Who are Your Design Heroes?
Finding and Understanding Lead Solvers in Innovation-Contest Communities

Der Fakultät für Maschinenbau
der Helmut-Schmidt-Universität /
Universität der Bundeswehr Hamburg

zur Erlangung des akademischen Grades eines
Doktor-Ingenieurs
vorgelegte

DISSERTATION

von
Diplom-Ingenieur
Manuel Moritz, MBA
aus Bruchsal

Hamburg 2021

1. Gutachter: Prof. Dr. Jens P. Wulfsberg
Laboratorium Fertigungstechnik
Fakultät für Maschinenbau
Helmut-Schmidt-Universität

2. Gutachter: Prof. Dr. Christian Lüthje
Institut für Innovationsmarketing
Dekanat Management-Wissenschaften und Technologie
Technische Universität Hamburg

Tag der mündlichen Prüfung: 17. Februar 2022

Kurzzusammenfassung

Ausgangssituation:

Durch die webbasierte Einbindung von organisationsexternen Akteuren im Rahmen des Innovationsmanagements und der Produktentwicklung (*open innovation*) ergeben sich für Unternehmen neue Möglichkeiten, um ihre Wettbewerbsfähigkeit durch neue Ideen für bessere Produkte zu steigern. Zugleich können Kunden, Freelancer, Studierende und andere Internetuser nunmehr Teil von (industrieller) Wertschöpfung werden.

In der Vergangenheit haben sich dabei zwei generische Ansätze kollaborativer Wertschöpfung (sog. *co-creation*) bewährt: eher kompetitiv ausgerichtete Wettbewerbsformate (*crowdsourcing*), in denen die TeilnehmerInnen um die beste Lösung und damit auch um einen oder mehrere Preise konkurrieren, sowie eher kooperativ ausgerichtete communitybasierte Formen der Zusammenarbeit, in denen die gemeinsame Problemlösung und Ideengenerierung durch Austausch, Feedback und das Teilen von Wissen im Vordergrund steht.

Zuletzt hat sich daneben auch eine neue und hybride Form der Zusammenarbeit herausgebildet, die die Vorteile der beiden zuvor genannten Ansätze verbindet. In so genannten *innovation-contest communities* werden innerhalb einer bestehenden Web-Community wiederkehrend Ideenwettbewerbe mit einem zeitlichen Rahmen und zu einer bestimmten Fragestellung durch Unternehmen oder eine dritte Partei (sog. Intermediär, der die Plattform betreibt) organisiert. Interessanterweise konkurrieren die NutzerInnen dabei nicht nur um Preise, sondern kooperieren darüber hinaus häufig mit anderen TeilnehmerInnen, indem sie Feedback geben und erhalten, sowie sich zu Ideen austauschen. Es werden neben der reinen Innovationstätigkeit folglich auch soziale Bedürfnisse der NutzerInnen nach Interaktion und Kommunikation erfüllt, wodurch die nachhaltige Lebensfähigkeit der Community und folglich eine langfristige partnerschaftliche Einbindung von Usern für Unternehmen möglich wird.

Forschungsbedarf:

Während zu den beiden erstgenannten und separaten Bereichen (Crowdsourcing und communitybasierte Innovation) bereits erheblicher Forschungsaufwand mit einem entsprechend guten Verständnis des jeweiligen Ansatzes als Konsequenz betrieben

wurde, fehlen bisher entsprechende Erkenntnisse im hybriden Setting. Die Vermischung der Elemente Wettbewerb und Kooperation im Falle von Innovation-Contest Communities lässt vermuten, dass Internetuser vielfältiger sind hinsichtlich persönlicher Hintergründe, Motivation und Verhaltensmuster. Somit sind auch bekannte Erkenntnisse und Erklärungsansätze hinsichtlich ihrer Übertragbarkeit zu hinterfragen.

Erste Case Studies haben ergeben, dass es innerhalb derartiger Communities vergleichbare distinkte Nutzerrollen mit spezifischen Verhaltensmustern gibt, die womöglich verallgemeinert werden können. Beispielsweise gibt es in der Regel innerhalb einer Community einen sehr großen Anteil an NutzerInnen, die sehr passiv und wenig innovativ sind, oder aber einen kleinen Kern besonders innovativer NutzerInnen, die nicht nur durch herausragenden Input überzeugen, sondern darüber hinaus durch kooperatives Verhalten gegenüber anderen NutzerInnen auffallen, indem sie sie dabei unterstützen, ihre Ideen zu verbessern.

Ein umfassendes Verständnis der unterschiedlichen NutzerInnen gibt es jedoch noch nicht. Wir wissen teilweise und können beschreiben, wie sich die NutzerInnen verhalten, jedoch nicht warum. Hier setzt die vorliegende Arbeit an. Ziel ist es, Nutzerrollen in Innovation-Contest Communities nicht nur zu identifizieren bzw. verifizieren und zu beschreiben, sondern den Fokus auch auf die NutzerInnen zu richten, um zu verstehen, warum sich bestimmte User so verhalten, wie sie es tun. Im Vordergrund der Untersuchung stehen so genannte *lead solver*, die wie bereits beschrieben dadurch hervorragen, dass sie sowohl außergewöhnlich innovativ als auch kooperativ in ihrem Verhalten sind. Dies macht sie zu wertvollen Community-Mitgliedern sowohl aus Sicht des Community-Betreibers als auch für das nach innovativem Input suchende Unternehmen.

Methodisches Vorgehen:

Zunächst wurde auf Grundlage aktueller Literatur das sog. *lead solver framework* mit den beiden Dimensionen *innovativeness* und *cooperative orientation* entwickelt und entsprechende Forschungshypothesen abgeleitet, die als Referenzrahmen für die eigene Untersuchung dienen. Anschließend wurde ein Mix aus qualitativen und quantitativen Forschungsmethoden auf einen singulären Untersuchungskontext angewendet, um auf Grundlage unterschiedlicher Daten ein tiefgreifendes Verständnis für das Lead Solver-Phänomen zu entwickeln.

Als erstes wurde eine Umfrage unter den Teilnehmenden eines Wettbewerbs innerhalb einer bestimmten Innovation-Contest Community durchgeführt, um die Heterogenität der User zu erforschen und die Geeignetheit des Forschungskontextes zu überprüfen. Dann erfolgte die Identifikation von Nutzerrollen (inkl. Lead Solver) mit Hilfe von Sozialer Netzwerk- und Clusteranalyse sowie Inhaltsanalyse basierend auf dem Nutzerverhalten während des Wettbewerbs. Schließlich wurden semi-strukturierte Interviews mit Vertretern aus jeder der zuvor identifizierten Gruppen durchgeführt, um mittels Grounded Theory-Analyse einerseits die Nutzerrollen im Allgemeinen detailliert zu beschreiben und andererseits das Lead Solver-Modell zu entwickeln, wodurch dieser Nutzertypus erstmalig ganzheitlich vorgestellt wird.

Ergebnisse:

Meine Forschung ergab, dass Lead Solver sich kooperativ verhalten, weil sie bereits (positive) Erfahrungen in anderen kollaborativen Kontexten gemacht haben, weil sie ein stark ausgeprägtes Gemeinschaftsgefühl für die Community haben und ein hohes Maß an Selbstwirksamkeit aufweisen. Außerdem sind sie vertraut mit Feedback-Mechanismen, die sie auch zur Verbesserung ihrer eigenen Fähigkeiten intensiv nutzen. Entsprechend veröffentlichen sie ihre eigenen Konzepte möglichst frühzeitig und engagieren sich in der Community durch Feedback ihrerseits. Weitere besondere Eigenschaften eines Lead Solvers sind: ausgeprägte Erfahrungen und Fachkenntnisse im jeweils relevanten Gebiet; motiviert durch einen individuellen Nutzwert jenseits direkter monetärer Kompensation (z.B. Lernen); ein hohes Maß an Selbstbestimmung und Leistungsmotivation bedingt durch eigene Projekte, die durch die Partizipation gefördert werden sollen. Lead Solver fordern sich gerne selbst heraus, zugleich kooperieren sie gerne mit anderen zum gegenseitigen Nutzen.

Ausblick:

Im Rahmen der vorliegenden Arbeit wurde zum ersten Mal das Phänomen der Lead Solver, die bereits in anderen Kontexten identifiziert, aber noch nicht verstanden wurden, ganzheitlich und unter Einbezug der Nutzerperspektive untersucht und ausgehend hiervon das Lead Solver-Modell entwickelt. Die Erkenntnisse aus diesem Modell dienen sowohl der Wissenschaft als Ausgangspunkt für weitere Untersuchungen, als auch dem Management von Unternehmen und Community-Betreibern als Handlungsempfehlung bezüglich der Ausgestaltung von kollaborativen Wertschöpfungsformaten. Letztere sollten bei konkreten Initiativen, wie etwa beim

Aufbau einer Innovation-Contest Community, gleichermaßen kompetitive wie kooperative Elemente einsetzen, um insbesondere Lead Solver anzuziehen und an sich zu binden. In Verbindung mit attraktiven individuellen Wertangeboten für die TeilnehmerInnen, die über direkte monetäre Anreize hinausreichen, besteht hiermit die Chance, synergetisch und langfristig gemeinsam Wert zu schaffen.

Who are Your Design Heroes?

Finding and Understanding Lead Solvers in Innovation-Contest Communities

by Manuel Moritz

Hamburg 2021

Preface

A dissertation is never the result of one person only. Rather, it is the outcome of a process of co-creation between many actors and a supportive environment in both private and work life.

I would like to thank Professor Jens Wulfsberg for giving me the opportunity to be part of the fabulous LaFT-team at Helmut Schmidt University and contribute to the interdisciplinary research of this unique institute.

I own my gratitude to many distinguished colleagues of the working group Value Creation Systematics, foremost Tobias Redlich for his friendship, support, and insight, but also many thanks to Sissy-Ve Basmer-Birkenfeld, Sonja Buxbaum-Conradi, Lennart Hildebrandt, and Pascal Krenz who are far more than colleagues to me and whose fellowship I highly appreciate.

I am grateful to my family and friends who always encouraged me on this journey. I thank my parents Meinrad and Sabine and my sister Anna for their support and love, but also my sister Linda who left us far too early – her smile and kindness always were and will be a source of inspiration to me.

Most importantly, I am grateful to my beloved wife Carolin for her care, strength, and encouragement, for our lovely daughter Felicitas who always puts a smile on my face and for two more kids on they way who kept me on track.

Manuel Moritz

Abstract

In the realm of innovation and new product development, collaborative value creation between firms and external users has proved to be a powerful means to solve problems and generate new breakthrough ideas effectively and efficiently. While organizations may increase their competitiveness with better products, users can benefit, too. They are able to participate in (industrial) value creation and thus enjoy collaboration with a reputable brand, to show off their capabilities, socialize with like-minded peers, learn new skills, or compete for a prize.

Two forms of co-creation are still prevalent these days: rather competitive crowdsourcing initiatives and platforms where users compete for a prize in a contest setting, and rather cooperative community-based approaches where sharing and joint problem solving with or without the involvement of firms is fostered. Lately, a new promising and hybrid form of web-based innovation could be observed that features both competitive and cooperative elements and thus combines advantages of the latter concepts. In *innovation-contest communities*, a competitive contest setting spurs innovation by recurrently solving a specific problem or task. At the same time, social needs of users are addressed. They can cooperate with other contestants by sharing ideas, interacting via commenting or by giving and receiving feedback during and beyond the contest.

While we have a solid understanding of users in crowdsourcing and communities, separately, we lack knowledge in the realm of a hybrid setting. Users are likely to be more heterogeneous regarding background, motivation and behavioral patterns and thus more research is required in this field to derive adequate strategies for community management and contest design. Few initial case studies on contest communities revealed user roles with similar behavioral patterns e.g., rather

passive lurkers or very active and innovative collaborators. A comprehensive perspective of users is missing though. We have begun to understand how users behave, but not why.

