leq i \leq n} (SCORE_i)^n} \prod_{i=1}^{n} SCORE_i \qquad (8.1)$$

where gSCORE is the group score, $SCORE_i$ is the score of i-th group member for a given individual level variable, and n is the size of the group.

Moreover, in this analysis, as the group level variables, the preference diversity measures introduced in section 3.3.2 were as well used. More specifically, measures that capture group diversity with respect to the implicit travel preferences (i.e., eight travel types/factors from section 3.3.1), and the explicit preferences (i.e., individuals' rankings of the ten pre-selected destinations).

Obviously, our motivation for the group level variables is the same as for the individual level variables, the personality traits and the group identity. Furthermore, since we are

able to measure the "objective" group diversity (i.e., diversity of the reported preferences of the participants) it is exciting to investigate how groups with different degrees of diversity overcame challenge of diversity and made their final decisions.

8.1.1 Three steps of analysis

To test our hypothesis that the flow and the overall group decision-making process differs within groups of different characteristics, a three-step analysis was implemented. First of all, since we were interested to understand different approaches that groups adopted to reach their final decisions, we focused on the textual descriptions of the decision-making process as acquired in the post-questionnaire. To this end, a qualitative analysis was carried out, more precisely, the grounded theory [CS90] qualitative approach was applied on the textual descriptions of the group decision-making process. As the result of the qualitative analysis we obtained a set of quantitative descriptors of the group decision-making processes that the participants reported. Then we were able to move forward to the second step of the analysis, i.e., relating the decision process descriptions with the characteristics of groups. Finally in the third step, having analysed this relationship, we were able to conjecture and test a model that predicts how the group would reach their final decision simply with a set of variables describing a group at hand.

Qualitative Analysis

In the post-questionnaire, the participants (individually) described their group decision-making processes. For each group, the descriptions of individual group members were combined in order to obtain a more comprehensive picture of the overall process. Then, in the first step of the qualitative analysis, and in several rounds, the group decision-making process descriptions were tagged with "codes". For instance, *"decision made from top-choices"*, *"a lengthy discussion about full choice-set"*, *"decision made by elimination process"*, *"discussion about whether and money"*, *"conflicting preferences within the group"*, *"similar preferences within the group"*, *"agreement on crucial criteria for the decision"*, etc.

In the second step, the "codes" were grouped into the concepts and categories, i.e., process description, discussion description, decision scheme, compromise or consensus, preferences within the group, group behavior.

As a result of the analysis, four categorical variables, i.e., the categorical decision process descriptors, were identified: 1) Organization of the decision process; 2) Preference disclosure technique; 3) Decision reaching technique; and 4) Group behavior type. Subsequently, each group could be characterized along these four dimensions, i.e., to each group four categorical decision process descriptors were assigned (more details are provided in section 8.2).

Correlation analysis and non-parametric tests

In the second analysis, the categorical decision process descriptors were related to the characteristics of the groups and the characteristics of the individuals, i.e., the group level variables, and the individual level variables. To investigate this relationship, a correlation analysis and non-parametric tests, i.e., the Independent-Samples Median Test and Kruskal-Wallis [KW52] Test were employed. The non-parametric tests were selected since the results of Shapiro-Wilk test [SW65] indicated a significant deviation of our variables from the normal distribution.

Discriminant analysis

Finally, we conducted a discriminant analysis [KIK80], with the goal to identify group level variables that best differentiate among different decision reaching approaches. Thus, the independent predictor variables are the group level variables, and the dependent outcome variable is the decision reaching approach as obtained by the qualitative analysis.

8.2 Results

8.2.1 Qualitative analysis

As the result of the first step of the analysis, i.e., the qualitative analysis, the following **decision process descriptors** were obtained:

1. Organization of the decision-making process (ORG) is a descriptor of three categories:
   a) STRUCTURED when the following was met:
      - The process started with a systematic approach, i.e., a) group members individually ranked the ten destinations; b) group members individually assigned points/ratings to the ten destinations; c) group members expressed their two or three top choices; d) group members agreed on objective criteria to rank the destinations (e.g., decision was made by ranking the universities at the ten destinations).
      - The process ended with a systematic approach, i.e., a) majority voting; b) aggregated points/ratings/ranks; c) ranking based on objective criteria.
   b) SEMI-STRUCTURED when:
      - The process has either started or ended with a systematic approach, but not both.
      - The process contained a real discussion about group members' preferences.
   c) UNSTRUCTURED when:
      - The process started with either an open discussion, or individual statements about trip expectations, or a lengthy discussion about individuals' subjective criteria, or a discussion of pros/cons of each destination (i.e., no organization within the process and no systematic method was employed).
      - The process was concluded by reaching a consensus.

2. Preferences disclosure technique (DSCL) is descriptor of four categories:
   a) POINTS/RATINGS/RANKINGS
   b) TOP-CHOICE
   c) NO-GOES, i.e., group members eliminated destinations they hated
   d) OPINION/SUBJECTIVE CRITERIA/PROS & CONS
3. Decision reaching technique (DCSN) is a descriptor of three categories:
   a) AGGREGATING POINTS/RATINGS/RANKINGS
   b) MAJORITY VOTING
   c) REACHING A CONSENSUS
      • The decision is reached a) unanimously, b) through an open discussion, and c) the choice is a *"middle ground"*, i.e., the least conflicting destination.
4. Group behavior type (TYPE) is a descriptor of three categories:
   a) TASK ORIENTED when the following is met:
      • A group chose a very structured approach to reach the final choice without much discussion or place for individuals' preferences, focusing only on the task *"solution"*.
   b) COLLABORATIVE when:
      • A group adopted a) the least misery approach, or b) they were open to hear everybody's opinions/wishes/complains, or c) the second choice was decided by a person who hated the first choice of the group, or d) the elimination process was adopted to take care that nobody hates the final choice.
   c) INBETWEEN when:
      • The group was goal oriented, but they also cared about individuals' opinions.

To further clarify, the categories were in parallel deduced from codes and concepts used to tag textual descriptions of the decision-making process. The categories have no hierarchical order or nesting. However, the first category describes the overall process; the second and third one constitute, in a way, phases of the process; and the forth one describes the behavior of the group during the process. Therefore, as the categories describe different dimensions of the same process, they are naturally interrelated.

Based on these results, the groups were assigned to the different categories. Table 8.2 illustrates the distributions of the newly introduced decision process descriptors across the 55 groups, of the INSTANCE1 data set.

8.2.2   Correlation analysis and non-parametric tests

With a correlation analysis, several relationships were discovered between the group level variables and the decision process descriptors, as shown in table 8.3.

Moderate and significant correlations were found between the adopted decision reaching technique, on the one side, personality traits and diversity of the group, on the other. Hence, the more agreeable, conscientious and emotionally stable a group as a whole was, and the lower the group diversity of implicit travel preferences (i.e., TR_DIV) the more

Table 8.2: Distribution of decision process descriptors

Organization of the decision process				
Unknown	Unstructured	Semi-structured	Structured	-
7	10	25	13	-
Preferences disclosure technique				
Unknown	Points	Top-choice	No-goes	Opinion
12	10	12	4	17
Decision reaching technique				
Unknown	Aggregate	Voting	Consensus	-
4	8	12	31	-
Group behavior type				
Unknown	Task-oriented	Inbetween	Collaborative	-
7	13	9	26	-

Table 8.3: Group characteristics and decision process descriptors

	ORG	DSCL	DSCN	TYPE
gAGR	-	-	.288*	-
gCNS	-	-	.311*	-
gEST	-	-	.338*	-
gGrIdent	-	.311*	-	.355**
SF_DIV	.364**	-	-	-
ST_DIV	.266*	-	-	-
TR_DIV	−.273*	-	−.324*	-

ORG: Organization of the process

DSCL: Preference disclosure technique

DCSN: Decision reaching technique

TYPE: Group behavior type

SF_DIV: Spearman Full Choice-set Diversity

ST_DIV: Spearman Top-Choice Diversity

TR_DIV: Diversity of implicit preferences

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level.

often the group would adopt a *"natural"* decision reaching technique, in terms of face-to-face discussion, such as the consensus reaching. The organization of the decision-making process (ORG) was more often unstructured for groups with diverse explicit preferences, and, on the contrary with the similar implicit travel preferences. Finally, as expected, group behavior was more collaborative and the preference disclosure was more *"natural"* (i.e., sharing personal opinions and trip expectations) as the group shared stronger group identity (as the group was more socially close).

To further explore these relationships, the non-parametric tests were employed to test the differences in scores of individual and group level variables between the different categories of the decision process descriptors.

The Independent Samples Median Test showed significant differences ($p = .038$) in the distribution of group members' individual Extroversion scores across the three process
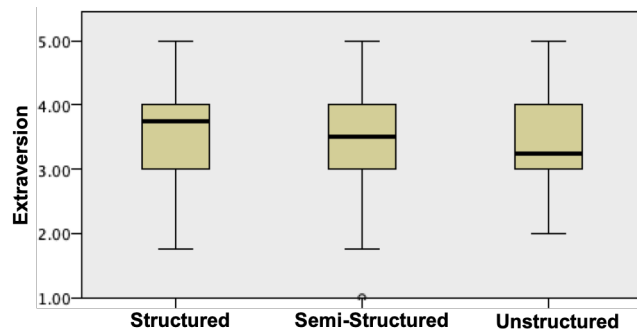
Figure 8.1: Distribution of Extroversion scores for process organization categories

organization categories (ORG) (figure 8.1) - the less extroverted members in the group are, the less organization, planning and structure their decision-making process had.

Furthermore, significant differences in the distribution of Implicit Travel Preferences Diversity (TR_DIV) were found across preference disclosure categories (DSCL) (figure 8.2a, $p = .013$), as well as, across decision reaching approach categories (DCSN) (figure 8.2b $p = .001$). As the two decision-making process descriptors are interrelated (the way group members reached their final decision depends on the way they disclosed their individual preferences), the lowest Implicit Travel Preferences Diversity (TR_DIV) was found for groups that disclosed their preferences in the form of POINTS/RATINGS/RANKINGS, and that reached their decision by AGGREGATING POINTS/RATINGS/RANKINGS. The moderate diversity was found for groups that disclosed their preferences in the form of OPINION/SUBJECTIVE CRITERIA/PROS & CONS, and that therefore made their final decision by REACHING A CONSENSUS. The highest diversity of implicit travel preferences (i.e., travel types/factors) was found for groups who disclosed their preferences in the form of TOP-CHOICE and NO-GOES, and reached their decision by adopting the MAJORITY VOTING technique.

(a) Preference disclosure

(b) Decision reaching technique
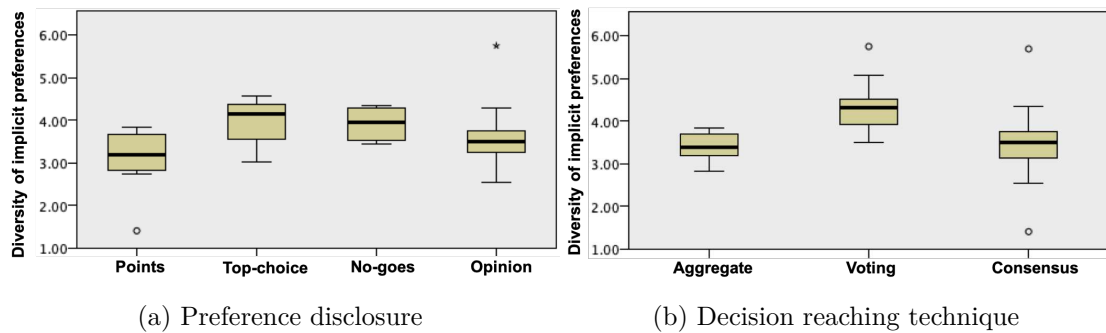
Figure 8.2: Differences in implicit travel preferences across preference disclosure and decision reaching technique categories

Also, again as obtained with the correlation analysis, significant differences were found in

the scores of the group identity for the group as a whole (group closeness) between the four categories of the preference disclosure techniques (DSCL) the groups adopted (see figure 8.3). The lowest median score of the group identity (group closeness) was found for those groups who disclosed their preferences in the form of POINTS/RATINGS/RANKINGS, followed by those who disclosed TOP-CHOICE and NO-GOES (having an equal median score), while the highest score of group identity was for the groups who disclosed their preferences in the form of OPINION/SUBJECTIVE CRITERIA/PROS & CONS. This result seems reasonable, the closer the group was the more the group members felt that they can (or even should) share their individual opinions and subjective criteria.
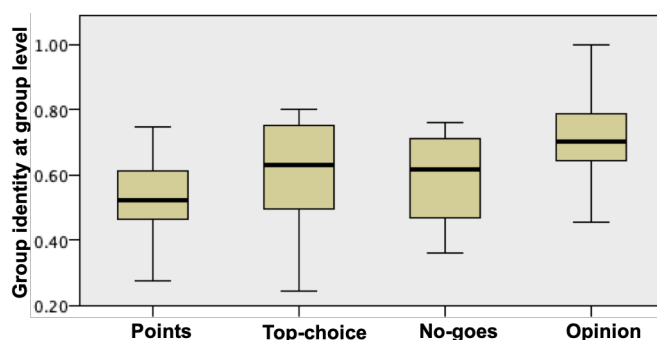
Figure 8.3: Distribution of group identity scores for the group as a whole across preference disclosure techniques

Finally, personality of the group as a whole differed significantly across the decision reaching technique categories (DCSN). More specifically, the differences were found for Agreeableness, Conscientiousness and Emotional stability traits, as identified by the correlation analysis. However, hereby we can illustrate the relationships in more details - figure 8.4.