The goal of this study is to explore user roles in contest communities in detail with a special focus on users I call *lead solvers*. These users who usually represent only a very small fraction of the community provide highly innovative input to a contest and at the same act in a cooperative manner and thus are very valuable for both innovation-seeking firms as well as community hosts.

By reviewing related literature, I initially developed the lead solver framework with the two dimensions *innovativeness* and *cooperative orientation* and derived research propositions as a reference for further research. Then, I applied a mix of both quantitative and qualitative methods on a single case setting to gain a deep understanding on the phenomenon of lead solverness based on rich data from multiple sources.

First, I conducted a survey among contest participants to explore user heterogeneity in the community under study. Second, I applied social network and cluster analysis in combination with content analysis to identify user roles (including *lead solvers*) based on user behavior during the contest. Finally, I conducted semi-structured interviews with representatives of each group to describe and fully understand user roles in general, but more importantly, to develop a *lead solver* model with a grounded theory approach.

My findings suggest that most *lead solvers* are cooperatively oriented because of prior (positive) co-creation experience, a strong sense of community and a high level of self-efficacy. In addition, they know about the power of mutual feedback which also helps them to improve their own designs. To receive feedback, they first need to release their work early. Complementary aspects to define *lead solverness* include skill set, motivation (lead solvers are not primarily driven by the prize money, but rather by a personal use-value e.g., skill development), self-determination and a strong need to achieve due to own projects that they want to push forward by means of participation. *Lead solvers* like to compete with

themselves and at the same time enjoy cooperating with others for the mutual benefit.

To sum up, I present the new concept of *lead solvers* that have not been studied comprehensively yet. While this kind of user has been identified in other settings by means of social network analysis, I contribute to extant literature by adding a users' perspective with insights from the individuals themselves. Regarding implications for management, I conclude that competitive as well as cooperative elements in a co-creation setting are crucial to attract and bind *lead solvers*. In combination with a broad set of value propositions where users individually can attach themselves to and a strong commitment by the seeking organization, there is a high chance to create a synergetic und mutually beneficial collaboration resulting in new ideas and innovative products.

Contents

List of figures

List of tables

List of equations

List of abbreviations

ACDC	Airbus Cargo Drone Challenge
ANOVA	Analysis of variance
B2B	Business-to-business
B2C	Business-to-consumer
ICT	Information and communication technologies
IP	Intellectual property
LM	Local Motors
NPD	New product development
R&D	Research and development
RQ	Research question
OSS	Open-source software
SDT	Self-determination theory
SNA	Social network analysis
SNS	Social networking sites

Part I: Focus and scope

Chapter 1

Introduction

1.1 Research problem and relevance

Across industries, we observe a radical shift in value creation practices towards more open approaches enabled by globally disseminated and broadly accessible information and communication technologies (Rifkin, 2015; Chesbrough, 2006).

In contrast to conventional strategies that focus on secrecy and knowledge appropriation, new patterns of value creation and business models have emerged that foster global collaboration based on structural and organizational openness and thus enable the integration of external knowledge and actors into value creation processes. The concept of *bottom-up economics* (Redlich, 2011) comprises such approaches that require a minimum degree of organizational openness ranging from open (Enkel et al., 2009) and user innovation (Hippel, 2006) over open production (Wulfsberg et al., 2011) to the more holistic perspectives of co-creation (Prahalad & Ramaswamy, 2004).

Opening up has many potentials among which are: better customer and market insights e.g., by integrating lead solvers, more diverse ideas for innovation e.g., by crowdsourcing, and better product quality via user feedback. Users, customers, and other actors that are now able to participate in industrial value creation benefit, too. They collaborate with firms mainly via online platforms to acquire new skills and learn, to exchange ideas with like-minded peers, to solve problems, to interact with their favorite brand, to offer services, get a job or earn money (Füller, 2010; Franke & Shah, 2003; Lakhani & Wolf, 2003).

Collaborative value creation does not require the involvement of corporate actors, though. In the world of open-source software and hardware, we find users from all over the world who gather in online communities to jointly work on projects and exchange ideas without firms being involved (Harhoff & Lakhani, 2016; Krogh & Hippel, 2006; Moritz et al., 2016). With access to free and easy to use software and means of digital fabrication e.g., in fab labs, users are able to solve problems and create both physical and digital solutions themselves and thus independently from commercial offerings.

In the realm of innovation, two general approaches have evolved historically that enabled significant technological progress in a broad range of areas: collaborative innovation in communities and competitive settings such as innovation tournaments or contests. Both concepts are widely spread in online environments today.

Web-based idea contests/challenges or crowdsourcing initiatives have proven to be an effective and efficient means for organizations to collectively solve problems or generate creative ideas and concepts for new products. A call for participation directly by a firm or via hosting by an intermediary platform publicly invites diverse users with different backgrounds and areas of expertise to submit their solutions to a specific task or problem. We mainly find competitive setups e.g., on crowdsourcing platforms where only few winning entries get rewarded and participants compete for a cash prize (Adamczyk et al., 2012).

We also find very prominent examples of community-based innovation (user innovation, brand communities, open-source software and hardware) where cooperation is more common. Users exchange ideas and share knowledge with peers and thus value is created jointly with or without firms being involved.

While a competitive challenge spurs innovation by focusing on a specific problem within a short period of time (crowdsourcing), cooperative settings are more open and rather long-term oriented with a strong focus of social exchange between users and collaborative innovation processes (co-creation).

Recently, a promising new and hybrid form of web-based innovation could be observed where the latter concepts merge into *innovation-contest communities*

(Bullinger et al., 2010). Advantages of both worlds are fostered. Users are challenged to provide solutions to a specific problem with the best solution to be awarded with a prize, at the same time participants can cooperate with other contestants by interacting via commenting or by giving and receiving feedback during and beyond the contest.

From both, research on contests and communities, we gathered a solid understanding of users, their motivation and behavioral patterns in the respective setting and thus scholars were able to describe what community management and contest design should look like (Adamczyk et al., 2012).

In a hybrid configuration, the situation is different though. While some users enjoy exchanging ideas with other users and learning, other users might be interested in competing, exposing their capabilities, and winning a prize. The group of participants thus seems to be more diverse regarding motivation, background, and behavior. What kind of users gather in such a competitive and the same time cooperative environment? Are their certain types of users? What types of users would be preferable from a firm's and community host's perspective? A firm might be more interested in the innovative output and thus creative and proficient users are required. The community host, in contrary, is more interested in building a viable and vivid community with lively discussions and social exchange. Can we find users that serve both needs?

Research in this field is still in a nascent state. We thus find only few studies that have begun finding answers to those questions. Bullinger et al. (2010) were among the first to study cooperative behavior in a contest setting. In an experimental setup, they found that innovativeness was high if a user was very competitive or very collaborative.

The latter results could not be supported by Hutter et al. (2011) who conducted social network and cluster analysis in a case study from a firm-hosted contest community. They identified different types or roles of users. While the vast majority of users was rather passive, a small group of users stood out from the mass providing outstanding innovative input while at the same acting in a very cooperative manner. The authors argue that these users (so-called communititors)

compete and collaborate at the same time and thus are very valuable contest community members.

Füller et al. (2014) built on previous work and studied user roles and contributions on a jewelry design contest community. Their results support the effectiveness of a hybrid setting to generate innovation. They also found that users benefit from interaction and mutual feedback. Again, user roles that differ regarding communication and contribution behavior could be identified ranging from passive *lurkers* to *masters*. The latter group comprises key users who provided exceptional input to the contest and at the same time heavily interacted with other users.

To sum up, we know how users (mainly in consumer-oriented settings) behave and found distinct behavioral patterns in the form of user roles in single contexts. We do not know however **why users behave the way they do and what exactly defines a certain user type or role**. Even more interestingly, across contexts a very small group of key users could be observed that not only delivers innovative input, but also contributes to a vivid community culture by helping others improving their ideas. This type of user can be of essential importance to both innovation-seeking organizations and community management of a platform host. Thus, this phenomenon deserves further attention.

In addition, studies in other contexts beyond the consumer realm are necessary to broaden the research base in this field. All authors mentioned above thus called for follow-up research to find out more about users in contest communities which is crucial to derive adequate strategies for community and contest management.

The goal of this study hence is to shed further light on different users and their specific behavior by analyzing an idea challenge in a community focused on engineering and industrial design. A special focus will be set on those rarely found users mentioned above which I call *lead solvers*. Lead solvers stand out from the community with a high level of innovativeness and a strong cooperative orientation. Those users have been identified in other contexts, however, until now we lack a clear understanding of this type of user.

How can they be identified? Why do lead solvers behave cooperatively and what are distinct characteristics and behavioral traits? These are the research questions I want to address in this study.

Answering those questions is relevant for a number of reasons. First, web-based co-creation settings where firms interact with online communities gain in popularity across industries. Firms and intermediary platforms will thus compete for the most innovative users. They have to offer more than money for users to come and stay. A vivid community with a strong cooperative culture can be such a (unique) value proposition where users like to spend their time. Second, product development for both digital and physical artifacts more and more takes place in the digital/online sphere which enables distributed and collaborative value creation. It is very likely thus that even more tasks beyond ideation and concept development will be shifted closer to external communities of proficient users and (potential) customers. Third, being able to identify certain user types on the basis of distinct behavioral patterns in the course of a contest gives community and contest management the chance to support users individually and thus increase the innovative output overall.

1.2 Research design and approach

The nascent state of research in the realm of contest communities calls for an exploratory approach in an empirical setting (Eisenhardt & Graebner, 2007). I thus decided to study user types/roles in contest communities and the phenomenon of *lead solvers* in the context of a single case study. A multi-method approach was chosen to look at the phenomenon under study from different perspectives (Flick, 2015). I applied both quantitative and qualitative methods in a series of three independent but consecutive studies to improve the validity of the results (Jick, 1979).

First, I ran a pre-study (study 1) via a survey with open-ended questions among contest participants to make myself familiar with the community and to explore user heterogeneity in general.

In study 2, I applied an established methodology to identify and describe distinct user types/roles (Füller et al., 2014; Gleave et al., 2009; Welser et al., 2011). Social network and cluster analysis based on the interaction behavior was used to identify user types/roles followed by an interpretive content analysis to check for distinct communication patterns among them. Beyond the effectiveness of this approach, it also ensures a certain level of generalizability of the results overall.

Finally, a qualitative approach (study 3: semi-structured interviews with representatives of each user group identified in study 2) was chosen to understand (lead) solvers. I used a grounded theory approach (Gioia methodology) to build the lead solver model on the basis of rich insights by the users themselves (Gioia et al., 2013).

1.3 Structure of thesis

The thesis comprises five main parts with nine chapters. I begin with a general introduction to the topic to state the relevance of the research problem, to reveal the research gap and to outline the overall research approach (**chapter 1**). In **chapter 2**, the most important terms that require clarification will be presented.

Part II covers the theoretical and methodological foundations of the study. First, I elaborate on insights from prior literature and theoretical foundations for this research (**chapter 3**). Starting from a general overview on innovation (3.1) and co-creation (3.2), I concentrate on two general forms of (open) innovation settings: community-based innovation (3.3) and innovation contests (3.4). After comparing those concepts (3.5), a new and hybrid form where the latter concepts merge into so-called innovation-contest communities is presented (3.6). The following section (3.7) introduces user types and roles in the context of a broad variety of online communities. Finally, I highlight gaps in extant literature and derive the main research questions for this study (3.8).

Chapter 4 explicitly outlines the research design and methodological approach of the thesis. First, I develop the lead solver framework (4.1) based on relevant and related literature with the two dimensions *innovativeness* and *cooperative orientation* which is then operationalized in the form of research propositions (4.2).

Subsequently, I will shortly outline the general methodological approach (4.3) and present the research setting at hand (4.4).

Part III consists of two consecutive studies. In study 1, I explore user heterogeneity in the case setting by means of a survey among the contestants (**chapter 5**). After a short introduction (5.1), I elaborate on the questionnaire development and present the data set (5.2). The findings will be discussed in section 5.3, followed by a discussion with implications for further research (5.4).