8.2.3 Discriminant analysis

In the final step of the analysis, the goal was to identify variables that are relevant for predicting the decision reaching technique (DSCL) that a group adopted for the given decision-task. This problem is directly related to the problem of GRSs as it addresses the question which method to use when aggregating individual preferences into a group model according to the group at hand. Here, we will not evaluate the prediction power of the model, but we will focus on identifying relevant variables when predicting the decision reaching approach.

To predict the decision reaching technique (DSCN) that a group adopted, group level variables (see table 8.1) were used as predictors. The discriminant model was built in the SPSS environment, with the Linear Discriminant Analysis classifier. As the goal of the analysis was to identify relevant predictors, the stepwise method was used to select the significant predictors.

(a) Agreeableness

(b) Conscientiousness

(c) Emotional stability
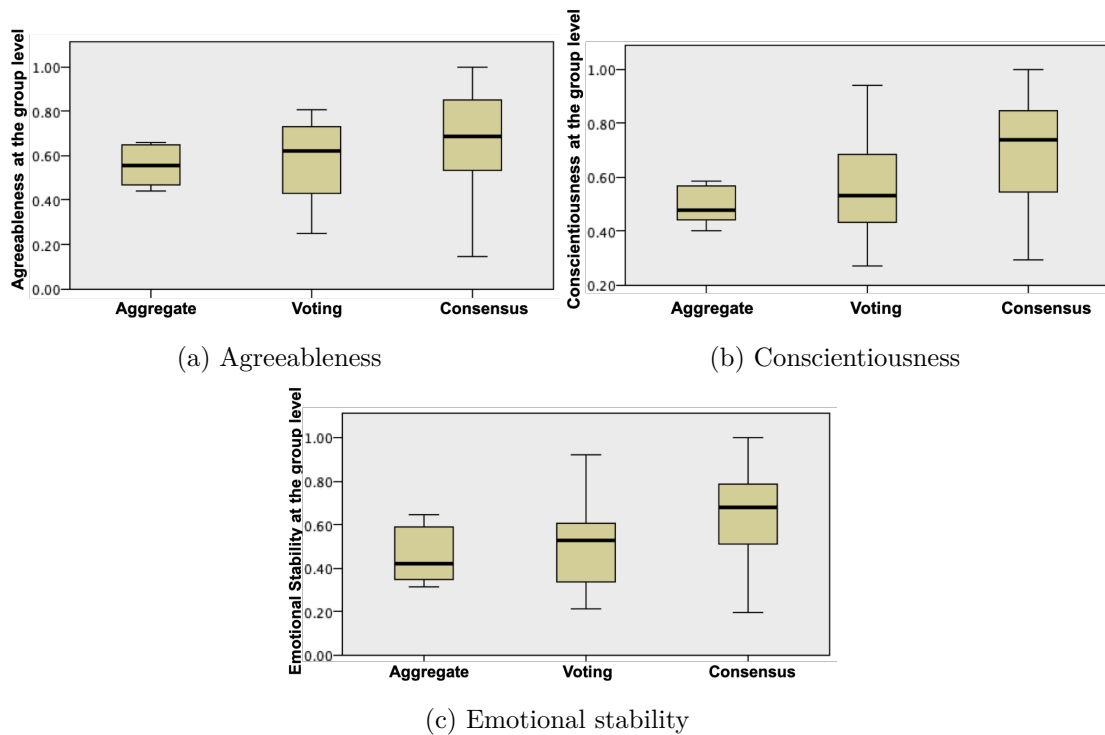
Figure 8.4: Differences in group personality across decision reaching technique categories

To build the model, 51 groups of 55 were pre-selected, since four groups with the unknown (i.e., unclassified) decision reaching technique had to be excluded.

In order to apply Linear Discriminant Analysis, it is important that the population co-variance matrices of the predictor variables across the three classes (i.e., three categories of the decision reaching technique descriptor) do not differ significantly. For this purpose we use Box's M test [Box49]. The null hypothesis of the Box's M test states that the population co-variance matrices are equal. Therefore, in order to be able to proceed with the discriminant analysis, and to be confident about the validity of the obtained results, the Box's M test has to be insignificant, with the p-value larger than .001 [HV16]. For the model at hand $p = .020$ which indicates that we cannot reject the null hypothesis, thus we can proceed with the analysis.

Further, the step-wise method selected two variables as significant predictors in the model, i.e., Implicit Preferences Diversity (TR_DIV with Wilks' Lambda .739 and significance level $p = .001$), and Conscientiousness of the group as a whole (gCNS with Wilks' Lambda .617 and significance level $p = .000$). Wilks' Lambda represents the ratio of within-classes sums of squares to the total sums of squares. A lambda of 1.00 occurs when observed class means are equal, while a small lambda indicates that class means appear to differ. The associated significance value indicate whether the difference is significant.

Since the number of classes to be predicted is three (i.e., Class I - AGGREGATING POINTS/RATINGS/RANKINGS, Class II - MAJORITY VOTING, and Class III - REACHING A CONSENSUS), the discriminant analysis resulted in two functions. Eigenvalue and canonical correlations from table 8.4 indicate that the two functions do a fair classification.

Table 8.4: Resulting discriminant functions

Function	Eigenvalue	% of Variance	Canonical Corr.
1	.384	69.3	.527
2	.171	30.7	.382

The Wilks' lambda also shows that the two functions do a fair separation of cases into classes. The smaller values of Wilks' lambda indicate greater discriminatory ability of the function. Moreover, associated chi-square statistics test the hypothesis that the means of the functions listed are equal across classes. The small significance value indicates that the discriminant function does better than chance at separating the classes (see table 8.5).

Table 8.5: Wilks' Lambda

Test of Functions	Wilks' Lambda	Chi-square	p-value
1 through 2	.617	22.926	.000
2	.854	7.480	.006

The discriminant functions coefficients, i.e., the coefficients that are used to calculate the discriminant score for the data sample instances, are presented in table 8.6. The magnitudes of these coefficients indicate how strongly the discriminating variables affect the score. Figure 8.5 illustrates how the two discriminant functions separate the data instances into the three classes. Different colors in the figure indicate the three classes, while the squares indicate the centers of the classes in the two-dimensional space.

Table 8.6: Standardized Canonical Discriminant Function Coefficients

	Functions	
	1	2
gCNS	$-.379$	.932
TR_DIV	.884	.480

gCNS: Group score on Consciousnesses

TR_DIV: Diversity of implicit preferences

The classification results of the discriminant functions are shown in table 8.7. The discriminant functions placed correctly 8 of 8 instances to the first class, 9 of 12 to the second and 19 of 31 to the third class. Overall, 70.6% of instances were correctly classified.
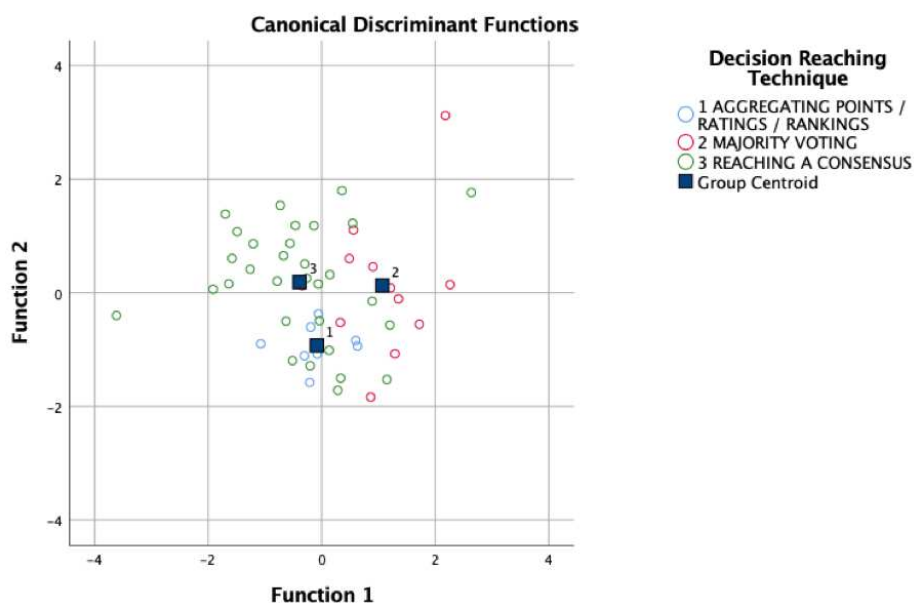
Figure 8.5: Canonical Discriminant Function

Table 8.7: Classification results

		DCSN	Predicted Class			Total
			Class I	Class II	Class III	
Original	Count	Class I	8	0	0	8
		Class II	2	9	1	12
		Class III	8	4	19	31
	%	1	100	0	0	100.0
		2	16.7	75.0	8.3	100.0
		3	25.8	12.9	61.3	100.0

70.6% of original cases correctly classified.

8.3 Discussion

In section 8.2, we have first presented the categorical descriptors of the group decision-making process obtained with the qualitative analysis. These variables describe different aspects of the decision-making process, and when combined, they provide a clear overview of the process. The first variable, i.e., organization of the decision-making process, characterizes the overall process and indicates whether the process followed some structure or not. The second variable, i.e., preferences disclosure technique, describes the beginning of the process, and how the group members exchanged their opinions. The third one, i.e., decision reaching technique, illustrates the final part of the process and which strategy the members employed in order to come to an agreement. Finally, we also identified a variable that characterizes the behavior of the group during the process. As described, the

obtained descriptors are clearly interrelated, which is also confirmed by the correlation analysis shown in table 8.8. However, it is evident that they do describe different aspects of the decision process.

Table 8.8: Categorical descriptors of the group decision-making process - correlations

	ORG	DSCL	DSCN	TYPE
ORG	1	.021	.109	.017
DSCL		1	.380**	.634**
DSCN			1	.553**
TYPE				1

ORG: Organization of the process

DSCL: Preference disclosure technique

DCSN: Decision reaching technique

TYPE: Group behavior type

*. Correlation is significant at the 0.05 level.
**. Correlation is significant at the 0.01 level.

Secondly, we presented significant relationships between individual and group characteristics, on the one hand, and the decision process descriptors, on the other. At the group level, personality traits, group identity and the diversity measures were all related to the decision process. At the individual level, we only identified the relationship with the Extroversion personality trait. These insights can serve as a guidance when adapting different aspects of the support a system provides for the group decision-making process to the group at hand. For instance, by knowing the group diversity scores, of the implicit and explicit preferences, a GRS can provide an appropriate support for the group members to express their preferences. More specifically, when a group is highly diverse considering implicit travel preferences (i.e., travel types/factors), a GRS should enable groups to express their top-choices or absolute no-goes, and not their opinions/ratings for each alternative (see figure 8.2a). Similar conclusions can be derived with respect to other group and individual characteristics.