Chapter 6 featuring study 2 starts with an introduction (6.1) and method section (6.2). Next, user types will be identified by applying a mix of methods starting with social network and cluster analysis followed by analysis of variance and content analysis (6.3). The comprehensive results will be presented in a user typology (6.4) which is then critically discussed (6.5).

Part IV focuses on understanding (lead) solvers. In study 3 (**chapter 7**), I take on a users' perspective by interviewing participants and representative users of each user group that was identified previously. Here, introduction (7.1), methodology (7.2) and data collection (7.3) require special attention as they set the basis for further extensive grounded theory analysis. In fact, I ran two rounds of analyses: one focusing on user types in general (7.4-7.6), and one with a special interest in lead solvers (7.7-7.8).

Part V closes this thesis by integrating the results of the separate studies. In **chapter 8**, I critically discuss my results and review the research framework with refined research propositions (8.1). In addition, limitations of my work as well as considerations on validity and generalization of the results will be presented (8.2).

Finally, **chapter 9** concludes by outlining contributions to the body of literature (9.1), by deriving managerial implications for practice (9.2), and by presenting a research outlook with suggestions for future research (9.3).

Chapter 2

Definition of terms

Co-creation refers to the collaborative value creation between different actors which Galvagno & Dalli (2014, p. 644) define as "joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically".

Collaboration and **cooperation** are mostly used inconsistently in literature. For Schoettle et al. (2014), collaboration is a stronger form of relationship between actors with a common vision, shared resources and a joint approach where trust and transparency is important. Cooperation on the other hand refers to a rather lose relationship where the overall goal might be similar, but operationalization happens independently from each other. While collaboration along this definition might be attributable to certain online communities with a common goal (open-source software), I prefer the term cooperation for contest communities as users pursue their own project but also help others with support and feedback.

Online community refers to a community where users interact with other people and organizations via a web-based platform for different purpose.

An **Innovation community** can be understood as "groups of individuals, affiliated through a common technology or use condition, who connect with each other […] and willingly and freely share with each other their problems and solutions to the various use conditions of that technology" (Harhoff & Lakhani, 2016, p. 111). In the context of this study, there are mainly two types of (innovation) communities. **Intermediary platforms** are hosted by a third party that manages a community of users and sets up challenges for seeking

organizations as a service. **Firm-hosted communities** are set up and hosted by an organization, thus there is a direct relationship with the community.

An **innovation contest** or **challenge** can be defined as "a (web-based) competition of innovators who use their skills, experience and creativity to provide a solution for a particular contest challenge defined by an organizer" (Bullinger et al., 2010).

A **user** is a person who uses an information system, in our case who engages in web-based communities and not a person who uses a product. A **solver** is a user who is part of a contest or innovation community. The terms are used synonymously in this study for the sake of simplicity and to avoid confusion regarding lead user theory.

User roles and **types** in online communities are not consistently defined and oftentimes used synonymously in literature. I prefer role over type as users in the context of innovation communities might evolve and change roles over time. Thus, I follow a rather generic understanding as behavioral and relational patterns that interact with each other in a community type-specific role ecology (Gleave et al., 2009; Welser et al., 2011). In a static analysis of a community as it is the case in my study, however, user type and a user role can be regarded as synonymous for the sake of simplicity.

Part II: Theoretical and methodological foundations

Chapter 3

Insights from prior literature

3.1 Where ideas come from

Innovation is at the heart of any firm. According to Drucker (1954, p. 37), "any business enterprise has two – and only these two – basic functions: marketing and innovation". Precisely defining the term *innovation* though is not easy as there are plenty perspectives (e.g. marketing, engineering, new product development) and different categories of innovation (e.g. radical, incremental, discontinuous) found in literature (e.g. Garcia & Calantone, 2002). Regarding the innovation artifact, the Oslo Manual (2005) describes four types: product, process, marketing and organizational innovations. These types share a common feature to be considered innovative: they need to be implemented.

In the context of product innovation this means an introduction of a new or significantly improved product on the market. The basis for such a product is an invention or in the most basic form: an idea (Koberg et al., 2003). Amabile et al. (1996, p. 126) argue that innovation is "the successful implementation of creative ideas". 'Successful' in this context means that an idea in the form of a product or service passes social evaluation (e.g. on the market) (Csikszentmihalyi, 1996).

These creative ideas set the basis for long-term competitiveness of firms and may originate from both inside and outside the organization. In fact, there is increasing evidence that ideas from users, customers and other external actors play a major role in innovation (Hippel, 2006). Traditionally, innovation management in organizations focused on inhouse research and development (R&D) with full

control of the process, also referred to as *closed innovation* (Chesbrough et al., 2006). Success of inhouse R&D efforts cannot be guaranteed though. In fact, corporate innovation processes are risky and expensive. There are limitations in team scale and diversity (Yang et al., 2009). Thinking outside the box is hard to manage.

Continuous pressure for innovation has forced companies thus to search for new ideas beyond corporate barriers. The concept of *open innovation* describes how external knowledge can be utilized and internally sourced ideas that do not match the business strategy may be applied outside a company's sphere (Chesbrough et al., 2006) (Figure 1, left). Integrating customers into corporate innovation practices can substantially increase the innovativeness of firms. Terwiesch & Ulrich (2009) argue that as much as one quarter of innovation opportunities stems from interactions with customers and new customer requirements derived as a consequence. Furthermore, external actors can also help to solve problems via *crowdsourcing* and improve products via feedback and testing (Boudreau & Lakhani, 2013) (Figure 1, middle). Open innovation practices are a promising means to complement traditional innovation and are well-known and established across a wide range of industries these days, e.g., Procter & Gamble, General Electric, Siemens, SAP.

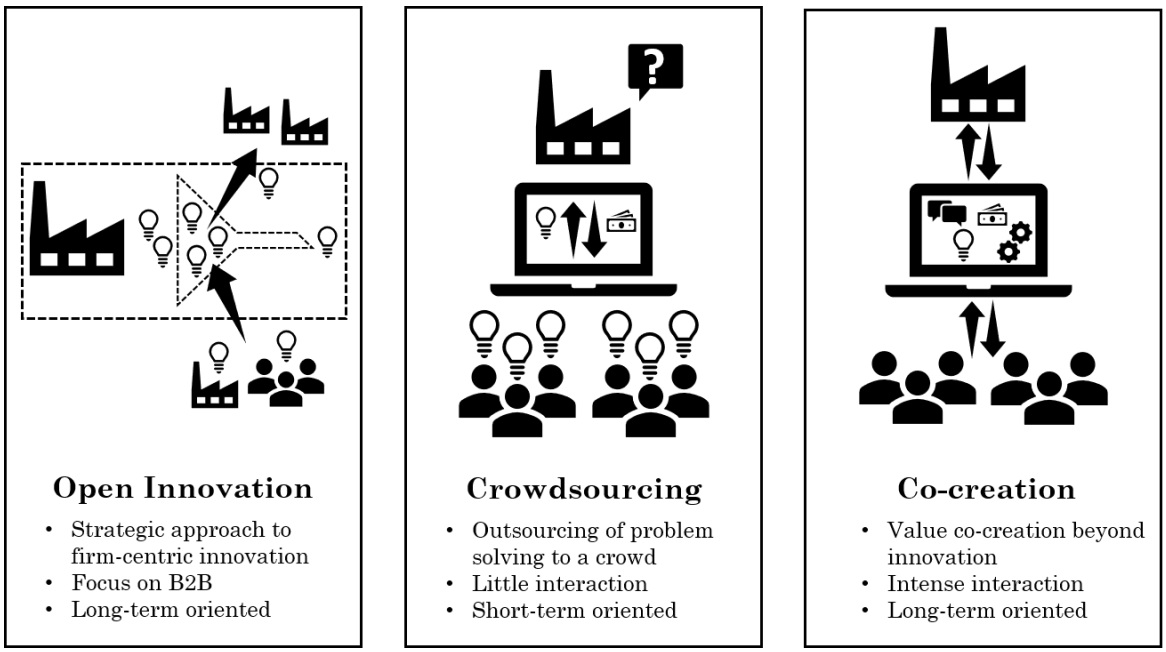


Figure 1. Concepts to integrate external knowledge into corporate innovation (author's own illustration)

3.2 The power of co-creation

The strategic concept of (value) co-creation reaches beyond open innovation as it extends the notion of openness to other stages of the value chain and thus provides a broader perspective regarding the integration of external actors. Even more, it serves as a process model that allows us to cover alternative value creation systems where users in online communities collaboratively create value and where companies not necessarily need to be involved or at least play a minor role (e.g., open-source software/hardware, user innovation communities). Co-creation thus shifts the focus from a firm-centric to a more comprehensive view where companies are part of a value creation system (Figure 1, middle).

The notion of co-creation first emerged in the context of marketing (Prahalad & Ramaswamy, 2004) and service sciences (Vargo et al., 2008), but quickly diffused into adjacent realms, e.g. innovation, branding, retail and production (Leclercq et al., 2016). A rather vague definition was proposed by Galvagno & Dalli (2014, p. 644) who understand co-creation as "joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically". Depending on the context, it may thus be operationalized in many ways ranging from customer integration in marketing following a weak notion to collaborative product development and testing with online communities in a strong notion (Roser et al., 2013). In the latter case, the community can be regarded a major asset of a firm which strongly influences the innovation outcome through collaborative idea generation, testing and feedback. The relationship can be best described as a long-term partnership or cooperation rather than a principal-agent-relationship. Products, components, and services are in the true sense of the word created cooperatively. Furthermore, these co-creation platforms also enable collaboration and knowledge sharing among users who publicly post and discuss their ideas or give feedback and suggestions for improvement (Jeppesen & Frederiksen, 2006).

There are many ways how firms may engage in value co-creation with external users and customers. Common concepts these days are communities and contests. Lately, another form has emerged that combines the specific advantages of the latter, namely *contest communities*.

3.3 Community-based innovation

Collaborative communities, both online and offline, have been studied widely in the context of innovation and there is considerable amount of evidence that they may have a substantial impact on technological progress (O'Mahony & Lakhani, 2011, West & Lakhani, 2008). With the advent of the Internet and the World Wide Web, global collaboration between hundreds of thousands of people was possible and thus the full potential of web-based joint value creation could unfold. At minimal cost, users can gather, share knowledge and ideas, and work together on specific problems. However, there is historical evidence that community-based innovation practices turned out to be advantageous in an offline context as well.

Allen (1983), for example, discovered *collective invention* processes as a fourth inventive institution (besides universities, corporate R&D and private inventors) e.g., at work in U.K.'s iron industry in the 19th century. Engineers and (competing) entrepreneurs of the same industry gathered in a community to collaboratively improve the performance of blast furnace technology for iron making by sharing knowledge and data of different furnace settings (e.g., temperature, height). This collaboration was mutually beneficial because information was hard to keep secret, most improvements were not patentable, competition for the best designs spurred innovation, and higher efficiency would increase profitability. This led to an overall increase of efficiency in iron production. Allen derived three distinct features for a setting of collective invention: a phase of incremental innovations in a technological field; actors of the same industry share technical information about designs and performances; a joint effort to improve the respective technology based on the shared knowledge.

Nuvolari (2004) studied similar collaborative practices in the field of steam engines in the U.K. during the 18th century. With a broad patent in place, Boulton and Watt had a monopole on steam engines. Cornish mine entrepreneurs who built and operated pumping engines based on their design had to pay royalties based on a share of the savings of fuel cost. The patent blocked further advancements of the technology by other engineers and thus no major innovation happened around the steam engine until the patent expired in 1800. After a short period, mine entrepreneurs set up a monthly journal in 1811 where they would share technical

specifications, procedures and performance data derived by development efforts of their engineers. Very quickly, competition between engineers arose and the sharing of best practices led to a flourishing era of technical progress. The rate of technical advance of the engines radically increased with major improvements of the thermodynamic efficiency of Cornish engines.