Finally, with the discriminant analysis, we have demonstrated that Conscientiousness of the group as a whole and diversity of the group in terms of implicit travel preferences, are the strongest predictors of the decision reaching technique the groups adopted. The analysis also showed that 70.6% of cases are correctly classified by using only these two predictors. This result clearly implies that a GRS can and should adapt the aggregation strategy when combining individual preferences according to the group at hand and its characteristics.

8.4 Conclusion

To summarize, in this chapter we presented three interrelated analyses. In the first, qualitative analysis, we identified categorical descriptors of the group decision-making process. In the second analysis, we established relationships between these categorical descriptors, and characteristics of groups. Lastly, based on a discriminant analysis, we identified significant characteristics of the groups when determining the decision reaching

technique the respective group adopted. With the three analyses we demonstrate that our hypothesis is supported, group characteristics are related with the organization, and the flow of the group decision-making process. Moreover, we give evidence that different aspects of the decision-making process can be, and in essence should be, personalized/adapted according to the characteristics of the group at hand. Moreover, we argue that GRSs should provide a decision support for groups, and our results can be used to make a GRS more efficient in its tasks, by a) adapting the preference disclosure technique, and b) adapting the decision reaching technique, according to the characteristics of a group at hand.

CHAPTER 9

Conclusion

This thesis was about group decision-making, group modeling, personalization and GRSs with a use case in the travel and tourism domain, when a group is faced with a simple decision task - choosing a destination to visit together. In our research we do not mainly, and only concern with the preference aggregation methods as it is usually done in the GRSs research [Mas15]. Instead, our approach has been a quite unique one as our starting point was not only the computer science literature, but also the literature from the social disciplines (i.e., psychology, sociology, etc.). Hereby, a short summary, together with the main conclusions of the presented studies are provided.

In **Chapter 2**, a detailed literature review is presented. We started with the travel and tourism domain and its main challenges for the personalization systems. Then, the basic RSs approaches were introduced, together with some examples for the tourism domain. This led to the detailed literature review of the GRSs, and again the applications in the tourism domain. Finally, a theoretical background, from the social science disciplines, about the group dynamics and decision-making process, group and individual behavior and characteristics is provided. This background enabled us to define a three-phases data collection procedure, covering various aspects considered as relevant for understanding group decision-making process with a use case in the travel and tourism domain.

In **Chapter 3**, we described in detail the data collection procedure, and the collected data. The result of the two procedure implementations were the two data sets, INSTANCE1 and INSTANCE2. INSTANCE1 consists of 200 participants organized in 55 groups, and the INSTANCE2 data set of 150 participants organized in 41 groups. The data sets contain:

1. Pre-discussion information which includes: participants' individual explicit preferences (i.e., ratings/rankings) and experience/knowledge about ten destinations, implicit travel-related preferences (i.e., eight travel types/factors obtained with a principal component analysis carried out upon the 30 questions for evaluating 17 Tourism Roles

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of Yiannakis and Gibson [YG92, GY02]), personality traits (i.e., Big Five factors [Gol90], and social relationships within the group.

2. Information about group discussions (i.e., descriptions of the decision-making process provided by participants).

3. Post-discussion information: participants' satisfaction with the group choice, perceived difficulty of the decision-making process, group identification level (i.e., happiness with belonging to a particular group), perceived similarity of the group preferences, and the overall feedback about the task.

Chapter 4 presents the first study with the collected data, focusing on the role of group members' individual preferences, which was organized in three sections:

- In the first part of this chapter, we show that majority of participants who did not have their most preferred options selected as the group choice were still satisfied with the decision. On the other hand, a small part of participants were dissatisfied regardless of the group choice. Therefore, this analysis supported and motivated the hypothesis that individuals' choice satisfaction is not simply a function of individual preferences and group choice, but that it might depend on various individual and group characteristics.

- In the second part of this chapter, we showed that high diversity of group members' preferences has a negative effect on the individuals' "well being", and on the group performance. However, it does not necessarily mean that members of highly diverse groups will be unsatisfied with the group choice - even though choice satisfaction was decreased in diverse groups, majority of participants were not unsatisfied (i.e., their satisfaction level was lower but not beneath the mid-point of the satisfaction measurement scale). Moreover, an important message conveyed by this analysis is that we need different group diversity measures in order to be able to recognize different effects that group diversity might have.

- Finally, in the third part of the chapter, our results indicated that weighting group members' preferences according to their centrality in the group preference network (i.e., network built upon pairwise similarities of the group members' explicit preferences about the ten destinations) consistently improves the performance (precision) of the standard preference aggregation strategies when predicting group choices. Moreover, non-linear (exponential) remapping of group members' individual preferences before aggregating them into a group model, also improves the performance of the standard preference aggregation strategies when predicting the first group choice, but not the second.

Next, in **Chapter 5**, the focus was on the function of personality in the group decision-making process. We illustrate that members' satisfaction levels with the group choices were related to their personality traits. Namely, highly satisfied participants overall were more open to new experiences, agreeable, emotionally stable, and they scored higher on the *Beach and Party Lover* travel factor (i.e., a role that taps into relaxing, sunbathing, partying and enjoying with friends) than the unsatisfied participants. At the group level, the result indicates that mixed groups manage to come to an agreement

that satisfies almost all the group members equally, and they manage to decrease the discrepancy between those who won and those who lost the most in the decision-making process. At the both levels, individual and group, it was clear that the passive players in the decision-making process (i.e., avoiders as defined by the Thomas-Kilmann conflict resolution styles) were highly satisfied with the final travel destination when it matched their own initial preference, but were extremely dissatisfied with the collectively chosen travel destination in case of a mismatch with their initially disclosed preferences. This result has some serious implications for the future designers of the decision-support systems. Clearly, the passive participants could be a potential "danger" for the GRS and the satisfaction of the group as a whole. Therefore, the system should specifically take care that these members are actively participating in the group discussion, in order to make sure that they do not fall into the dissatisfaction.

In **Chapter 6**, the results indicate that socially central members of the group are perceived as more influential, but they do not *"win"* more often in the group decision-making process. Moreover, social relationships are a useful indicator of the group identity level that members feel about each other, while social closeness of the group is even related with how the members' perceive their group to be similar in terms of preferences. Furthermore, it is demonstrated that socially central group members are significantly more satisfied with the group choice, even when they are the *"losers"* in the decision-making process. Finally, it is showed that socially close groups make better group decisions.

With the three analyses, we investigated the individual relationships that the preferences (explicit and implicit ones), personality and social relationships have with the group decision-making process. The obtained results surely brought us to many new findings, however, with a model that captures direct and indirect effects that these concepts have on the group members' choice satisfaction and their performance in the decision-making process (Individual Loss), facilitate even better understanding of the group decision-making process.

In **Chapter 7**, with the conditional process analysis we modeled the combined effects, and we showed that:

- Group members' centrality in the group preference network decreased members' loss (IL) in the decision-making process, and in a direct, and an indirect path (i.e., through the individual loss) increased the choice satisfaction. However, the direct effect became insignificant when a member was happy with being a part of a particular group.

- Diversity of preferences, of course, increased group members individual loss in the decision-making process, but not for members who scored high on the Conscientiousness personality trait.

- Group members with greater knowledge about the ten destinations managed to decrease their loss in the group decision-making process.

- Emotional stability had a direct effect on the choice satisfaction, as shown in Chapter 5, while the other personality traits became insignificant in a single model that captured the combined effects.

Finally, in **Chapter 8**, we focused on a different goal, and analysed the relationship between certain group characteristics and the characteristics of the group decision-making process itself. The results demonstrated that a decision-reaching technique that a group adopted to decide on a travel destination to visit together can be predicted with two group characteristics, i.e., Conscientiousness personality trait aggregated at the group level, and group diversity of the implicit travel preferences (the eight travel types/factors). Moreover, significant correlations were identified between group characteristics and the characteristics of the group decision-making process. This finding is a strong motivator that decision support systems should also adapt how the decision-making support is provided to a group based on the characteristics of that group.

9.1   Research questions

Hereby, the answers for the research questions stated in the introduction chapter are provided and elaborated.

RQ 1 What is the role of the group members' explicit preferences in the travel-related group decision-making process? To answer this question, additional three questions were defined:

> **RQ 1.1 What is the relationship between the match-mismatch between member's individual preferences and the group choice, and the choice satisfaction of that member?** The match-mismatch between group members' individual preferences and the group choice, as expressed with the individual loss variable (IL) is negatively correlated with the choice satisfaction. Nevertheless, this correlation was only moderate in its magnitude, and the analysis indicated that majority of participants were satisfied regardless of the group choice. The conditional process analysis, in Chapter 7, also showed a moderate direct effect of the individual loss on the choice satisfaction. Therefore, we can answer that the match-mismatch between individual and group preferences directly, and moderately affects the choice satisfaction.

> **RQ 1.2 How does the composition of members' preferences relate to group members' "well-being" and their performance in the decision-making process?** The composition of group members' preferences was analysed in the form of group diversity. In this manner, we concluded that when group members were found in highly diverse groups, they tended to be less satisfied with the group choice, they perceived the decision-making process as more difficult, and they were less happy with belonging to that particular group. With respect to the group performance in the decision-making process, diverse groups had significantly higher mean individual loss, and they increase the difference between the "winner" and the "loser" of the process. Finally, the conditional process analysis showed that group diversity had a direct and positive effect on the individual loss. Therefore, we can say that composition of members' explicit preferences, expressed as the

group diversity, decreased group members' "well-being", increased individual loss, and deteriorated group performance in the decision task.

RQ 1.3 Can we use network structures of preferences within the group to better predict the actual group choices? We compared the performance of the state-of-the-art methods with the proposed approach. The first approach used the degree centrality of the members in the group preference network, to weight group members' preferences in a group preference model. The obtained results indicate that network structure consistently improve the performance of the state-of-the-art methods when used to predict group choices.

RQ 1.4 Can we use non-linear transformations of preferences to better predict the actual group choices? To answer this question, we again compared the state-of-the-art approaches with the proposed method. This method used an exponential remapping of the group members' explicit preferences, to emphasize the importance of top-rated/ranked options. With the obtained results we observed that the non-linear remapping only partially improved the performance of the state-of-the-art methods when used to predict group choices.

RQ 2 What is the role of personality in the group decision-making process? Again, in order to answer this question we define a set of sub-questions:

RQ 2.1 How is the personality, and the travel type of a member related to her satisfaction with the group choice? In our analysis, we defined satisfied and unsatisfied group members, as well as "winners" and "losers" of the decision-making process. By comparing the differences in personality traits scores in these categories, we came to conclusion that group members with a "positive" personality, i.e., open to new experiences, agreeable, emotionally stable, and collaborative, were generally more satisfied with the group choice, regardless of what that choice was. However, for the "passive" players, the satisfaction was determined by the group choice, and whether that choice complied with their personal preferences.

RQ 2.2 How does the group personality composition relate to the performance of that group in the decision making-process? Relying on the findings of the previous research [WB08], we firstly calculated the conflict resolution styles of our group members, from their Big Five personality traits. Then, we investigated the differences in performance between groups with different compositions of Thomas-Kilmann conflict resolution styles (i.e., collaborating, accommodating, competing, avoiding). We defined five types of groups, four for each of the resolution styles, and one that represented a mixed group. With the obtained results, we came to conclusions, 1) groups with majority avoiders tend to perform the worse in the decision-making process, as they have the greatest different between the most satisfied and the least satisfied group member; and 2) mixed groups (i.e., groups with members of various conflict resolution styles) tend to perform the best in the decision-making process, as they have the smallest difference in the loss of "winners" and "losers" of the process.

Therefore, personality of group members, and the personality composition within the group, plays a significant role in group members' choice satisfaction, as well as, in group performance in the decision-making task.

RQ 3 What is the role of the social relationships within the group for the group decision-making process?

RQ 3.1 Are socially central members of the group perceived as more influential in the decision-making process? Categorizing the members' as socially central and non-central in the group, and testing the difference between the two categories, we observed that socially central group members are perceived as more influential in the decision-making process.

RQ 3.2 Are socially central members of the group actually more influential in the decision-making process? Even though socially central members were perceived as more influential by their fellow group members, we found no evidence that they managed to have "their way" more often, since we found no difference between socially central and non-central members in the extent of their Individual Loss when it comes to the actual group choice.

RQ 3.3 Can we use social relationships within the group as an indicator of the members' level of identification with the group (i.e., group identity as defined by the social identity theory)? A significant, and strong correlation was identified between reported group identity of the participants and the social closeness that the members felt for each other. Moreover, the non-parametric tests showed that in socially close groups, participants tend to report significantly higher group identity. Thus, we can say that social relationships within a group can be used as an indicator of the group identity.

RQ 3.4 Is the social structure of the group related to the group members' perception of their preference similarity? With the non-parametric tests, which evaluated the differences between socially close and non-close groups, as well as, between the socially central and non-central group members, we concluded that socially central group members, and members of socially close groups perceive their groups differently in terms of preferences, but we did not find enough evidence to show that they perceive their groups as more similar than the non-central group members, and the members of the non-close groups. In the same analysis, we also tested whether the preferences were more similar for socially close groups, and the non-parametric tests showed that socially close groups actually had more diverse preferences than the non-close groups.

RQ 3.5 Are socially central members of the group, and socially close groups happier with the outcomes of the decision-making process? Indeed, the analysis showed that socially central group members and socially close groups were significantly happier with the group choice.

RQ 4 How can we model the combined effect of the preferences, personality and social relationships on the group members' satisfaction with the outcome

of the group decision-making process? In order to evaluate the effect that the three constructs (i.e., preferences, personality and social relationships) had on the group decision-making process, we employed the conditional process analysis, and the assumptions about the model were obtained from the results of the previous findings. The analysis was carried out with the INSTANCE1 data set, and the results indicated that: 1) the personality should be modeled as a direct effect on the choice satisfaction; 2) the group members' preferences position should be modeled with a mediating effect, having a direct, and an indirect (via group members' individual loss in the decision-making process) path from the group members' centrality in the group preference network to the choice satisfaction; and 3) the strength of social closeness should be modelled as a moderator of the group members' preferences centrality effect on the choice satisfaction.

RQ 5 How do the group characteristics relate to the group decision-making process?

RQ 5.1 How can we characterize group decision-making process? In the post-questionnaire, participants provided descriptions of their group decision-making process. With a qualitative analysis we were able to extract four main characteristics (descriptors) of the group decision making process. The first descriptor tapped into how was the overall process organized (structured, semi-structured, or unstructured); the second descriptor captured how did the group members disclose their individual preferences (by rating/ranking the options, by providing their top-choices, by providing their absolute "no-goes", or by expressing their general, subjective opinions); the third descriptor showed how did the group members reach their final decision (by aggregating ratings/rankings, by voting, or by reaching a consensus); and finally the fourth descriptor of the decision-making process illustrated how did the group behave during the process (they were either completely task-oriented, collaborative, or in between the two behaviours).

RQ 5.2 Is there a relationship between group characteristics and the characteristics of the group decision-making process? With a correlation analysis multiple significant correlations were identified between the characteristics of the decision-making process and the characteristics of the group, i.e., organization of the process was significantly correlated with the group diversity; preference disclosure technique with the strength of group identity; decision-reaching technique with the group personality, and group diversity with respect to the implicit preferences (travel types/factors); and group behaviour type also with the strength of group identity.

RQ 5.3 Which group characteristics can be used to predict a decision-reaching approach that a group adapts? Using the discriminant analysis two group characteristics were identified as significant for predicting a decision-reaching technique that the group adopted, i.e., the group score on the Consciousness personality trait, and the group diversity of the members' implicit preferences (i.e., the eight travel types/factors). With the two group characteristics, the classification accuracy of 70% was achieved.

9.2 Contributions and implications

Hereby, we will summarize the contributions of the thesis, and discuss their implications for the GRSs:

- First of all, it is of great importance to emphasize the methodological contribution of the thesis. Namely, in our best knowledge, we have not yet seen a research which collected such a rich, multidimensional data, including preferences, personality, travel types, social relationships, group diversity, etc., that enables a variety of views on a single issue - the group decision-making process with the use case in the travel and tourism domain. Moreover, the three-phases study structure allowed us to have a more comprehensive overview of the process, and to observe participants before, during and after their discussions. The usage of observational data can help in the construction of a more dynamic model of recommendations that integrates preference information derived by the observation of the discussion process into the baseline user preference model. Actually, it is clear from our studies that the final group choice is not completely determined by the initial preferences of the group members, i.e., the preferences expressed while evaluating domain items without any reference to or influence of the group. We conjecture that the observed dynamics of within group interactions must be carefully considered in order to better predict which items may suit the group. This data can also be used to identify a better aggregation strategy, as we showed in Chapter 8. However, we also hypothesize that this type of information can be exploited to revise the initial user preferences learned by the system using the historical preference data of the users. For instance, if a content based model was fitted to the known ratings of a user, this model can then be revised by considering the items that the user liked or criticized during the group discussion. As a matter of fact, a mobile system called STSGroup motivated by our study has been implemented and presented in [NR17c]. The system allows group members to be engaged in a group discussion where they can exchange messages together with proposing items that are thought to be suitable for their group and react to other group members' proposals by giving feedback such as likes, dislikes or best-choice. The interactions between the members and the system during the group discussion are monitored and taken into account in order to provide appropriate recommendations and choice suggestions for group members. The group recommendations are accompanied by explanations that are computed on the base of the group members' actions and contexts. Hence, this system builds upon the observational study, and it convincingly demonstrates 1. the importance of the study scope and focus in the area of GRSs; and 2. why the research in the area of GRSs needs more similar studies that better tackle into the behavior of users and not only preferences.

- Our second contribution taps into **the role of group members' individual preferences in the group decision-making process**. First of all, the analysis indicated that yes, match/mismatch between individual and group preferences is a predictor of choice satisfaction, but contrary to the current GRSs research assumptions that it is an

exclusive determinant of the group members' choice satisfaction. This is an important lesson for future research in the area of GRSs - we cannot simply focus on the preference aggregation techniques as the sole challenge of GRSs, and we cannot assume that an option that is a middle ground of group members' preferences to be a satisfying solution for each and every group. This was also confirmed with our proposed alterations of the state-of-the-art aggregation strategies which weighted group members' individual preferences according to their importance in the group preference network (an edge in a group preference network represents preference agreement between pair of group members). The method strongly emphasized the importance of individual top-choices and managed to predict group choices better than the unaltered, state-of-the-art methods. Furthermore, we showed that diversity of group members' preferences does have a negative effect on the group performance and the group members' "well-being" in the decision-making process, but this effect was only mild in its magnitude. This is as well a contradiction to the current assumptions that conflict is bound to arise and that satisfaction of group members will significantly deteriorate. In fact, the opportunistic behaviour of group members is often disregarded, especially in the case of travelling and tourism - people form groups because they want to be in those groups and they are willing to make certain compromises in order to stay a part of the group.

- The third contribution is about **the function of group members' personality and social relationships within the group in the decision-making process**. We demonstrated that the main effect is actually embodied in the group members' satisfaction with the group choice. Again, even though the theory of personality and social networks suggests that sources of influence in a group can be identified with the help of group members' personality types and their social position in the group, we found no evidence that some personality types, nor socially central members were more influential than the others (i.e., they did not manage to have their top preferred options selected as the group choice). This is yet another important lesson for the GRSs. Several approaches use personality and social relationships as measures of influence in the preference aggregation strategies, and in our specific context we illustrated that this cannot be done. However, the results do support the use of personality and social relationships in the GRSs, and preferences aggregation strategies, but in a different manner, i.e., personality and social position of a group member can be used as an indicator of that member's resilience to the dissatisfaction, caused by discrepancy between her preferred options and the option chosen by the group. Hence, we can take care that none of the group members becomes dissatisfied with the group choice (recommendations), but in an adaptive way, by accounting for group members' individual susceptibility to dissatisfaction.

- Another contribution of the thesis is the model that **combines the effects of preferences, personality, and social relationships on the choice satisfaction of the group members**. We showed that preferences have a direct and an indirect (i.e., mediating) effect on the choice satisfaction, the personality only the direct effect, while social relationships had a moderating effect on the direct connection between

preferences and the choice satisfaction (i.e., preferences become irrelevant when a group is socially close). Moreover, the model indicated that experience, personality and group preference diversity are predictors of group members' individual loss in the decision-making process. In terms of GRSs, we confirm our assumption that a group recommendation approach has to include all these different aspects in order to evaluate what kind of effect an item being recommended to a group will cause, in the other words, will the item be accepted by a group, or not.

- Our final contribution is about **characterizing the group decision-making process and identifying group characteristics as determinants of the undertaken characterized approach**. The main conclusion of this contribution is that certain group characteristics can be used and should be used to adapt the system support that a group receives for their group decision-making process, and that actually different phases of that process can be personalized according to the group at hand. One of the main tasks of GRSs is to support groups to reach their final decision, and with this respect, we demonstrated that the support should as well be personalized.

With the results of our analyses and the listed contributions we shed some light on to the question, what should be considered and what counts when designing an efficient group recommender that delivers acceptable and satisfying recommendations for all group members.

9.3 Limitations and future work

We are well aware of the limitations of this work. Firstly, even tough our data sets are unique, containing information about individual preferences, group choices and various other aspects evaluated throughout the thesis, we can surely say that the size of those data sets is the main limitation of this work. Clearly, it would be utmost compelling to evaluate our initial results using larger data sets, also in different domains. This is of course one of the goals of our future work.

Moreover, our data collection procedure is not the one that can scale (i.e., participants filling in questionnaires, and observing the group decision-making process), therefore to collect the data in the future the first step would be to develop a system (e.g., a GRS) that allows us to capture not only individual preferences and group choices, but as well personality, relationships within the group, travel types, and to observe the decision-making process. To this end, in our future work we plan to use the results of the thesis, in order to generalize the seven-factor model and the picture-based approach of Neidhardt et al. [NSSW14, NSSW15] to a group recommendation approach. Additionally, even though our data collection procedure cannot scale as an automated procedure could, we do plan to make an open data platform, where we would provide an extensible procedure details, and all the templates that we used to collect the data, together with an access to the already collected data. In this way, we hope that different research groups could have a look at the problem from their own particular perspective accounting for

their own interests in the topic, therefore inviting more research as the one presented in this thesis. Also, we have not had a chance to have a look at the cultural differences that may occur in such a group decision-making task and setting. By making this platform, and having research groups from different parts of the world participating in such a study, we would open the door to such a possibility.

Furthermore, when it comes to the analyses presented in the thesis, the last two chapters (i.e., Chapter 7 and 8) demonstrate results obtained only for the INSTANCE1 data set. Our plan is to extend these analyses, and to evaluate the obtained results on the INSTANCE2 data set. Also, it is essential to note that our analyses and results do not imply any causal relationships, but they do indicate that the overall setting of the issue is a multidimensional "cube" of interrelated variables. Therefore, the discussion about values of these variables, their relationship, and their "impact" makes a basis for GRSs.

Finally, in the thesis we have introduced a group preference model, and methods to predict group choice (in Chapter 4, section 4.3.1) that account for the group members' individual preferences only, disregarding other aspects that we evaluated, e.g., diversity, personality, social relationships, etc. In the future, the objective would be to combine these aspects in a group preference model, and in a method for predicting group choices (i.e., for delivering group recommendations). As previously mentioned, the approach that we plan to implement differs substantially from the existing ones, as instead of identifying sources of influence in the group, and weighting the importance of group members' preferences accordingly, we would actually work on identifying group members' susceptibility to dissatisfaction, based on their personality, and social position in the group (etc.), and accordingly deliver recommendations to make sure that no member of the group ends up being dissatisfied.

An immense amount of work has been done in this thesis, however this is only a top of the ice berg when it comes to fully understanding the group behavior, the group decision-making process with a use case in the travel and tourism domain, and how we could design systems that would effectively help groups in this particular context.

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Pre-Questionnaire (INSTANCE1)

Presurvey Tourist roles

Welcome to a survey that explores group decision making behavior in travel and tourism. It is the result of a collaboration of several academic institutions that has been initiated by TU Vienna. It serves as a pre-survey for a study on decision making of tourists that is conducted in the context of courses held at different universities.

The answers you give will be kept private and serve only the purpose of an aggregate analysis.