In the late 19th century, producers of Bessemer steel in the U.S. jointly formed the Bessemer Association to serve as a patent pool to circumnavigate a situation of patent blockage that resulted in a slowdown of innovation in steel production. Designs and performance data were shared and cross-licensed and thus the pace of innovation increased. (Nuvolari, 2004)

Another interesting case can be found in the silk industry: In the early 19th century, London and Lyon competed for predominance in silk production. Whereas patenting and secrecy was the favored mode of innovation in the U.K., the industry in Lyon set up a system of open use of technological innovation which led to a rapid dissemination and adoption of new technologies. Finally, Lyon flourished as an industrial district for modern silk production, while the London-based silk industry vanished. (Nuvolari, 2004)

More recent examples of collaborative innovation can be found in the realm of computer technology and software development. In 1975, students at Stanford University founded the Homebrew Computer Club where people interested in developing applications for the newly invented microprocessor gathered and shared information about their ideas and designs. One of the members was Steve Wozniak who presented his computer called Apple. As some applications reached a mature level and commercialization started, however, the atmosphere turned more competitive which in the end led to its disbanding in 1986. (Osterloh & Rota, 2007)

The most striking case of collaborative innovation in online communities can be found in the realm of open-source software (Hippel & Krogh, 2003, Osterloh & Rota, 2007). Starting in the early days of software development in the 1970s and 80s, open-source (meaning openly sharing code and permitting others to use and modify it) has evolved from a countermovement against proprietary software and

operating systems (resulting in restrictions in use and freedom to make modifications) to the predominant innovation mode of the software industry today (Lerner & Schankerman, 2010).

These days, we find huge online communities where users contribute code (e.g., Linux, Apache, Mozilla). Beyond the voluntarism of users of the early phase, open source as a development model reached maturity in the sense that nowadays it is an essential part of software development worldwide. Large corporations like SAP, Oracle, IBM, or Google are strongly interacting with or hosting their own communities. Red Hat runs a billion-dollar business solely around services based on the open-source operating system Linux. It was recently bought by IBM for US$ 34 billion. Some even sponsor open-source communities by assigning their employees to open-source projects. In fact, modern ICT, its applications and the Internet as we use it today would not work or even exist without the open-source movement (e.g., MySQL, Mozilla, Google's Android, Apple's iOS and OS X) (Weber, 2004).

What all these cases have in common is the fact that actors privately invest resources in innovation activities and then freely reveal the results of their effort (knowledge in the form of information as public goods) to a community or the public. This kind of behavior cannot be explained with traditional theories on innovation that basically claimed that technological progress happens either via *private investments of individuals* that receive a temporary exclusive right to exploit an invention (monopole e.g., via patents) in exchange for their effort, or alternatively via a *collective-action* innovation model where society favors a publicly-funded research system and the outcome is a non-rival and non-excludable public good (publicly disclosed knowledge). (Krogh & Hippel, 2006)

Thus, von Hippel & Krogh (2003) proposed a new, hybrid innovation model which they call *private-collective innovation* that should explain how actors derive private benefits from public disclosure. They argue that innovators under this notion gain net benefits for themselves despite or rather through revealing their innovations for free. On the one hand, they solve a problem that they face anyways (and thus private investment is worth it). On the other hand, sharing their knowledge with others gives them the chance to gather feedback and make use of improvements

by others. In addition, it enables dissemination and adoption of the original idea. So, in the end the contribution to a public good is self-rewarding for the innovators.

Serving a personal need is one motive to participate in innovation communities. Other motives found to be present in community settings are enjoyment, stimulation, a sense of community, or satisfaction in tackling challenging tasks (intrinsic motivations). Furthermore, direct and indirect extrinsic motives drive user participation, e.g. monetary compensation for work, career signaling, learning and skill improvement. (Hertel et al., 2003; Lakhani & Wolf, 2003; Lerner & Tirole, 2002)

Developing software along the community-based innovation model is favorable for many reasons (Osterloh & Rota, 2007). First, software is an *information good*. That means, in stark contrast to the creation of physical artifacts, the marginal cost of reproduction and distribution is nearly zero once it is created. There is no rivalry in consumption. Sharing the code or information does not preclude the contributor from using it. Second, contributors can be regarded as *user innovators* (Hippel, 1986, 2006). Such users know a product very well and are thus able and willing to suggest improvements or modify it according to their needs. By sharing an innovation, a user gives other interested people the possibility to learn, study his or her product and improve it further which might benefit the originator as well. Last, software development calls for a modular architecture which enables distribution and collaboration among many developers (Baldwin & Clark, 2003). With modern ICT in place, this process can be organized independent of place and time and is thus perfectly suited for global collaboration of different actors.

Beyond software, today these features apply to many other contexts in the age of information and digitization with the most prominent example being Wikipedia. In the realm of hardware development too we find similar community-based approaches enabled by advanced cloud-based design, engineering and project management software and technological progress of digital means of production, namely open-source hardware (Moritz et al., 2016; 2018). Since hardware thus becomes more like software, hardware development may be organized in the same distributed and collaborative manner at least in the early phases of new product

development (NPD) (ideation, concept development, design and testing) (Lerner & Tirole, 2002).

Lakhani (2016, p. 111) proposed a more general definition for innovation communities to be understood as "groups of individuals, affiliated through a common technology or use condition, who connect with each other […] and willingly and freely share with each other their problems and solutions to the various use conditions of that technology".

Integrating user communities into the value creation process of a company is quite common these days, in particular as these communities usually entail *lead users* and *user innovators* that can be a valuable source for improving products and adding new features (e.g. Franke & Shah, 2003; Füller et al., 2007; Hippel, 1986; Lüthje, 2004; Lüthje et al., 2005; Lüthje & Herstatt, 2004; Piller et al., 2010). In the innovation context, firms make use of communities to build brands (Füller et al., 2008; McWilliam, 2000; Muniz & O'guinn, 2001), to collect feedback and new ideas, to identify market demands or develop new product features and complementary functions based on user input, see also Figure 2 (Bayus, 2013; Jeppesen & Frederiksen, 2006). Companies like Quirky, Dell, Lego or Threadless are just some prominent examples where users are an essential part of the value creation process (Poetz & Schreier, 2012). They provide ideas for products and designs and in some cases can participate in the concept development phase. Most companies share a portion of revenues generated by products that were inspired by users with the community.

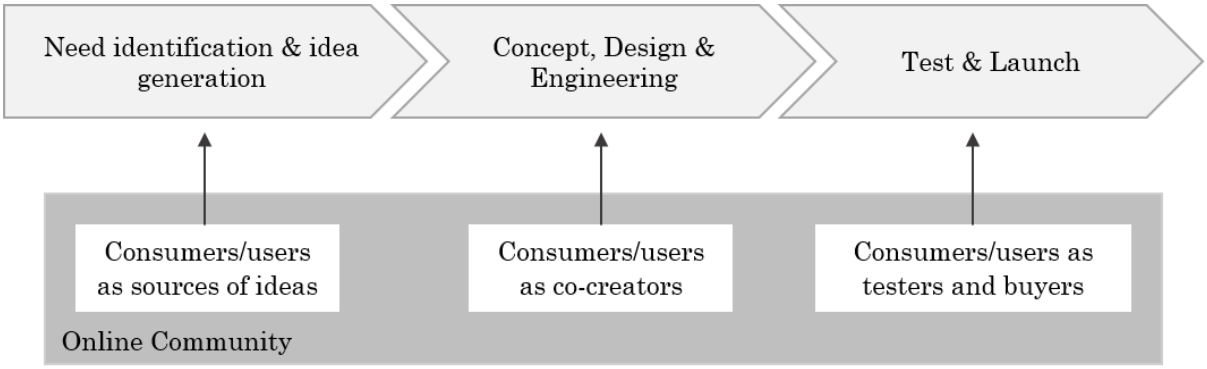


Figure 2. How users of online communities contribute in NPD (adapted from Füller & Hienerth, 2004)

Despite the potential benefits derived by firm-community interaction, hosting and collaborating with a community implies challenges in finding and attracting users, coordinating their activities, and maintaining continuous engagement. Finding and attracting (lead) users can be demanding (Eisenberg, 2011). Users are more likely to gather in communities around certain technologies, brands, or products and very often in the realm of consumer products where contributors are in fact heavy users of those.

Motivational drivers can be both intrinsic and extrinsic. However, whereas in open-source communities most users derive benefits for their professional careers in some way (e.g. via signaling and learning), hobbyists and enthusiasts in consumer or brand communities prefer sharing and free-revealing for the sake of serving personal needs and interacting with the respective company in a non-competitive setting (firm recognition) as well as exchanging ideas with like-minded peers (peer recognition) (Jeppesen & Frederiksen, 2006). In the context of the lead user concept, Brem et al. (2018) analyzed how social media can be utilized to search for (lead) users via tools like netnography, broadcasting or crowdsourcing.

In any case, companies that want to attract users need to provide an open platform and open up some of their products or at least product features for users to engage with. This requires a strategic shift in the R&D mindset. Furthermore, firms need to provide sufficient resources for community management and inhouse subject matter experts that engage in communication with users as recognition by the firm (within the community) can be a strong motivational factor apart from unserved user needs (Jeppesen & Frederiksen, 2006).

Users are free to choose when, how and what they contribute (self-selection) (Harhoff & Lakhani, 2016). The outcome of a user community thus is hard to define ex ante. Users contribute only to projects that are of interest to them which requires rethinking coordination, integration, and governance. Modular product architectures are favorable as they enable distributed product development (Baldwin & Clark, 2003). Another possibility is to use web-based toolkits to direct and coordinate user interactions (Franke & Piller, 2004).

Firm recognition within the community (and indirectly peer recognition) can be an important motivation to participate (Jeppesen & Frederiksen, 2006). Thus, openly acknowledging valuable contributions by giving attributions to certain users is important for continuous involvement. The issue of monetary compensation in a case where revenues will be generated based on user input can be tricky though. On the one hand, users want to be treated fairly meaning that they want their effort to be recognized and, in some ways, compensated (Franke et al., 2013). On the other hand, financial compensation for users and thus competition for money can destroy a community culture based on sharing and collaboration. After all, ensuring continuous participation, collaboration and contribution by users is crucial for a viable user community.

In essence, innovation in and innovating with (online) communities is quite common these days and proved to be a viable case for the concept of co-creation. Firms that manage to build up a user community have a strong resource base at hand and can tap into a constant source for new ideas, products, and features. Firm-community relationships are long-term oriented, mutually beneficial and based on collaboration, openness, and trust. Innovation communities with or without a firm being involved follow a common goal and make a joint effort to reach it. The outcome is not clear at the beginning and users can hardly be controlled. Therefore, community building and management requires constant effort and investment of resources and thus should be embedded in corporate strategy. The risk of failure is high, but so is the potential for new ideas leading to a competitive advantage or a unique selling proposition.

At first view, not every product, brand, technology, or organization seems to be suitable for community-based innovation processes, e.g., B2B markets, commodities, or defense industry. Still, every product or service serves a need that someone has, every purchase is made by a customer and every product or service is used by people. An organization should thus consider co-creation of value with communities at some point as firm-hosted communities may serve also other purposes than innovation, e.g., marketing, branding, recruiting, customer support.

3.4 Innovation contests

Innovation contests and competitions just like communities have a longstanding track record to spur innovation and solve problems in a wide range of fields of application, e.g., agriculture and food, aviation, energy, medicine, navigation. Famous examples include the invention of margarine as a substitute for butter in the 19th century, the invention of food canning and the discovery of the longitude at sea in the 18th century, or the first non-stop flight across the Atlantic Ocean. (Adamczyk et al., 2012)

Lately, innovation contests as a means to problem solving and to create breakthrough innovations have gained in popularity as a broad and diverse audience from all over the world can easily and at low cost be addressed with web-based applications. For example, the X Prize foundation regularly hosts public competitions related to specific technologies and intended to improve humanity. The first initiative was the Ansari X Prize announced in 1996 with the goal of encouraging private spaceflight activities. A prize money of US$ 10 million would be awarded to the first contestant who until 2005 demonstrates flying to the edge of space twice within two weeks with a vehicle that has one pilot and two passengers on board and that can be reused at least by 90 % of its parts. Twenty-six teams signed up for the competition. In 2004, the prize was handed over to the Tier One project after two successful flights. The underlying technology is now used by Virgin Galactic among others, a company that wants to offer suborbital spaceflight for tourists soon. Ever since, more than fifteen X Prize-contests have been initiated covering a broad range of topics, e.g., water abundance, rainforest preservation, oil cleanup, learning and literacy. Similar approaches to solve specific problems are undertaken by governmental agencies, e.g., NASA Centennial Challenges, DARPA Grand Challenges.