There are 12 questions in this survey

Demographics

1 [UNI] To which University do you belong to? *

Please choose **only one** of the following:

○ Haifa
○ Bozen-Bolzano
○ TU Vienna
○ Klagenfurt
○ Delft
○ Other [ ]

2 [StudentID] Please provide your studentID *

Please write your answer here:

[ ]

3 [Gender] What is your gender? *

Please choose **only one** of the following:

○ Female
○ Male

4 [Age] What is your age? *

Please write your answer here:

[ ]

Tourist roles 1

6 [TR1] To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I am original, come up with new ideas	○	○	○	○	○
I am curious about many different things	○	○	○	○	○
I am ingenious, a deep thinker	○	○	○	○	○
I have an active imagination	○	○	○	○	○
I do a thorough job	○	○	○	○	○
I am a reliable worker	○	○	○	○	○
I do things efficiently	○	○	○	○	○
I make plans and follows through with them	○	○	○	○	○
I am full of energy	○	○	○	○	○
I generate a lot of enthusiasm	○	○	○	○	○
I have an assertive personality	○	○	○	○	○
I am outgoing, sociable	○	○	○	○	○
I am helpful and unselfish with others	○	○	○	○	○
I have a forgiving nature	○	○	○	○	○
I am generally trusting	○	○	○	○	○

7 [TR2] To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I like to cooperate with others	○	○	○	○	○
I seldom feel blue	○	○	○	○	○
I am relaxed most of the time	○	○	○	○	○
I am not easily upset	○	○	○	○	○
I remain calm in tense situations	○	○	○	○	○
When I go on vacation I mostly relax and sunbathe	○	○	○	○	○
On vacation I go to warm places with lots of sun, sand, and ocean	○	○	○	○	○
On vacation I spend most of the day on the beach, go out every night, drink with friends, and do crazy things	○	○	○	○	○
On vacation I try to meet people of the opposite sex for uncomplicated romantic experiences	○	○	○	○	○
I enjoy meeting the local people, trying the food, and speaking the language	○	○	○	○	○
On vacation I try to get to know the ways of the culture, and generally avoid the regular tourist route	○	○	○	○	○
I visit museums which house archaeological artifacts from ancient sites and civilizations	○	○	○	○	○
Visiting the sites, and studying the history of ancient civilizations have a special meaning for me	○	○	○	○	○
When I go on vacation I leave all the planning, hotel reservations, organized tours, etc., to my travel agent	○	○	○	○	○
I take packaged vacations and organized tours	○	○	○	○	○

8 [TR3] To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I participate in activities involving an element of risk such as sky diving, rock climbing or ski jumping	○	○	○	○	○
I engage in risky/exhilarating activities which provide me with emotional highs	○	○	○	○	○
I go on adventure travel such as a hike down the Grand Canyon, jungle treks, and the like	○	○	○	○	○
I explore out of the way places and enjoy the challenges and hardships involved in getting there	○	○	○	○	○
I go to exclusive night clubs, attend yacht parties, and socialize with celebrities	○	○	○	○	○
I vacation in elite, exotic, or out of the way world class resorts such as Monte Carlo, Tahiti, or the French Riviera	○	○	○	○	○
For me, vacations are a sort of a spiritual quest in which I try to discover knowledge about my roots, history, or traditions	○	○	○	○	○
My purpose in travel is to explore the meaning of life and what I can learn about myself	○	○	○	○	○
I visit regular tourist attractions but I avoid packaged vacations and organized tours	○	○	○	○	○

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
While I leave some of my travel arrangements to my travel agent, I plan my own route/destination, make my own hotel reservations, and often play it by ear	○	○	○	○	○
I stay in first class hotels, go to shows and dine at the best restaurants	○	○	○	○	○
I travel first class, and stay at the best luxury resorts	○	○	○	○	○
I try to make it on my own, living with the local people, and often take jobs to keep myself going	○	○	○	○	○
I drift from place to place living a hippy style existence	○	○	○	○	○
On vacation I take it easy getting away from it all	○	○	○	○	○

Tourist roles 4

Preferences

9 [TR4] To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I head for places that are quiet and peaceful such as a deserted beach, a cabin in the hills, etc	○	○	○	○	○
On vacation I stay physically active engaging in my favorite sports	○	○	○	○	○
I go on vacation mostly to engage in my favorite sports (e.g. tennis, sailing, golf, skiing, hunting, etc.)	○	○	○	○	○
I participate in planned study programs which may include lectures, workshops, and the like	○	○	○	○	○
I take educationally oriented vacations that enable me to study and/or acquire new skills and knowledge	○	○	○	○	○

10 [CITY_TIMES] How many times have you been in each of the following cities? *

Please choose the appropriate response for each item:

	0	1	2	3	More than 3
Amsterdam	○	○	○	○	○
Berlin	○	○	○	○	○
Copenhagen	○	○	○	○	○
Helsinki	○	○	○	○	○
Lisbon	○	○	○	○	○
London	○	○	○	○	○
Madrid	○	○	○	○	○
Paris	○	○	○	○	○
Rome	○	○	○	○	○
Stockholm	○	○	○	○	○

11 [Rank] How much would you like to visit following destinations? Rate them on a scale from (1) to (5), where (1) means not attractive and (5) means highly attractive. *

Please choose the appropriate response for each item:

	1	2	3	4	5
Amsterdam	○	○	○	○	○
Berlin	○	○	○	○	○
Copenhagen	○	○	○	○	○
Helsinki	○	○	○	○	○
Lisbon	○	○	○	○	○
London	○	○	○	○	○
Madrid	○	○	○	○	○
Paris	○	○	○	○	○
Rome	○	○	○	○	○
Stockholm	○	○	○	○	○

12 [CRITERIA] Which aspects are most important to you when you decide on a travel destination? *

Please number each box in order of preference from 1 to 6

	Distance
	Weather
	Sightseeing
	Budget
	Social Activities
	Other

Decision-Making Task (INSTANCE1)

Group members' decision making tasks

Instructions

1. **Inform yourself about destinations**

Consider the following destinations: Amsterdam, Berlin, Copenhagen, Helsinki, Lisbon, London, Madrid, Paris, Rome and Stockholm. Inform yourself autonomously about each destination using following links:

- https://en.wikipedia.org/wiki/Amsterdam
- https://en.wikipedia.org/wiki/Berlin
- https://en.wikipedia.org/wiki/Copenhagen
- https://en.wikipedia.org/wiki/Helsinki
- https://en.wikipedia.org/wiki/Lisbon
- https://en.wikipedia.org/wiki/London
- https://en.wikipedia.org/wiki/Madrid
- https://en.wikipedia.org/wiki/Paris
- https://en.wikipedia.org/wiki/Rome
- https://en.wikipedia.org/wiki/Stockholm

2. **Group decision task**

Please read the following scenario:

*Imagine that you are working on a research paper together with the other group members. Interestingly, your university offers you the opportunity to submit this paper to a conference in Europe. If the paper gets accepted, **the university will pay** to each group member the trip to the conference. In addition, you **will be able to spend the weekend after the conference at the conference destination to do some sightseeing**.*

Ten conferences will take place in European capitals around the same summer period. Content-wise, these conferences are similar; the key difference is their location in Europe. The locations are: Amsterdam, Berlin, Copenhagen, Helsinki, Lisbon, London, Madrid, Paris, Rome and Stockholm.

Your <u>*task*</u> is to decide to which conference (destination) you will submit your paper, and what would be your second choice (in case the first choice would not be feasible for some unexpected reason)? **The decision process should not take more than 30 minutes.**

The observers of the group should not be involved in the decision making process. During the group meeting the observers' task will be to fill out their (previously provided) observers' report and to audio-record the group discussion. In order to audio-record, the group members are asked to sign a consent form.

Observers' template (INSTANCE1)

OBSERVATION OF GROUP ACTIVITY

(*Observer's template*)

1. Did the group's members set temporal plan for the process? (*Mark only one option*.)

  ☐ Yes

  ☐ No

2. How much time did the group members intend to spend on the **orientation**? (in "minute" unit)

   (*Only use if the answer of the question 1 is Yes*)

3. How much time did the group members intend to spend on the **discussion**? (in "minute" unit)

   (*Only use if the answer of the question 1 is Yes*)

4. How much time did the group members intend to spend on the **decision**? (in "minute" unit)

   (*Only use if the answer of the question 1 is Yes*)

5. How much time did the discussion **actually** take? (in "minute" unit)

6. How fast the decision was made? (*Mark only one option.*)

  ☐ Less than 5 minutes

  ☐ From 5 to 10 minutes

  ☐ More than 10 minutes

7. Did the group members play different types of roles? (E.g. leader, follower, or information seekers, etc.) (*Mark only one option*.)

  ☐ Yes

  ☐ No

8. What is the role of each member played in the group?

   (*Only use if the answer of the question 7 is Yes*)

   User 1's role:

   User 2's role:

User 3's role:

User 4's role:

BEHAVIOR PART

Please count each unit of interaction and classify them into the most appropriate category.

9. **Behavior of Group member 1 (Name:)**

   Corresponding to each category, please specify the number of actions undertaken by this user.

   Tick all that apply.

   ○ C1_Show solidarity / "Friendly"   (the number of the action: times)

   ○ C2_Show tension release   (the number of the action: times)

   ○ C3_Agree   (the number of the action: times)

   ○ C4_Give suggestion   (the number of the action: times)

   ○ C5_Give opinion   (the number of the action: times)

   ○ C6_Give information   (the number of the action: times)

   ○ C7_Ask for information   (the number of the action: times)

   ○ C8_Ask for opinion   (the number of the action: times)

   ○ C9_Ask for suggestion   (the number of the action: times)

   ○ C10_Disagree   (the number of the action: times)

   ○ C11_Show tension   (the number of the action: times)

   ○ C12_Show antagonism / "Unfriendly" (the number of the action: times)

10. Behavior of Group member 2 (Name:)

Corresponding to each category, please specify the number of actions undertaken by this user.

Tick all that apply.

○ C1_Show solidarity / "Friendly"   (the number of the action: times)

○ C2_Show tension release   (the number of the action: times)

○ C3_Agree   (the number of the action: times)

○ C4_Give suggestion   (the number of the action: times)

○ C5_Give opinion   (the number of the action: times)

○ C6_Give information   (the number of the action: times)

○ C7_Ask for information   (the number of the action: times)

○ C8_Ask for opinion   (the number of the action: times)

○ C9_Ask for suggestion   (the number of the action: times)

○ C10_Disagree   (the number of the action: times)

○ C11_Show tension   (the number of the action: times)

○ C12_Show antagonism / "Unfriendly" (the number of the action: times)

11. Behavior of Group member 3 (Name:)

Corresponding to each category, please specify the number of actions undertaken by this user.

Tick all that apply.

○ C1_Show solidarity / "Friendly"   (the number of the action: times)

○ C2_Show tension release   (the number of the action: times)

○ C3_Agree   (the number of the action: times)

○ C4_Give suggestion   (the number of the action: times)

○ C5_Give opinion   (the number of the action: times)

○ C6_Give information   (the number of the action: times)

○ C7_Ask for information   (the number of the action: times)

○ C8_Ask for opinion   (the number of the action: times)

○ C9_Ask for suggestion   (the number of the action: times)

○ C10_Disagree   (the number of the action: times)

○ C11_Show tension   (the number of the action: times)

○ C12_Show antagonism / "Unfriendly" (the number of the action: times)

12. Behavior of Group member 4 (Name:)

Corresponding to each category, please specify the number of actions undertaken by this user.

Tick all that apply.

○ C1_Show solidarity / "Friendly"   (the number of the action: times)

○ C2_Show tension release   (the number of the action: times)

○ C3_Agree   (the number of the action: times)

○ C4_Give suggestion   (the number of the action: times)

○ C5_Give opinion   (the number of the action: times)

○ C6_Give information   (the number of the action: times)

○ C7_Ask for information   (the number of the action: times)

○ C8_Ask for opinion   (the number of the action: times)

○ C9_Ask for suggestion   (the number of the action: times)

○ C10_Disagree   (the number of the action: times)

○ C11_Show tension   (the number of the action: times)

○ C12_Show antagonism / "Unfriendly" (the number of the action: times)

DECISION PART

13. Which social decision scheme was the group using?

☐ Delegating

☐ Averaging

☐ Voting

☐ Reaching consensus

☐ Other:

14. How willing the group members were to give up their first choice in order to reach the joint decision?

Group member 1:

Very unwilling   ☐   ☐   ☐   ☐   ☐   *Very willing*

Group member 2:

Very unwilling   ☐   ☐   ☐   ☐   ☐   *Very willing*

Group member 3:

Very unwilling   ☐   ☐   ☐   ☐   ☐   *Very willing*

Group member 4:

Very unwilling   ☐   ☐   ☐   ☐   ☐   *Very willing*

Observers' HOW TO (INSTANCE1)

MANAGING THE OBSERVATION OF GROUP ACTIVITY
(*This document is based on Bales Interaction Process Analysis - IPA*)

REQUIREMENT

The observer is required to identify a "unit" of interaction. According to a basic definition proposed by Bales, a "unit" can be a single simple sentence or its equivalent. If a complex sentence is containing an independent clause and at least one dependent clause or a compound sentence joined by "and", "but" and so forth is used, the observer should fragment it down into the small "units".

In addition to speech, the "unit" of interaction also includes:

- Facial expressions
- Gestures
- Body attitudes
- Emotional signs
- Nonverbal acts of various kinds

Once having the set of categories in mind, the observer listens and watches for the smallest "unit" of interaction (either verbal or nonverbal) so that this enables him/her to make a score in one of the categories of the IPA system.

GROUP DECISION PROCESS

Group decision process is composed of four phases:

1) **Orientation** (In this phase the group defines the problem that needs to be discussed and decided. Also, they define the process or approach that they will be following during the discussion.)
2) **Discussion** (In this phase the group acquires, exchange and process information.)
3) **Decision** (Decision is reached by using a certain social decision scheme. Social decision scheme is a strategy to combine individual inputs into the single group decision, e.g. voting)
4) **Implementation** (In this phase decision is implemented and evaluated.)

DOCUMENT ("Observers' template")

Time taken for executing the various steps

1

1) Did the group members set temporal plan for the process? If so, how much time did they intend to spend on orientation? discussion? and decision step?
2) How much time did the discussion take?
3) How fast the decision was made?

Role of each member

4) Did the group members play different types of role such as leader, follower, or information seekers, etc.?
   - A leader is the one in the group who is responsible for ensuring the harmonization and often guides other members by unifying, directing, coordinating, supporting and motivating their efforts.
   - A follower is a person who takes actions under the control or instruction of a leader or tries to coordinate his / her actions with those of a leader.
   - Information seekers / information givers are people who are responsible for providing and asking for the relevant information about destinations.
   - Opinion seeker / giver: Asks for more qualitative types of data, such as attitudes, values, and feelings / provides opinions, values, and feelings
   - Initiator/contributor: Recommends novel ideas about the problem at hand, new ways to approach the problem, or possible solutions not yet considered
   - Compromiser: Shifts his or her own position on an issue in order to reduce conflict in the group
   - Dominator: Asserts authority or superiority; manipulative
   - Playboy/girl: Uninvolved in the group; cynical, nonchalant

Criteria discussed

5) What was the preference of each member, and their reasons?
   For example:
   - User 1: Rome; reason: food, weather etc.
   - User 2: Madrid, reason: Real Madrid fan
   - User 3: Paris, reason: shopping

Behavior

Please count each unit of interaction and classify them into the most appropriate category, according to the category descriptions shown below.

Category	Description	Example	Note
1. Show solidarity / "Friendly"	+ Showing hospitality, sympathy or similarity of feeling + Indicating of being attracted, demonstrating affection + Expressing of desire for cooperation or solidarity + Showing a protective or nurturing attitude + Praising, rewarding, approving or encouraging others + Reassuring a person having difficulty + Complimenting, congratulating + Confiding in another + Expressing gratitude or appreciation + Surrendering or giving into another + Friendly submission so that another can go ahead + Confession of ignorance + Apologizing, or smiling directly at another + Offering to undertake a job on behalf of others + Offering assistance, time, energy, money		
2. Show tension release	+ Showing cheerfulness, satisfaction, enjoyment, relish, pleasure, delight or happiness or any of act indicating that the member is thrilled, elated or excited + Giving joke or laughs (*)		(*) This kind of act may contain the hidden meaning or emotional implications. The joke or laughter is very common form of interaction, but it is not always too clearly. Behaviors such as shrugs or facial expression portraying surprise, or fear seem to be risky, dangerous and better avoided.
3. Agree	+ Showing accord, agreement reflecting through either verbal or nonverbal expression	+ Nodding head, thumb up + "I see", "Yes" or "M-hmn" + "That's the way I see it too" + "I think you're right" + "Yes, it is true" + "Exactly" or "Precisely" + "I feel the same way you do"	

		+ "I hope so"	
4. Give suggestion	+ **Mentioning a problem to be discussed** + **Pointing out the relevance of a remark** + Calling a meeting to order + Referring to the agenda + **Persuading members** to do some actions or **urge him/her to do something** + Opening a new phase of activity or new focus of effort +Signifying the end of a phase of activity	+ "Next I want to call your attention to the distance issue" + "Come back to the main topic, please" + "Do you see?" + "Don't you think we should consider the weather first?" + Why don't we write down all preferences of each member and find out which one is overlapped?	If there is any negative feeling is detectable besides the suggestions, it should be scored in the Category 12: "Show Antagonism/Unfriendly". Similarly, it should be placed under Category 1: "Show Solidarity/Friendly" if any appreciable positive feeling is present.
5. Give opinion	+**Showing value judgment, inference** +Affirm belief, moral obligation +Stating policy, intention, guiding principle or law +Referring to indefinite future time perspective	+ "I think we ought to be fair about which place will be chosen", + "I hope we can find 3 interesting sites in Paris to visit" + "It seems right to me that London does not have many fascinating activities to join" + "In this group, we should share our opinions" + "I always believe / feel that Amsterdam is the most beautiful place to visit in spring"	
6. Give information	+ **Reporting factual (not necessarily true), verifiable (testable) observations or experience** + Giving statements that are easily confirmed by observation or generally recognized	+ "It would take 4 hours to get there" + "Traffic jams are always happening in…" + "The weather in Amsterdam at this time is not good"	This category should be distinguished with Category 5: "Give Opinion". These statements that are objective, not much emotionally toned, not vague and in principle are testable will be classified into this category. Otherwise, they should be stored under Category 5: "Give Opinion".

7. Ask for information	+ **Questions requesting a rather simple factual**, descriptive, objective type of answer **than an evaluation, or the expression of feeling** + Questions about situations, tasks or about the group itself + Question may be direct or indirect	+ "What is about the public transportation in London?" + "How many hours can we spend there?" + I have forgotten what the weather in Paris is like. + "I'm not sure whom we can contact when we get there" + Have you ever been in London?	If the type of answer requiring guessing, supposing or looking forward in time to events that have not yet occurred, should be classified into Category 8: "Ask for Opinion".
8. Ask for Opinion	+ **Questions seeking value judgment, beliefs or attitudes**, or one person's insight + Questions that require a **diagnosis of a situation** + Questions that **attempt to encourage a statement of reaction, or freedom to express interest or disinterest**, or any predetermined answer	+ "Would you like to stay in hotels?" + "Would you like to travel to Munich?" + What do you think about Rome?	Although the statements are given in the question type such as "Don't you see we need to…?" or "Do you see?", they should be identified as persuasive effort, so they are properly stored in Category 4: "Give Suggestion".
9. Ask for Suggestions	+ **Requesting guidance in problem-solving process** + Indicating a feeling of confusion or uncertain about the position of the group regarding to its goals	+ "I don't know what to do" + "Where are we?" + "Where do we start?"	If the question is asked in a such way that a specific answer is implied, it should be placed in Category 4: "Give Suggestion". For instance, the statement "I wonder if we should make a contact to local travel agent or our friends to know more about this issue" should be in Category 4.
10. Disagree	+ **Rejecting another person's statement** of information, opinion, or suggestion + **Making argument**	+ Shaking the head + Thumb down + "I don't think so" + "I don't think that's right"	Negative feeling could be existed, but must NOT be strong. Otherwise, it would be scored in Category 12: "Show Antagonism/Unfriendly".
11. Show Tension	+ Indicating signs of emotional anxious such as appearing startled, blushing, showing embarrassment, shyness, clicking a pen, sweating, swallowing, or		A special sign in this category is laughter. It also may seem to indicate of a reduction of tension, but it appears to be more

	wetting the lips persistently + Including any verbal expressions of fear, apprehension, worry, fright, or panic + Trying to suppress, conceal something that is considered discreditable such as ineptitude, ignorance		dependable as sign of tension rather than a sign of its reduction, such as giving embarrassed or tense laughter.
12. Show Antagonism / "Unfriendly"	+ Attempting to override the other in conversation, interrupting the other, interfering with his/her speaking + Belittling others, making fun of others, maliciously sarcastic, complaining, criticizing, ill-treating, tricking, or deceiving. + Showing acts that are disrespectful, rebellious, disobedient, irresponsible, disorderly, annoying + Attempting to control, regulate, or supervise in a manner that the freedom of choice or consent of the other person is either greatly limited or nonexistent + Passive refusal to act that frustrate the other, disappointing the other, withholding resources from other members, refusing to talk loud enough to be heard + Displaying attitudes that indicate that the person lacks energy or enthusiasm, or is inattentive, bored. + Retiring, leaving, or quitting	*Giving commands such as* + "Come here" + "Stop that" + "Shut up" + "Get out" *Displaying attitudes indicating they're bored* + Yawning + Closing the eyes + Daydreaming + Looking away from others in the group and from the work + Letting the eyes wander	

Decision approach taken

6) Which social decision scheme was the group using:

+ Delegating: the group as a whole does not make the decision, but instead the decision is delegated to one of the members, a subgroup within the group, or someone outside of the group.

+ Averaging: the group makes decisions by combining each individual's preference using some type of computational procedure (i.e. the individual preference could be averaged to yield a group decision).

+ Voting: the group selects the destination favored by the majority of the members, or in some cases, a more substantial plurality (such as two-thirds majority) is needed before a decision becomes final.

+ Reaching consensus: the decision is made when everyone agrees on a course of action and expresses satisfaction with the decision.

+ Other:

__Guidance:__

During the discussion, the observers should give the priority to *non-verbal expressions* such as body attitudes/ body languages/ gesture/ facial expressions of a group's members. They need to classify members' behaviors into the suitable categories and count how many times such behaviors have been displayed. Regarding *verbal-expressions*, the observers are only required to check members' behaviors into the corresponding categories, and they do not need to count simultaneously as they are able to fulfill the form after the discussion by using audio tapping.

Post-Questionnaire (INSTANCE1)

There are 15 questions in this survey

Group decision

1 [UNI] To which University do you belong to? *

Please choose **only one** of the following:

- ○ Haifa
- ○ TU Vienna
- ○ Bolzano
- ○ Klagenfurt
- ○ Delft

2 [StudentID] Please provide your studentID *

Please write your answer here:

[   ]

3 [Outcome_first] Which destination was the first choice of your group? *

Please choose **only one** of the following:

- ○ Amsterdam
- ○ Berlin
- ○ Copenhagen
- ○ Helsinki
- ○ Lisbon
- ○ London
- ○ Madrid
- ○ Paris
- ○ Rome
- ○ Stockholm

4 [Outcome_second] Which destination was the second choice of your group? *

Please choose **only one** of the following:

- ○ Amsterdam
- ○ Berlin
- ○ Copenhagen
- ○ Helsinki
- ○ Lisbon
- ○ London
- ○ Madrid
- ○ Paris
- ○ Rome
- ○ Stockholm

5 [Scheme] Shortly describe how you reached the group decision? *

Please write your answer here:

6 [Wikipedia] Did you use the provided links for information on any of these destinations? *

Please choose the appropriate response for each item:

	Yes	No
Amsterdam	○	○
Berlin	○	○
Helsinki	○	○
Copenhagen	○	○
Lisbon	○	○
London	○	○
Madrid	○	○
Paris	○	○
Rome	○	○
Stockholm	○	○

Assessment of group choice

7 [AddInfo]Did you use any additional information sources when making your decision? *

Please write your answer here:

8 [RecQual]

To what extend do you agree or disagree with the following statements?

(1) means fully disagree and (5) means fully agree

*****

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
The 10 alternative destinations were appealing	○	○	○	○	○
Many destinations were appealing	○	○	○	○	○
I did not like any of the destinations	○	○	○	○	○

9 [ChoiceSat]

To what extend do you agree or disagree with the following statements?