In the business context too, contests proved to be a powerful tool for innovation. In 2006, the video streaming service Netflix set up the Netflix Prize where US$ 1 million would be given to the team that would provide a significantly better collaborative filtering system than the inhouse solution to predict user ratings for movies. Within half a year, 20,000 teams from all over the world signed up. In 2009, a winner team was announced who managed to improve Netflix' algorithm

by 10 %. Another prominent example is the Hyperloop Pod competition series hosted by the aerospace company SpaceX. The goal of these challenges that are majorly directed towards engineering students was to demonstrate feasibility of the Hyperloop transportation concept. In the latest competition, the pod design prototype of the winning team reached a top speed of more than 450 km/h.

What these contests both web-based and offline have in common, is a specific problem that needs to be solved. This problem is then published in the form of an open call for participation with a specific contest configuration (e.g., time, prices, process, criteria). The idea behind the concept is to receive as many solutions or ideas as possible from a crowd of diverse and highly motivated solvers around the world with different backgrounds and experiences and therefore to find a truly creative and innovative solution to the problem that otherwise would not have been found. Usually, the submission will be privately transferred to the seeking organization directly or via an intermediary. After the submission phase follow one or more rounds of evaluation (e.g. via community voting, expert jury) and refinement leading to the final ranking and awarding of one or more winners in exchange for the intellectual property rights of the submissions, see also Figure 3. (Harhoff & Lakhani, 2016)

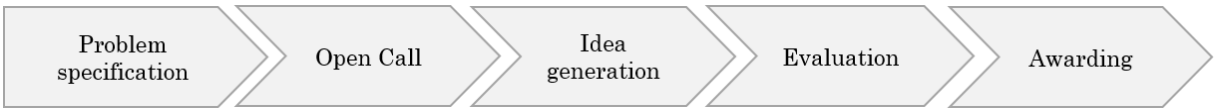


Figure 3. Generic process of an innovation challenge (author's own illustration)

An innovation contest where many people compete for one or more prizes naturally evokes competitive behavior between the actors who invest time to receive something in return. During the contest, there is limited to no interaction between users and the submissions usually remain hidden to other participants. In fact, Foege et al. (2019) found that users follow IP protection strategies against other users and the seeking organization, just like firms do. The seeking organization may engage directly with users by giving feedback which in fact can increase the effort of solvers as the perceived chance of winning is higher (Yang et al., 2009). In this case, the seeker establishes many dyadic relationships to different users, the users among themselves however do not form any relationships.

More formally, Adamczyk (2012) defines innovation contests as "time-limited competitions arranged by an organization or individual calling on the general public or a specific target group to make use of their expertise, skills, or creativity in order to submit a solution for a particular task previously defined by the organizer who strives for an innovative solution". From an organizational perspective, an innovation contest can be part of an open innovation strategy and usually relates to new product development (NPD). Contests can also be understood as a form of *crowdsourcing*, a term that Howe (2009) defined as the "act of taking a task once performed by a designated agent (usually an employee), and outsourcing it to a large, undefined group of people external to the company in the form of an open call".

Asking external actors to come up with new product ideas is somewhat counterintuitive at first view. Traditional innovation literature would argue that truly creative ideas are out of scope for conventional consumers. Rather, inhouse marketers and engineers with their experience and domain-specific expertise are the ones who come up with new ideas (Cooper, 1987). More recent research however found that integrating product users and customers in NPD via crowdsourcing can be a powerful source of new product ideas. In fact, Poetz & Schreier (2012) found in an experimental setting that crowdsourcing may lead to superior outcomes compared to traditional inhouse NPD processes in terms of novelty and customer benefit, in particular when solving needs-based problems. Crowdsourcing should therefore be considered at least as a complementary approach in organizations' innovation strategy.

Sourcing truly new and creative ideas or solutions to a problem outside the firm can be more effective than traditional approaches (Piller & Walcher, 2006). On the one hand, the diversity of the solver community brings in multiple perspectives on the issue that needs resolution; on the other hand, the winning solutions survived competition in the contest and thus they are more likely to succeed in the market afterwards. It can also be more efficient. Firms receive a lot of input by solvers to choose from within a short period of time. Even more interestingly, firms pay only for working solutions, but not for failures. (Yang et al., 2009)

Clearly defining a problem so that other people can respond to it, is one thing that is not easy and requires some experience (Jeppesen & Lakhani, 2010). Finding and attracting potential (preferably innovative and diverse) solvers and subsequently managing a web-based contest with potentially thousands of participants is another critical issue that can be quite challenging for a seeking organization (Adamczyk et al., 2012). Ebner et al. (2009) elaborated on success factors of innovation contests and found in their study that the right incentive regime, intense community management and communication with the users as well as trust (building) are crucial. Füller et al. (2011) found that the experience of the participation itself is an important determinant for user attractiveness. Providing a modern co-creation platform with compelling features thus is a prerequisite. Beyond the technical infrastructure, satisfaction with the outcome derived for example via a jury voting, perceived fairness with the process and a sense of community are additional factors that influence future actions of users and their willingness to spread the word about the platform/product/brand/company (Gebauer et al., 2013).

These are just some of the reasons why professional intermediary platforms and knowledge brokers have emerged that position themselves in between the two parties to assist in connecting to and interacting with external actors and provide a full service for seekers from problem definition over contest hosting and community management to the final evaluation of solutions. By working with an intermediary, seeking organizations can outsource risks and effort, reduce uncertainty of the outcome and address tensions about power (control vs. openness), competence (professional vs. personal) and identity (group vs. individual) (Lauritzen, 2017). These intermediary platforms usually are domain-specific with a large community of solvers at hand (e.g. InnoCentive for scientific problems, TopCoder for algorithms, Kaggle for data analytics, OpenIDEO for social impact) (Harhoff & Lakhani, 2016).

With increasing popularity and dissemination of crowdsourcing practices from both sides, seekers and solvers, innovation contests received further attention by scholars in the field of innovation management. Emerging research categories include the economic perspective of contests (e.g., what problems should be solved

in a contest setting? How do awards influence the outcome of contests?), the management perspective (e.g., How to organize a contest? How to find and attract users?) as well as categories that focus on the purpose of a contest (educational, innovation and sustainability). Little is known though about the outcome of innovation contests as existing literature mainly draws upon few success stories. Challenges with contests, failures and threats received little attention. (Adamczyk et al., 2012)

There is a considerable amount of research that discusses procedural aspects of contests (see also Table 1). For example, we know that higher prices, lower time expenditure, shorter and clear problem descriptions, a longer duration of the contest and greater popularity (of the topic and the involved companies/brands) result in a higher number of participants. Another strand of research derived a set of fifteen design elements that serves as a comprehensive framework when it comes to setting up a contest. (Adamczyk et al., 2012)

Regarding solver characteristics, Jeppesen & Lakhani (2010) found that both technical and social marginality of users (meaning distance from the technological field and the respective community) increases the chance to find creative and unexpected solutions in a contest. Hence, it is crucial to broadcast a call as widely as possible so that such users can be addressed.

Motivational aspects that are the basis for attraction and facilitation are also known to a certain extent. We find both intrinsically and extrinsically motives among contestants. Rewards, platform features and contest setting should thus be adapted accordingly (Boudreau et al., 2011). Winning the prize money is an important driver. This seems fair: a user solves a problem or comes up with a new product idea that helps a firm to make more profit. However, only one or few users get remunerated for their effort and many others come away empty-handed. The higher the number of contestants, the lower is the chance of winning for an individual user. Thus, we should see other factors at work beyond monetary compensation. Lakhani et al. (2010) found fame and reputation among peers to be important drivers for participation. Another aspect is indirect signaling for jobs. Rather intrinsic elements present in contests comprise fun, learning and finding enjoyment in competing with others.

The process of voluntary self-selection of contestants (in comparison to employees where management dictates what to work on) was found to be particularly important, too. People who self-select themselves into a specific task are willing to spend more time on the problem at hand (Boudreau & Lakhani, 2011).

Table 1. Design elements of an innovation contest (adapted from Adamczyk et al., 2012)

Design element	**Attributes**					
Media	Online	Mixed	Offline			
Organizer	Company	Public Org.	Non-profit	Individual		
Problem specification	Low (open task)	Defined	High (specific task)			
Degree of elaboration	Idea	Sketch	Concept	Prototype	Solution	Evolving
Target group	Specified	Unspecified				
Participant as	Individual	Team	Both			
Timeline	Very short term	Short term	Long term	Very long term		
Reward/ Incentives	Monetary	Non-monetary	Mix			
Community functionality	Given	Not Given				
Evaluation	Jury	Peer Review	Self-assessment	Mix		
Attraction/ marketing	Online	Offline	Mixed			
Facilitation/moderation	Professional	Peer	mixed			
Sponsorship/partnership	Family & friends	Universities	National Assoc.	Specific industry	Educ. Agencies	Mix
Contest phase	One	Two (Refinement)	More			
Replication	Biannual	Annual	Less frequent	More frequent		

To sum up, (web-based) innovation contests are a promising means for firms to generate a large number of solutions to a specific problem or ideas for new products within short time and with manageable financial investment and risk by broadcasting an open call to a large and diverse crowd of solvers with or without the help of an intermediary platform. In exchange for their effort and the intellectual property, winning solvers usually receive a monetary compensation by the seeking organization. It can thus be referred to as a transaction: money for solutions/ideas. Key to innovative solutions is to find and attract many diverse

solvers that are willing to and capable of delivering creative and out-of-the-box input to the task at hand (Poetz & Schreier, 2012). A contest thus has to be designed thoroughly.

Distinct features of contests are competition between users and ideas, little to no interaction between users and a rather short-term commitment by both firms and users. As the barriers to set up a contest are comparably low, running an innovation contest is a good starting point for organizations to try out open innovation practises. However, it requires an open mindset and a cultural shift of corporate innovation.

3.5 Comparing communities and contests

We have learned how organizations can innovate and co-create value with external actors either by building up a community of customers, users of products or technology enthusiasts or by crowdsourcing solutions to specific problems or ideas for new products via contests. Both approaches hold specific characteristics and advantages that need to be considered beforehand.

Overall, innovating with communities fosters collaboration between firms and users, but also **cooperation** within user groups. Free revealing and sharing of knowledge and ideas is the common basis for a mutually beneficial relation and a sense of community (Preece et al., 2004). Interactions and communication between users enrich the variety of ideas and thus improve the quality overall (Perry-Smith & Shalley, 2003). Building up and managing a community requires a strategic commitment and provision of sufficient resources by an organization and thus should be long-term oriented. A vivid user community may have a strong impact on the innovativeness of a firm. Users are regarded as innovation partners and part of a value co-creation system.

Innovation contests, in contrary, are more specific, time-bound, rather short-term oriented and based on the concept of **competition**. Firms outsource problem solving and idea generation to a crowd of users with or without an intermediary platform. Time pressure and a challenging task can fuel creativity among the solvers (Amabile, 1996). In exchange for their effort and the intellectual property,

some of the users receive a monetary compensation. The contestants compete for one or more prizes. In most cases, there is little to no interaction between users and submissions remain hidden to other users during the contest. Seeking organizations face a low risk as the financial investment is manageable. For a fixed price (usually paid to only a few winning contestants), they receive a large number of ideas to choose from. Hosting a competition requires a minimum level of organizational openness. In fact, some intermediaries host anonymous challenges where the seeking organization is not known and will be only communicated to the winners.