(1) means fully disagree and (5) means fully agree

*****

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
I like the destination that we have chosen	○	○	○	○	○
I am excited about the chosen destination	○	○	○	○	○
The chosen destination fits my preference	○	○	○	○	○
I didn't prefer the chosen destination, but it was fair.	○	○	○	○	○

10 [Difficulty]

To what extend do you agree or disagree with the following statements?

*

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
Eventually I was in doubt between some destinations.	○	○	○	○	○
I changed several times before making the decision.	○	○	○	○	○
I think we have chosen the best destination from the options.	○	○	○	○	○
The task of making this decision was overwhelming.	○	○	○	○	○
To make the decision was easy.	○	○	○	○	○
The decision process was frustrating.	○	○	○	○	○

11 [Group_Identification] To what extend do you agree with the following statements on the relationship between and your group? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I identify with the other students in my group	○	○	○	○	○
I see myself as a member of this group	○	○	○	○	○
I am glad to be a member of this group	○	○	○	○	○
I feel strong ties with my group	○	○	○	○	○

12 [Group_Similarity] To what extend do you agree with the following statements? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
I considered the other members in my group to be similar to each other in terms of their preference	○	○	○	○	○
I considered myself similar to the other members in my group in terms of our preferences	○	○	○	○	○

Assessment of task

---

13 [Org] How do you assess the setup and organisation of this exercise? *

Please choose **all** that apply:

- [ ] I did not understand what we should do.
- [ ] Most people in our group had no idea what we should do.
- [ ] The task was well described.
- [ ] More and better instructions on what we should have done would have been helpful.

---

14 [Feedback] How did you find participating in this task? Select these statements that best describe your thoughts. *

Please choose **all** that apply:

- [ ] It was exciting.
- [ ] I liked it.
- [ ] I learned something.
- [ ] This exercise was chaotic.
- [ ] This exercise was boring.
- [ ] This exercise was useless.

---

15 [Repeat] Would you like to participate more often in exercises like this one? *

Please choose **all** that apply:

- [ ] Yes, definitely.
- [ ] Maybe, sometimes.
- [ ] No.
- [ ] Never, ever again.

Pre-Questionnaire (INSTANCE2)

Travel and Tourism Study - Soc. Rel. - PreSurvey

This research project is a cooperation within the International Federation for Information Technologies in Travel and Tourism (IFITT), with several participating universities worldwide: TU Wien, Universität Klagenfurt, Delft University of Technology, Free University of Bolzano, Leiden University, University of Sarajevo. The research goal is to study decision-making in the travel and tourism domain. The research will be carried out in three phases and in each phase all the relevant details about the corresponding tasks will be timely distributed.

The answers you give will be kept private and serve only the purpose of an aggregate analysis.

There are 19 questions in this survey

Demographics

[]To which University do you belong? *

Please choose **only one** of the following:

- ○ TU Wien
- ○ Universität Klagenfurt
- ○ TU Delft
- ○ Free University of Bozen-Bolzano
- ○ Leiden University
- ○ University of Sarajevo
- ○ Other [_____]

[]Please provide your studentID *

Please write your answer here:

[_____]

[]What is your group identification number, code or name? *

Please write your answer here:

[_____]

[]What is your gender? *

Please choose **only one** of the following:

- ○ Female
- ○ Male

[]What is your age? *

Only numbers may be entered in this field.

Please write your answer here:

[_____]

[]Which country do you originally come from? *

Please choose **only one** of the following:

- ○ Afghanistan
- ○ Åland

Personality and travel attitudes 1

[]To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I am original, come up with new ideas	○	○	○	○	○
I am curious about many different things	○	○	○	○	○
I am ingenious, a deep thinker	○	○	○	○	○
I have an active imagination	○	○	○	○	○
I do a thorough job	○	○	○	○	○
I am a reliable worker	○	○	○	○	○
I do things efficiently	○	○	○	○	○
I make plans and follows through with them	○	○	○	○	○
I am full of energy	○	○	○	○	○
I generate a lot of enthusiasm	○	○	○	○	○
I have an assertive personality	○	○	○	○	○
I am outgoing, sociable	○	○	○	○	○
I am helpful and unselfish with others	○	○	○	○	○
I have a forgiving nature	○	○	○	○	○
I am generally trusting	○	○	○	○	○

Personality and travel attitudes 2

[]To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I like to cooperate with others	○	○	○	○	○
I seldom feel blue	○	○	○	○	○
I am relaxed most of the time	○	○	○	○	○
I am not easily upset	○	○	○	○	○
I remain calm in tense situations	○	○	○	○	○
When I go on vacation I mostly relax and sunbathe	○	○	○	○	○
On vacation I go to warm places with lots of sun, sand, and ocean	○	○	○	○	○
On vacation I spend most of the day on the beach, go out every night, drink with friends, and do crazy things	○	○	○	○	○
On vacation I try to meet people of the opposite sex for uncomplicated romantic experiences	○	○	○	○	○
I enjoy meeting the local people, trying the food, and speaking the language	○	○	○	○	○
On vacation I try to get to know the ways of the culture, and generally avoid the regular tourist route	○	○	○	○	○
I visit museums which house archaeological artifacts from ancient sites and civilizations	○	○	○	○	○
Visiting the sites, and studying the history of ancient civilizations have a special meaning for me	○	○	○	○	○
When I go on vacation I leave all the planning, hotel reservations, organized tours, etc., to my travel agent	○	○	○	○	○
I take packaged vacations and organized tours	○	○	○	○	○

Personality and travel attitudes 3

[]To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I participate in activities involving an element of risk such as sky diving, rock climbing or ski jumping	○	○	○	○	○
I engage in risky/exhilarating activities which provide me with emotional highs	○	○	○	○	○
I go on adventure travel such as a hike down the Grand Canyon, jungle treks, and the like	○	○	○	○	○
I explore out of the way places and enjoy the challenges and hardships involved in getting there	○	○	○	○	○
I go to exclusive night clubs, attend yacht parties, and socialize with celebrities	○	○	○	○	○
I vacation in elite, exotic, or out of the way world class resorts such as Monte Carlo, Tahiti, or the French Riviera	○	○	○	○	○
For me, vacations are a sort of a spiritual quest in which I try to discover knowledge about my roots, history, or traditions	○	○	○	○	○
My purpose in travel is to explore the meaning of life and what I can learn about myself	○	○	○	○	○
I visit regular tourist attractions but I avoid packaged vacations and organized tours	○	○	○	○	○
While I leave some of my travel arrangements to my travel agent, I plan my own route/destination, make my own hotel reservations, and often play it by ear	○	○	○	○	○

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I stay in first class hotels, go to shows and dine at the best restaurants	○	○	○	○	○
I travel first class, and stay at the best luxury resorts	○	○	○	○	○
I try to make it on my own, living with the local people, and often take jobs to keep myself going	○	○	○	○	○
I drift from place to place living a hippy style existence	○	○	○	○	○
On vacation I take it easy getting away from it all	○	○	○	○	○

Personality and travel attitudes 4

[]To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I head for places that are quiet and peaceful such as a deserted beach, a cabin in the hills, etc	○	○	○	○	○
On vacation I stay physically active engaging in my favorite sports	○	○	○	○	○
I go on vacation mostly to engage in my favorite sports (e.g. tennis, sailing, golf, skiing, hunting, etc.)	○	○	○	○	○
I participate in planned study programs which may include lectures, workshops, and the like	○	○	○	○	○
I take educationally oriented vacations that enable me to study and/or acquire new skills and knowledge	○	○	○	○	○

Preferences1

In the following we will present you short descriptions of different tourism destinations where you might not yet know all of them, please read them carefully and then answer the questions.

PORQUEROLLES ISLAND OF HYÈRES PROVINCE (FRANCE): As the first sea resort of the French Riviera, Hyères offers enchanted and preserved beaches, a clean water and a guarantee of bright sun. Whether you seek shade, privacy or relaxation spots, with over 40 kilometres of coastline, you will have plenty of creeks to choose from to go for a swim, build a sand castle or take an afternoon nap. The ongoing revegetation program requires that everyone take care of the environment.

RIGA (LATVIA): Riga is famous for its Old Town (Vecrīga) and city center (Centrs). One will find a breathtaking range of architectural styles in the historical centre – from Baroque to Classicism, from Renaissance to Art Deco, from Romanesque to National Romanticism. Furthermore, Riga's wealth of Jugendstil or Art Nouveau buildings, complete with their fantastically ornate flourishes, stands out as unparalleled anywhere in the world. The old town of Riga is a UNESCO World Heritage Site. For the history, art and architecture lovers Riga is the right place to visit.

BUDAPEST (HUNGARY): This city is never usually in the radar for best places to party but there is one word that describes the nightlife: Sparties! The ridiculously lavish pools turn into summer night bath parties from June to September. It's wild! Moreover, with its cheap alcohol, hostels designed for parties, and amazing ruin bar scene, Budapest is a great place to grab a drink. The ruin bar scene is one of the best bar scenes in Europe – drinking in the ruins of old abandoned building adorned with a garage sale décor. It's fun, it's arty, and it's incredible.

SERRAVALLE SCRIVIA, (ITALY): Serravalle is a municipality in the Province of Alessandria in the Italian region of Piedmont. Serravalle is the home of the largest Designer Outlet in Europe - Seravalle Designer Outlet. It combines a relaxing atmosphere with 300 of best known designer brands. In a picturesque setting, just 50 minutes from Milan, you will find Dolce&Gabbana, Versace, Salvatore Ferragamo and many more at 30-70% less all year round. For an unforgettable shopping experience Serravalle is is the must visit fashion destination.

GIRONA (SPAIN): Once well-known maybe only for paella, has really became the center of the new way of cooking over the past 15 years. In the little old town of Girona, you will find El Celler de Can Roca with 3 Michelin stars that are absolutely deserved! Girona's location in Costa Brava provides the city access to amazing food. With the mountainous Pyrenees on one side of Costa Brava and the Mediterranean Sea on the other, Girona has freshly pressed olive oil, deeply red tomatoes, seafood plucked from the sea and some of the freshest garlic we have ever eaten. And we can't forget the wine. Girona is a city where Empordà wines flow freely and for little cost. For food lovers, Girona is a 'must' place to visit!

BLED (SLOVENIA): Lake Bled is a lake in the Julian Alps of the Upper Carniolan region of northwestern Slovenia, where it adjoins the town of Bled. Put simply, Bled is beautiful beyond words. Romantic and timeless, come and seek your corner of paradise. There is much to keep you busy, but don't rush too much, Bled isn't the place for that. You can walk, ride or take the tourist train around the lake. Climb the surrounding hills for excellent vantage points. You can also use the lake as a base for exciting day trips to Lake Bohinj, Vintgar Gorge, Radovljica and Kropa.

INTERLAKEN (SWITZERLAND): Switzerland's stunning Interlaken is a town in the Interlaken-Oberhasli administrative district in the Swiss canton of Bern. It is an important and well-known tourist destination in the Bernese Highlands region of the Swiss Alps and it stands out as the adventure and extreme sports capital of Europe. There's no shortage of activities in the region designed to get your heart racing, including canyoning, rafting, bungee jumping, and paragliding. And if you get bored of those, you can head up into the valley of Lauterbrunnen. Here you'll find some of the world's most celebrated base-jumping sites.

SNAEFELLSNES PENINSULA (ICELAND): The inherent sustainability of Iceland is one of the things that make it a truly remarkable destination. Ecotourism in Iceland is feasible through the country's strong commitment to sustainability, use of clean energy, conservation, and educating travellers on the importance and means towards a sustainable ecotourism industry. Snaefellsnes peninsula has been given the well deserved nickname "Iceland in miniature". It offers scenic tour with great ocean view, stunning landscape, northern lights searching and an easy cave exploration in Cave Vatnshellir.

PORTREE (SCOTLAND): Portree is the largest town on Scotland's Isle of Skye, a bustling port as well as a thriving cultural center, though the population is less than 2,500. The harbor is the focal point, featuring a number of pubs, seafood restaurants and spectacular views across the bay. It's one of the best places to base your stay if you plan to explore this incredibly scenic wild region, due to its close proximity to some of the most breathtaking and unique attractions, including rock formations like the Old Man of Storr, Kilt Rock, and the extraordinary pinnacles of the Quaraing.

SEGOVIA (SPAIN): Segovia is a historic city northwest of Madrid, in central Spain's Castile and León region. Its centuries of settlement have resulted in a rich architectural legacy, including medieval walls, Romanesque churches, a former royal palace and a Gothic cathedral. Its iconic ancient Roman aqueduct has more than 160 arches, most in the original mortarless granite, and stands above Plaza Azoguejo in the heart of the city. For history lovers Segovia is the place for for one single stunning Roman view, and a spectacular piece of Roman engineering.

[]How many times have you visited each of the following destinations? *

Please choose the appropriate response for each item:

	Never heard about before	0	1	2	3	More than 3
Porquerolles	○	○	○	○	○	○
Riga	○	○	○	○	○	○
Budapest	○	○	○	○	○	○
Serravalle Scrivia	○	○	○	○	○	○
Girona	○	○	○	○	○	○
Bled	○	○	○	○	○	○
Interlaken	○	○	○	○	○	○
Snaefellsnes	○	○	○	○	○	○
Portree	○	○	○	○	○	○
Segovia	○	○	○	○	○	○

[]

How would you like to visit following destinations? Rate them on a scale from (1) to (10), where (1) means not attractive and (10) means highly attractive. *

Please choose the appropriate response for each item:

	1	2	3	4	5	6	7	8	9	10
Porquerolles	○	○	○	○	○	○	○	○	○	○
Riga	○	○	○	○	○	○	○	○	○	○
Budapest	○	○	○	○	○	○	○	○	○	○
Serravalle Scrivia	○	○	○	○	○	○	○	○	○	○
Girona	○	○	○	○	○	○	○	○	○	○
Bled	○	○	○	○	○	○	○	○	○	○
Interlaken	○	○	○	○	○	○	○	○	○	○
Snaefellsnes	○	○	○	○	○	○	○	○	○	○
Portree	○	○	○	○	○	○	○	○	○	○
Segovia	○	○	○	○	○	○	○	○	○	○

Preferences2

[]Which aspects are the most important to you when you are deciding which destination you will visit? *

All your answers must be different and you must rank in order.

Please number each box in order of preference from 1 to 9

[ ]

Distance

[ ]

Weather

[ ]

Sightseeing

[ ]

Budget

[ ]

Social Activities

[ ]

Sport Activities

[ ]

History and Culture

[ ]

Night Life

[ ]

Experience of close friends and family

Social relations

In this question group you will be asked about relationships with your fellow group members. Note that your answers will not be in any way disclosed and will be anonymized!

[]Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. *

Please write your answer(s) here:

For each group member use one row!

[]How emotionally close do you feel to each of the group members? *

Only answer this question if the following conditions are met:
count(SOC_SQ001, SOC_SQ002, SOC_SQ003, SOC_SQ004) > 0

Please choose the appropriate response for each item:

Only answer this question for the items you selected in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

Only answer this question for the items you did not select in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

	1	2	3	4	5	6	7	8	9	10
{SOC_SQ001}	○	○	○	○	○	○	○	○	○	○
{SOC_SQ002}	○	○	○	○	○	○	○	○	○	○
{SOC_SQ003}	○	○	○	○	○	○	○	○	○	○
{SOC_SQ004}	○	○	○	○	○	○	○	○	○	○

from 1 (*"not emotionally close at all"*) to 10 (*"very emotionally close"*)

[]How often do you talk to each of your group members on average? *

Only answer this question if the following conditions are met:
count(SOC_SQ001, SOC_SQ002, SOC_SQ003, SOC_SQ004) > 0

Please choose the appropriate response for each item:

Only answer this question for the items you selected in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

Only answer this question for the items you did not select in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

	Very infrequently	Somewhat infrequently	About average	Somewhat frequently	Very frequently
{SOC_SQ001}	○	○	○	○	○
{SOC_SQ002}	○	○	○	○	○
{SOC_SQ003}	○	○	○	○	○
{SOC_SQ004}	○	○	○	○	○

[]For how long do you know each of the group members? *

Only answer this question if the following conditions are met:
count(SOC_SQ001, SOC_SQ002, SOC_SQ003, SOC_SQ004) > 0

Please choose the appropriate response for each item:

Only answer this question for the items you selected in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

Only answer this question for the items you did not select in question SOC ('Please provide Student ID number and name (separated by semicolon) for each of your fellow group members. ')

	For less than six months	For more than six months, but less than a year	For more than a year, but less than three years	For more than three years, but less than five years	For more than five years
{SOC_SQ001}	○	○	○	○	○
{SOC_SQ002}	○	○	○	○	○
{SOC_SQ003}	○	○	○	○	○
{SOC_SQ004}	○	○	○	○	○

Flexibility

[]In general, how flexible do you perceive yourself when it comes to the choices made in a group setting? *

Please choose the appropriate response for each item:

	Not flexible at all	Not flexible, except from some rare cases	Sometimes flexible and sometimes not	Often flexible	Completely flexible
Select the one that applies	○	○	○	○	○

[]How flexible do you perceive yourself when it comes to the holiday destination choices made in a group setting? *

Please choose the appropriate response for each item:

	Not flexible at all	Not flexible, except from some rare cases	Sometimes flexible and sometimes no	Often flexible	Completely flexible
Select the one that applies	○	○	○	○	○

Decision-Making Task (INSTANCE2)

Group decision-making task

Instructions

Please read the following scenario:

Imagine that you are working on a research paper together with the other group members. Interestingly, your university offers you the opportunity to submit this paper to a conference in Europe. If the paper gets accepted, **the university will pay** *to each group member the transportation and accommodation costs. In addition, you* **will be able to spend the weekend after the conference at the conference destination to do some sightseeing***.*

Ten conferences will take place in different European destinations around the same **summer period***. The destinations are: Porquerolles Island of Hyères Province (France), Riga (Latvia), Budapest (Hungary), Serravalle Scrivia (Italy), Girona (Spain), Bled (Slovenia), Interlaken (Switzerland), Snaefellsnes Peninsula (Iceland), Portree (Scotland) and Segovia (Spain). The document with the descriptions of the destinations is provided to you in a printed form.*

Your <u>task</u> is to decide to which conference (destination) you will submit your paper, and what would be your second choice (in case the first choice would not be feasible for some unexpected reason)? **The decision process should not take more than 35 minutes.**

Post-Questionnaire (INSTANCE2)

Travel and Tourism Study - Soc. Rec. - PostSurvey

Thank your for participating in the in-class group decision study. With this short survey we would like to collect feedback about the process and how satisfied you are with the outcome.

There are 19 questions in this survey

Group decision

[]To which University do you belong? *

Please choose **only one** of the following:

○ TU Wien

○ Universität Klagenfurt

○ TU Delft

○ Free University of Bozen-Bolzano

○ Leiden University

○ University of Sarajevo

[]Please provide your studentID *

Please write your answer here:

[   ]

[]What is your group identification number, code or name? *

Please write your answer here:

[   ]

[]Which destination was the first choice of your group? *

Please choose **only one** of the following:

○ Porquerolles

○ Riga

○ Budapest

○ Serravalle Scrivia

○ Girona

○ Bled

○ Interlaken

○ Snaefellsnes

○ Portree

○ Segovia

[]Which destination was the second choice of your group? *

Please choose **only one** of the following:

○ Porquerolles

○ Riga

○ Budapest

○ Serravalle Scrivia

○ Girona

○ Bled

○ Interlaken

○ Snaefellsnes

○ Portree

○ Segovia

[]Shortly describe how you reached the group decision? *

Please write your answer here:

[   ]

Assessment of group choice

[]

To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
I like the destination that we have chosen	○	○	○	○	○
I am excited about the chosen destination	○	○	○	○	○
The chosen destination fits my preference	○	○	○	○	○
The chosen destination is a fair choice	○	○	○	○	○

(1) means fully disagree and (5) means fully agree

[]

To what extend do you agree or disagree with the following statements? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
Eventually I was in doubt between some destinations.	○	○	○	○	○
I changed several times before making the decision.	○	○	○	○	○
I think we have chosen the best destination from the options.	○	○	○	○	○
The task of making this decision was overwhelming.	○	○	○	○	○
To make the decision was easy.	○	○	○	○	○
The decision process was frustrating.	○	○	○	○	○

(1) means fully disagree and (5) means fully agree

[]To what extend do you agree with the following statements on the relationship between and your group? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I identify with the other students in my group	○	○	○	○	○
I see myself as a member of this group	○	○	○	○	○
I am glad to be a member of this group	○	○	○	○	○

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I feel strong ties with my group	○	○	○	○	○

(1) means fully disagree and (5) means fully agree

[]To what extend do you agree with the following statements? *

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
I considered the other members in my group to be similar to each other in terms of their preference	○	○	○	○	○
I considered myself similar to the other members in my group in terms of our preferences	○	○	○	○	○

(1) means fully disagree and (5) means fully agree

[]Please provide Student ID and name (separated by semicolon) for each of your fellow group members. *

Please write your answer(s) here:

For each group member use one row.

[]To what extent did each of your group members influence your acceptance of the final group choice? *

Only answer this question if the following conditions are met:
count(INFL_SQ001, INFL_SQ002, INFL_SQ003, INFL_SQ004) > 0

Please choose the appropriate response for each item:

Only answer this question for the items you selected in question INFL ('Please provide Student ID and name (separated by semicolon) for each of your fellow group members.')

Only answer this question for the items you did not select in question INFL ('Please provide Student ID and name (separated by semicolon) for each of your fellow group members.')

	Not at all	Very little	To some extent	To a considerable extent	To a great extent
{INFL_SQ001}	○	○	○	○	○
{INFL_SQ002}	○	○	○	○	○
{INFL_SQ003}	○	○	○	○	○
{INFL_SQ004}	○	○	○	○	○

1 (one) means that you sticked with your preferred options until the end of the discussion, and 5 (five) means that you changed your mind or that you did not want to fight for your preferred options for some reason.

Group behavior

[]How much time did the group discussion take? (in minutes) *

Only numbers may be entered in this field.

Please write your answer here:

[   ]

If you can make a clear disctinction between the discussion process (i.e., you and other group members exchanged information, ideas and preferences) and the decision-making process (e.g., after a discussion, you and other group members decided on the final choice by, for example, a majority voting), then provide the time needed for the discussion process.

[]How much time did it take you to make a decision? *

Please choose **only one** of the following:

○ Less than 5 minutes.

○ From 5 to 10 minutes.

○ More than 10 minutes.

If you can make a clear disctinction between the discussion process (i.e., you and other group members exchanged information, ideas and preferences) and the decision-making process (e.g., after a discussion, you and other group members decided on the final choice by, for example, a majority voting), then provide the time needed for the decision-making process.

[]Which social decision scheme did your group use to reach the final decision? *

Please choose **all** that apply:

☐ Delegating

☐ Averaging

☐ Voting

☐ Reaching Consensus

☐ Other: [   ]

Delegating: the group as a whole does not make the decision, but instead the decision is delegated to one of the members, a subgroup within the group, or someone outside of the group.

Averaging: the group makes decisions by combining each individual's preference using some type of computational procedure (i.e. the individual preference could be averaged to yield a group decision).

Voting: the group selects the destination favored by the majority of the members, or in some cases, a more substantial plurality (such as two-thirds majority) is needed before a decision becomes final.

Reaching consensus: the decision is made when everyone agrees on a course of action and expresses satisfaction with the decision.

[]

How willing were you to give up your own preferences (i.e., preferred options) in order to reach a group decision? *

Please choose **only one** of the following:

○ 1

○ 2

○ 3

○ 4

○ 5

Assessment of task

[]How do you assess the setup and organisation of this exercise? *

Please choose **all** that apply:

- [ ] I did not understand what we should do.
- [ ] Most people in our group had no idea what we should do.
- [ ] The task was well described.
- [ ] More and better instructions on what we should have done would have been helpful.

[]How did you find participating in this task? Select these statements that best describe your thoughts. *

Please choose **all** that apply:

- [ ] It was exciting.
- [ ] I liked it.
- [ ] I learned something.
- [ ] This exercise was chaotic.
- [ ] This exercise was boring.
- [ ] This exercise was useless.

[]Would you like to participate more often in exercises like this one? *

Please choose **all** that apply:

- [ ] Yes, definitely.
- [ ] Maybe, sometimes.
- [ ] No.
- [ ] Never, ever again.