Regarding the innovation process, a major difference between the two approaches is the **moment of knowledge disclosure**. In communities, users reveal their ideas and knowledge early so that others can pick up their ideas and further develop them. Quite the opposite happens in a contest setting: User submissions usually will not be published until the end of the contest when the winners are announced. Sometimes only the winning ideas will be shown, and all the other ideas remain secret. This influences user dynamics and behaviors. In the collaborative setting, users can benefit from freely revealed ideas of others which decreases their own effort as there are fewer appropriation opportunities.

Boudreau & Lakhani (2015) studied how the setup of an innovation problem (early vs. late disclosure) influenced participants behavior. They found that early disclosure of ideas (collaborative approach) and subsequently a lower incentive leads to a lower number of participants with less effort and to fewer novel solution paths than in a competitive setting. Due to knowledge-spillovers and a convergence of superior solution paths during the innovation process, however, the average quality of results and the maximum performance was higher. In contrast, the competitive configuration with late knowledge disclosure resulted in more diverse solution paths as users explored different and unconventional ways in parallel. The overall performance was lower though.

They conclude that the community mode is more suitable if there is a common knowledge/technology base and thus solution trajectory to build on. On the other hand, contests are an appropriate means in case there is complete uncertainty about the solution space to a specific problem. Firms who want to strategically

work with a community of external actors and effectively find truly new and creative solutions or ideas should thus consider a staged process: Starting off with a contest to explore different paths followed by a collaborative setting where early releasing and knowledge sharing is promoted.

Wooten & Ulrich (2013) studied the effect of entry visibility in contests with quite different results. They found that open contests where submissions are visible to other contestants lead to more entries as more participants enter the competition. One reason to explain this is that it is easier for users to pick up inspiration from others and challenge themselves to come up with better ideas. Furthermore, an open setting provides a better learning environment. This might encourage users to enter a competition as well. On the downside, the variance of solutions in terms of quality and scope is lower compared to traditional blind settings. Even more strikingly, Bockstedt et al. (2016) found in a similar open environment that contestants are more likely to succeed in a contest the earlier they submit their idea despite the potential risk of free riding and loss of intellectual property. Users succeed because of and not despite openness and sharing.

Another distinguishing characteristic that is related to the moment of disclosure is the **feedback**. While feedback during the process of creation by both the firm/host and other users is an essential feature in communities, it is limited to some rare cases in contests where the seeking organizations engages in feedback activities. As recognition of peers and the hosting firm is a strong motivational factor for participation, feedback is an crucial means to address this need (Jeppesen & Frederiksen, 2006). Beyond the social side, feedback by others is also an important driver for quality improvement and technological advancement, e.g., in software development (Lerner & Tirole, 2002).

In contests too, feedback by the seeking organization may have a positive influence on the outcome. Wooten & Ulrich (2017) found that direct feedback increases participation and benefits average entries, in particular. Yang et al. (2009) argue that feedback by the seeker will lead to an increase of effort by contestants as the perceived chance of winning is higher. This has two effects: it mitigates the risk of underinvestment of users when there are many competitors and the chance of winning is lower; at the same time, the number of entries and the chance to receive

more diverse solutions increases (Terwiesch & Xu, 2008). Table 2 summarizes and compares the two general setups.

Table 2. Comparing innovation communities and contests

Communities	Contests
Purpose	
Co-create value with users to jointly innovate	Outsourcing problem solving or idea generation to a large and diverse crowd to find high-value input
Main features	
• Collaboration • Long-term oriented • Free revealing and sharing of knowledge • Needs-driven/self-rewarding • Feedback/user interaction • Open tasks • Continuously	• Competition • Short-term oriented • Secrecy of intellectual property • Reward-driven (money) • Little to no feedback/user interaction • Specific problem/task • Time-bound
Advantages	
• self-serving needs • Need-based problems (novel functionalities) • Rapid innovation cycles by feedback • Long-term binding users	• Low risk with fixed investment • Clear task description • Recruit people with money • No commitment to solvers necessary (intermediary)
Challenges	
• Agenda setting hard • Outcome unclear • Hard to control • Balance between openness and secrecy • Community management	• Incentive regime/Reward system • Find and attract the right users • Find the right intermediary • Solver loyalty

3.6 Innovation-contest communities

We have seen that both concepts, communities and contests have shortcomings if applied solely. While communities are well suited for generating a collective output with joint and collaborative effort, contests should be preferred to solve a specific problem by asking a crowd of diverse solvers anticipating that parallel exploration in different directions will result in a broad variety of solution paths including truly innovative and creative submissions (Harhoff & Lakhani, 2016).

These days, we find growing evidence for a new hybrid and promising form of web-based innovation that harnesses the best of both approaches: Competition to spur

innovation and cooperation/collaboration to improve ideas and socialize via feedback and knowledge sharing. In "community-based innovation contests" (Bullinger et al., 2010) or "innovation-contest communities" (Füller et al., 2014) users compete for prizes in time-bound and topic-specific contest-like challenges, but at the same time they cooperate and interact with other users in the course of the contest by giving feedback on visible entries and sharing ideas and inspiration (see also Figure 4).

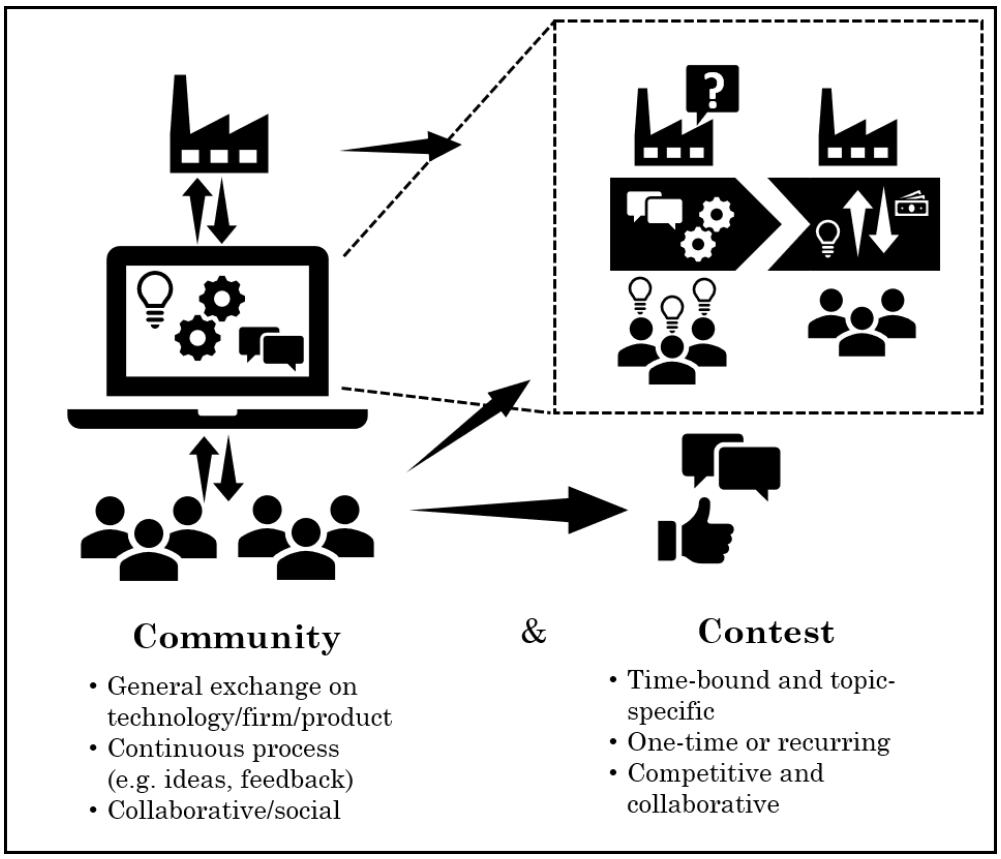


Figure 4. General setup of an innovation-contest community (author's own illustration)

In fact, Bullinger et al. (2010) found that 40 of 73 analyzed innovation contest settings provided community functionalities that enable interaction and cooperation between users despite the competitive environment of the contests. This coincident interplay of both mechanisms deserves further attention by research (Bullinger et al., 2010).

Generally, we can find two forms of contest communities: **firm-hosted communities** that are initiated for a onetime innovation challenge (e.g., Osram LED Emotionalize, Swarovski Enlightened Jewelry, OpenLab Hamburg Make A

Difference) and **intermediary platforms** with a community of solvers at hand that self-select themselves into recurring challenges of seeking organizations (e.g., Launch Forth, HeroX, OpenIDEO, jovoto). The latter form is more common these days as the intermediaries provide professional service and established processes to seeking firms from task definition over community management to evaluation. The platforms center around different tasks (e.g., design, engineering, concept development) and fields (e.g., social innovation, marketing, transportation) and are home to hundreds of thousands of users from all over the world. What they have in common, is a strong focus on cooperation and collaboration between users and at the same time they feature competitive elements in the challenge configurations.

With the intermediary in place, a triad is established with competing interests of solvers, seeking organizations and the platforms itself (see also Figure 5). The **seeking organization** is looking for innovative solutions and new ideas to choose from and the intellectual property rights to exclusively exploit them at minimum cost and within in a short period of time. Other reasons to run a challenge include strengthening the firm/brand image, recruiting new employees or gain public interest.

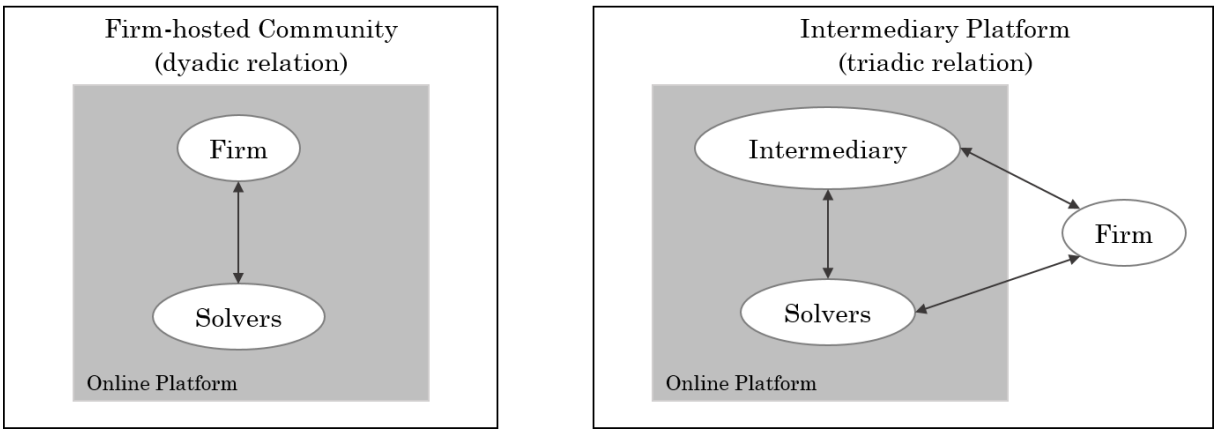


Figure 5. Relational setup of firm-hosted vs. intermediary platform (author's own illustration)

The **solver community** is remarkably diverse in terms of motivational drivers and interests. While some enjoy the community of like-minded peers and like to learn and exchange ideas, others are more interested in building reputation, challenging themselves, making money, or being recognized by the seeking organization or the intermediary (Boudreau et al., 2011; Lakhani et al., 2010). In

any case, users want to be treated fairly regarding their invested effort and expect a mutually beneficial relation with different forms of appreciation. They will continuously join the intermediary's platform and co-create value, if interesting organizations run compelling challenges, if the platform provides easy-to-use functionalities and if they feel a sense of community with other users and the platform hosting organization.

The **intermediary's** task is to balance these interests. In fact, the community-hosting platform must serve both parties equally: the challenge hosts earn money by providing new and unconventional ideas to the customers (the seeker) with the help of its major asset and resource base, the community (the solvers). However, the innovation provider can only deliver this output if he is able to find and constantly attract innovative users on the one hand, and on the other hand, if he manages to build up and maintain a vivid community with a strong community culture in the long term so that users frequently join in and decide to spend their time on this platform and not another one.

While various studies in the distinct contexts of communities and contests led to a comprehensive understanding of users, their motivations, and behaviors (with economic models, innovation processes and managerial implications), research lags behind in the case of hybrid contest communities where cooperation and competition occur at the same time. An increasing popularity of this setting in the landscape of open innovation and co-creation practices calls for further attention of research (Adamczyk et al., 2012; Füller et al., 2014; Wooten & Ulrich, 2013). Of particular interest are **user characteristics and behavioral dynamics** as these set the basis for developing adequate management models (functionalities, price regime, attraction, evaluation etc.). An outline of recent research on these issues including gaps and limitations will be given hereinafter.

Bullinger et al. (2010) were among the first to study participants' cooperative behavior in an (experimental) competitive contest setting and its effect on innovativeness (= a person's ability to come up with useful and novel solutions) through the lens of boundary spanning. Boundary spanners are people who are "skilled in bridging interests, professions and organizations" (Webb, 1991, p. 231) or, in other words, persons with "a predisposition to bring people together in

collaboration" (Obstfeld, 2005, p. 111). The scholars observed that people not only compete to win the prize, but also interact with other users by commenting, giving feedback, and exchanging ideas. Interestingly, they found a U-shaped relation between the innovativeness of a user and his or her cooperative orientation meaning that users that were very innovative either had a very cooperative orientation or a rather competitive mindset, respectively (see also Figure 6).

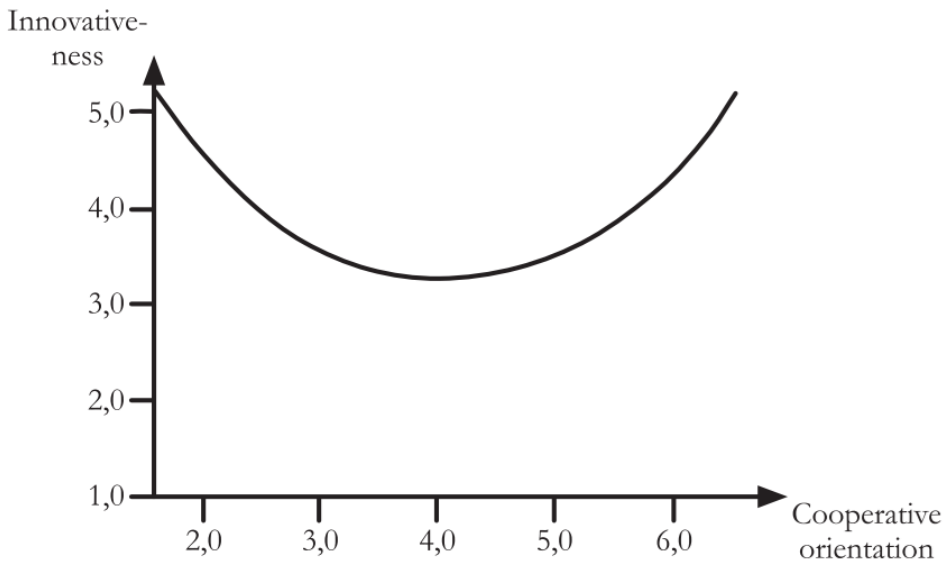


Figure 6. U-shaped relation between innovativeness and cooperation (Bullinger et al., 2010, p. 298)

Users in the middle ground had a rather low degree of innovativeness. They suggest designing a challenge accordingly: Providing adequate community functionalities to address the needs of cooperative users is essential if the goal is to build up a community and receive innovative input at the same time. In contrast, an extremely competitive configuration (e.g., no interaction, few and high prizes, no visibility of entries) will attract competition-oriented users that are able to deliver highly innovative input, too.

The question arises how a challenge setup can be designed to serve the needs of both user groups, the cooperators and the competitors. Therefore, a better understanding of the users/different types of users is necessary (e.g., skills, motivation, goals). The authors also identified an interesting type of user: *proactive boundary spanners*. These users are driven by curiosity and a need to support others. With a strong cooperative orientation, they are essential community builders and communicators besides their ability to submit high-quality input to

the innovation contest. From a community management perspective, it would be extremely useful to learn how to attract these users and how to identify them in the course of a contest (e.g., via semi-automated content analysis).

In a case study, Hutter et al. (2011) analyzed an industrial design contest community with focus on users and their behavior during a contest. They explored behavioral patterns on the individual user level that entailed both, elements of cooperation and competition which they call *communitition* (referring to the concept of co-opetition on the firm level). Their findings challenge the results of Bullinger et al. (2010) as they identified another promising type of user: the *communititor*. This type is characterized by a behavior that is both competitive and cooperative. A *communititor* wants to win the prize, but simultaneously engages in community collaboration. They argue that these users are more likely to submit designs of higher quality. Community management should thus design contests and the platform accordingly to attract this type of user (e.g., incentive regime, community functionalities). Further research on different contexts is necessary though to better understand competitive and collaborative features in a contest setting and to generalize findings on user groups derived from this study.

Füller et al. (2014) built on the concept of communitition and conducted research on user roles and contributions in a different context (jewelry design) to better understand user behavior in hybrid contest settings and find out whether and how hybrid structures lead to innovation. First, they found that hybrid contest settings are an effective means to generate innovative output and that users in this context benefit from interaction, exchange, and mutual support. Furthermore, they identified user roles based on the communication and contribution behavior that seem to be stable across contexts. And finally, they too identified a promising user role among others that they call *masters*. Users in this group deliver many exceptionally innovative submissions and are heavily engaged in interactions with other users, just like communititors. However, other user roles such as *socializers* may be just as important for a vivid community culture in a hybrid setting. The authors thus call for further research on the user level to find out more about what constitutes a user role in the context of contest communities (e.g., motives, personality).

Before I derive specific research questions, we will take a closer look on user types and user roles generally found in online communities and social networks. A broader perspective will help us to review generalizable results from different contexts that might be transferable into the realm of contest communities.

3.7 User types/roles in online communities

Different types of users and user roles have been studied widely, majorly in the context of online or virtual communities in general. A broad overview of user roles in different kinds of online communities will be presented below.

An interesting question is whether one should talk of user roles or user types in the digital context. The answer to this question is important when we discuss mobility and transformation of users and 'activation' strategies. Traditionally, the stability and change of a role was attributed to norms and expectations (McCalister et al., 1967) or social interactions and negotiation, e.g. roles can be "put on and taken off like clothing" without influencing the personality (Turner, 1978, p. 1). However, traditional mechanisms are not present in online communities. Thus, roles might change more quickly. Faraj et al. (2011, p. 1231) argue that in online communities participants will "make and then take situationally specific roles that only for the moment in which they are needed". In contrast, Panciera et al. (2009) found in the context of Wikipedia that power editors did not significantly change their role over time. Preece & Shneiderman (2009) suggest a trajectory of specific roles that users in online communities follow.

In this study, I follow a more generic understanding along Gleave et al. (2009) and Welser et al. (2011) who argue that social roles (in complex systems like online communities) are behavioral and relational patterns that interact with each other in a community type-specific role ecology. Thus, generic roles can be defined and users over time (theoretically) move between them (see also Arazy et al., 2016). In a static analysis of a community, a user type and a user role can be regarded as synonymous for the sake of simplicity.

3.7.1 Online communities

Kim (2000) applied online community building processes in different online contexts and came up with generic roles that can be understood as progressive steps of user involvement (Figure 7). Users start as *visitors* when they initially get in touch with the community at hand. They are no members of the community at this stage. Next, they pass a membership ritual and officially join the community as *novices*. Now they are new community members who need to get used to the culture and conduct of the respective online group. After some time, they move on to the stage of a *regular*, meaning an experienced user who is well-established among the peers. Few committed or special users may then proceed to the stage of a *leader* after passing a leadership ritual, e.g., by being assigned administrator rights or other community management roles. Finally, there is the stage of the *elder*, a merit position for long-time members.

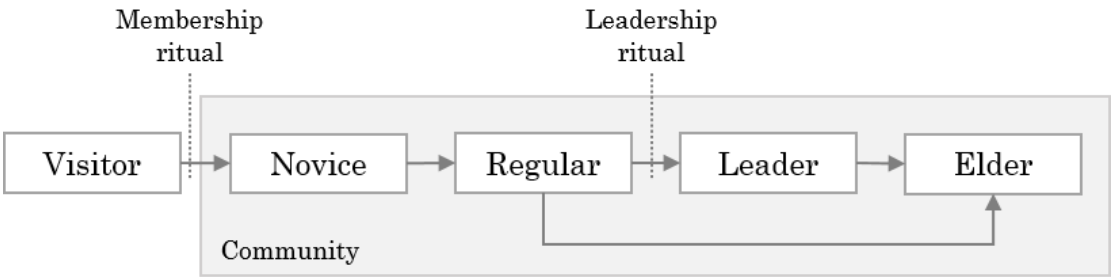


Figure 7. Membership life cycle in online communities (adapted from Kim, 2000)

Kim argues that community building and maturing takes years in the physical sphere, whereas it may happen within days in the digital world. Thus, community management should think about the membership life cycle of users from the beginning and develop adequate strategies to address the needs of each group, e.g., low entry barrier for visitors to become novices, role assignments for leaders.

3.7.2 Communities of consumption

Another perspective on user types in online communities was offered by Kozinets (1999) who analyzed virtual *communities of consumption* by means of netnography. Communities of this kind are related to a special consumption activity (e.g., wine, Porsche cars, Barbie dolls). Users who share enthusiasm for

and have special knowledge of a certain consumption activity gather online to socially interact with other like-minded people.

He argues that membership in such a community is constituted by two elements: the relationship of a user with the consumption activity itself and the intensity of the social relationships within the community. Based in these two dimensions, he describes four distinct types of users: *tourists*, *minglers*, *devotees*, and *insiders* (Figure 8). *Tourists* occasionally stop by. They are neither part of the community, nor deeply committed to the consumption activity. *Minglers* too are not that much interested in the consumption activity, but they are enjoying the social interaction with other users in the community.

In contrast, *devotees* and *insiders* can be considered as heavy users regarding the consumption activity at hand. From a marketing perspective, you want to identify and address these types of users with your marketing effort as they represent potential customers. *Insiders* in particular are capable of boosting a firm's image by word-of-mouth recommendation inside the community. With their strong social ties, they might even promote the consumption activity (of a certain product or brand) and thus help to socialize *minglers* and *tourists* and turn them into *devotees* or *insiders*.

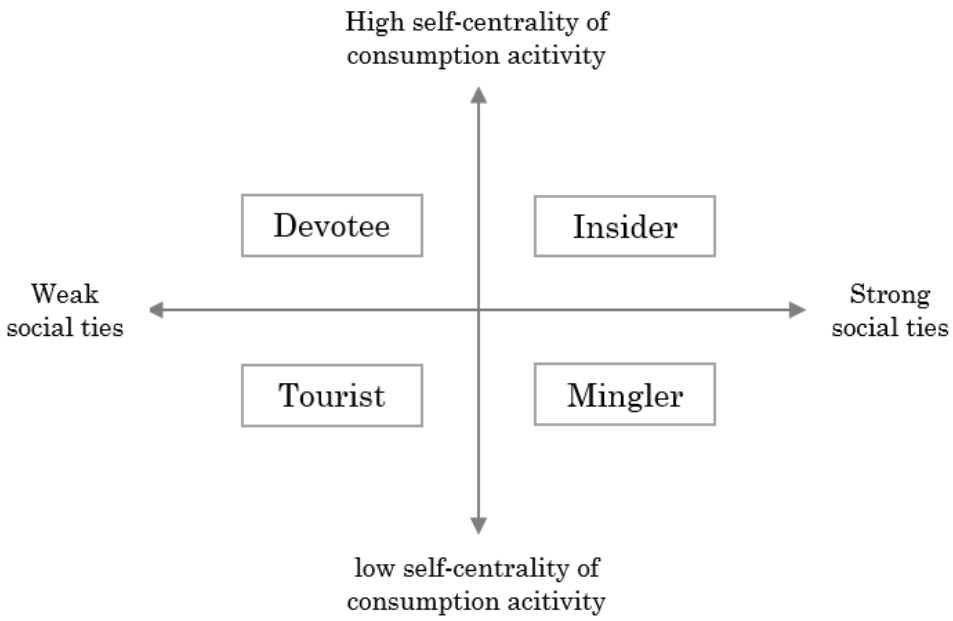


Figure 8. Member types in a virtual community of consumption (adapted from Kozinets, 1999)

The user types also differ regarding social interaction modes. These modes explain why and how users communicate. For some users, communication is a means towards information ('selfish' *devotees* and *tourists*) or transformation (*insiders* as activists), while for others communication in itself represents a personal need, either short-term oriented with superficial communication (recreational mode: *tourists*) or long-term oriented cooperation within the community (relational mode: *minglers and insiders*).

Kozinets outlines a framework based on the user types and interaction modes that enables us to segment and thus better understand online communities and its users to formulate adequate (marketing, innovation, community) management strategies.

3.7.3 Social networking sites

Brandtzæg (2012) conducted a longitudinal study of the usage of social networking sites (SNS, e.g. Facebook, Twitter, YouTube) to analyze the effect on users' social capital. Based on usage behavior (e.g. user contributions and activities, purpose of usage) and building on the *Unified Media User Typology* framework (Brandtzæg, 2010), he was able to distinguish five clusters/types of users of SNS (Figure 9).

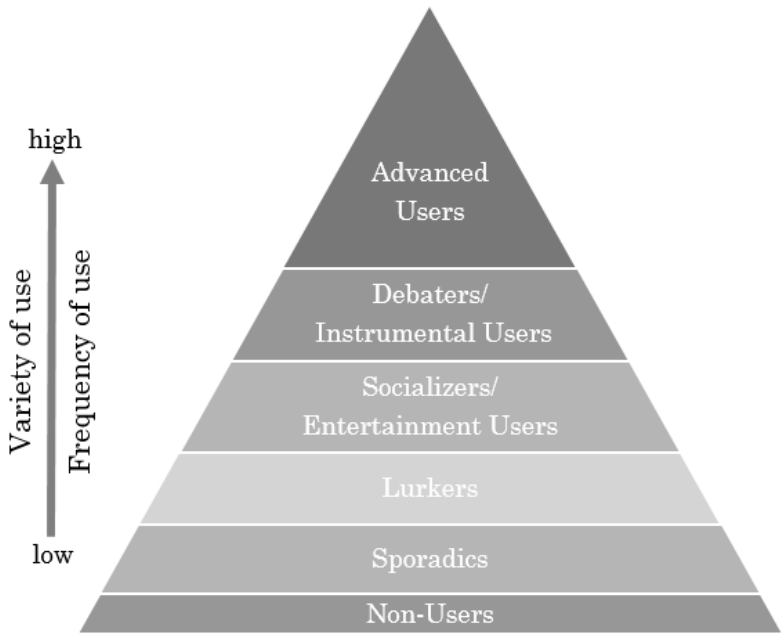


Figure 9. User hierarchy in the Media User Typology (adapted from Brandtzæg, 2010)

Advanced Users represent a small group (ca. 5 % of the population) of highly active users who frequently use SNS for a broad range of activities. *Debaters* (10-15 %) are quite active as well, however they majorly engage in discussions and debating.

In contrast, *Socializers* are more interested in social interaction with friends and family via SNS than contribution to discussions. Finally, *Lurkers* and *Sporadics* who merely use SNS and if they do, they log in for the sake of time-killing and passive consumption, add up to about two thirds of all users. Interestingly, the study revealed that the number of *Advanced Users* remains stable over time, while the number of *Lurkers* and *Sporadics* declined to the benefit of the group of *Socializers*.

3.7.4 Commons-based peer-production

We have already learned how users from all over the world gather in online communities to jointly produce knowledge or other informational goods such as software which will be freely revealed afterwards. What these communities have in common, is a mode of value co-creation and collective action that Benkler (2006) calls *commons-based peer production* which he defines as "decentralized individual action carried out through widely distributed, nonmarket means that do not depend on market strategies, autonomous, self-selected, decentralized action". With increasing popularity among users and relevance/influence of the outcome of these communities on traditional industries and markets, scholars started to research user characteristics and dynamics to better understand this phenomenon.

One of the most prominent cases of co-production of knowledge in online communities is Wikipedia where thousands of voluntary users are contributing by either writing, editing, or reviewing articles for the free online encyclopedia. Arazy et al. (2016) identified emergent user roles in the community and found that work processes in the course of the creation of an article are organized around a stable set of roles. In an early phase in the life cycle of an article, *All-Round Contributors* play an important role. They engage in different activities ranging from the creation and deletion of content, over copy-editing towards hyperlinking. *Quick-and-Dirty Editors* focus on content creation without properly complying with community standards. *Copy-Editors* amend minor errors regarding spelling and

grammar. Two user roles focus on the outer shape of an article: *Content Shapers* reorganize the structure of the text, whereas *Layout Shapers* focus on the markup. Finally, there are *Vandals* who add wrong content or delete sections on purpose, and *Watchdogs* whose task is to revert vandalism. Interestingly, more than half of all users change roles over time, the roles themselves however remain stable. The authors conclude that this *turbulent stability* serves as an emerging and non-formal framework to organize knowledge work in online communities. Without formalized roles, users will self-select themselves into tasks that they want to work on. Community management and platform designer should thus try to guide users by defining tasks that are inherent to the project/product at hand.

Rich insights on user roles were also gained from the realm of open source software (Krogh & Hippel, 2006). For example, Ducheneaut (2005) analyzed how developers evolve inside an open source software community by passing through different stages/roles (Figure 10).

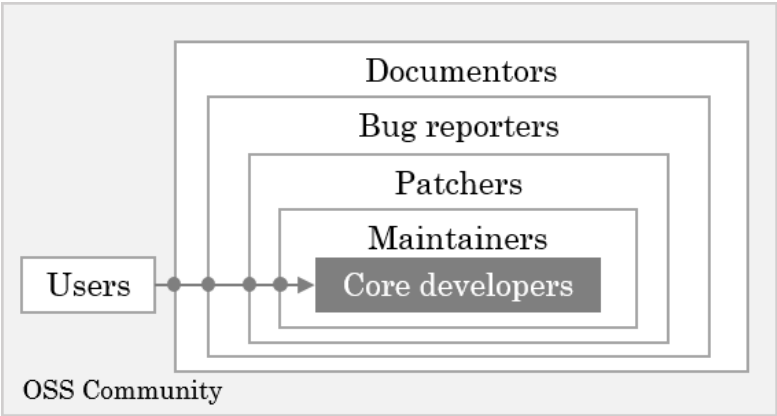


Figure 10. Layered organization in OSS communities (adapted from Ducheneaut, 2005)

They start off by peripherally monitoring the activities and documenting development progress. This early phase of observation and assimilation to the norms and values of the community was found to be an important step towards successfully joining a developer community (Krogh et al., 2003). After some time, they move on to become *bug fixers* and *patchers* which means that they obtain access to the versioning system of the software and thus contribute to the project's quality. Users who successfully pass this stage are then taking charge of small modular projects as *maintainers* where they develop, publish, and defend sub-components in front of the core developers who decide on the integration into the

software's architecture. While the developers' responsibility may grow over time in terms of relevance and size of the projects and thus the status and reputation of a user within the community will increase, final decisions on the software usually remain reserved to the *core developers*, the group/individual who is in control of the software project.

3.7.5 Innovation and contest communities

As the state of research on web-based innovation contests and hybrid contest communities still is nascent, only little research on user types and roles was conducted in this realm.

Dahlander & Frederiksen (2012) studied the impact of the structural position of users on innovativeness within the social network of a (collaborative) user community. They neglected a hitherto conventional dichotomous distinction of users (core vs. periphery) and applied a continuous model instead, which would allow them to derive more nuanced details regarding different types of users. They argue that individual user characteristics (e.g., lead user attributes) are not sufficient to explain a certain level of innovativeness. Instead, diverse perspectives from other fields and relationships to users in different communities are just as important to bring new sources of innovation into a community. While they find support that users who are closer to the core of the community show a higher level of innovativeness, they also conclude that users in the periphery who are active members in multiple online communities (so-called *boundary spanners*) bring in new perspectives and are thus likely to deliver innovative output as well.

Bullinger et al. (2010) studied user behavior in a collaboration-oriented contest setting with a similar theoretical approach (*boundary spanning*). Two kinds of users stood out in terms of innovativeness: Extremely competitive users who did not engage in boundary spanning, e.g., commenting and feedback, but solely focused on their entry. The other group comprised *proactive* and *reactive boundary spanners*, meaning users who either commented on the submissions of other users or who received many comments by others and picked up suggestions to improve their idea. The cooperative and innovative potential makes the proactive boundary spanners an interesting type of user who deserves further attention.

Hutter et al. (2011) explored cooperative and competitive user behavior in a design contest community. Via social network and content analysis, they were able to identify four generic types of users who can be differentiated regarding their submission and communication/interaction behavior. *Observers* are rather passive. They sign up and browse through the platform, submit little or no ideas and hardly comment or interact with other users. *Competitors* on the other hand are eager to win. They want to showcase their capabilities by submitting many innovative ideas but are hardly engaging in social interaction with other users. In contrast, *cooperators* are majorly interested in exchange and feedback activities with other users. They submit only few ideas themselves, though. The most promising type of users is the *communititor*. Users of this group are strongly interconnected with other users. They send and receive many comments, give feedback, and make suggestions for improvement. Even more strikingly, communititors were also the most innovative users in terms of number and quality of ideas. The authors thus argue that the latter type of user is important for the viability of a contest community. Furthermore, they conclude that in a contest community cooperative and competitive behavior of users may be positively correlated with idea quality.

Füller et al. (2014) were among the first to explore user heterogeneity and user roles in the context of an innovation-contest community (for jewelry design) with a hybrid setup featuring both competitive and collaborative elements. By analyzing user contributions and communication patterns, they were able to identify six distinct user roles. Like previous studies on social networks and other online communities have shown, a large portion of the users (up to 85%) was found to be rather passive (also known as lurkers, tourists, or peripherical users in other contexts). *Passive idea generators* and *passive commentators* did hardly engage in commenting and contributed only few ideas. The quality of the ideas was rather low and thus the entries did not receive much attention by other users. *Efficient contributors* are rather passive too. By submitting few, but high-quality ideas though these users grab a lot of attention by other users who leave comments and give feedback. In contrast, *idea generators* submit many ideas with high quality, like *devotees* found by Kozinets. These ideas however do not meet the interest of other users. Thus, this user type is not engaging in communication. *Socializers*

represent an interesting group of users bearing in mind the competitive setting of the contest. These users seem to be majorly interested in social interaction with other users just as *minglers* or *debaters*. The authors regard this type of user to be an important factor for a healthy community culture. Finally, *masters* were identified as a small, but special group of users who submitted the best ideas both in terms of quality and quantity. At the same time, *masters* were heavily involved in communication and interaction with other users via feedback and commenting. The scholars compare them to Kozinets' *insiders*.

A similar study was conducted by Fuger et al. (2017) inside a contest community with a focus on social innovation. With the same methodological approach, the researchers identified four roles among the users. Again, a vast majority of users is rather passive (about 90 % are *passive users*). *Allrounders* (10 %) can be regarded as average users in terms of communication behavior and idea quality. *Collaborators* represent a group of users who are strongly interconnected to other users and at the same time deliver high-quality input. They send and receive a lot of comments and suggestions for improvement. *Contributors* communicated a bit less but submitted more designs. The latter two groups are representing the key members of the community.

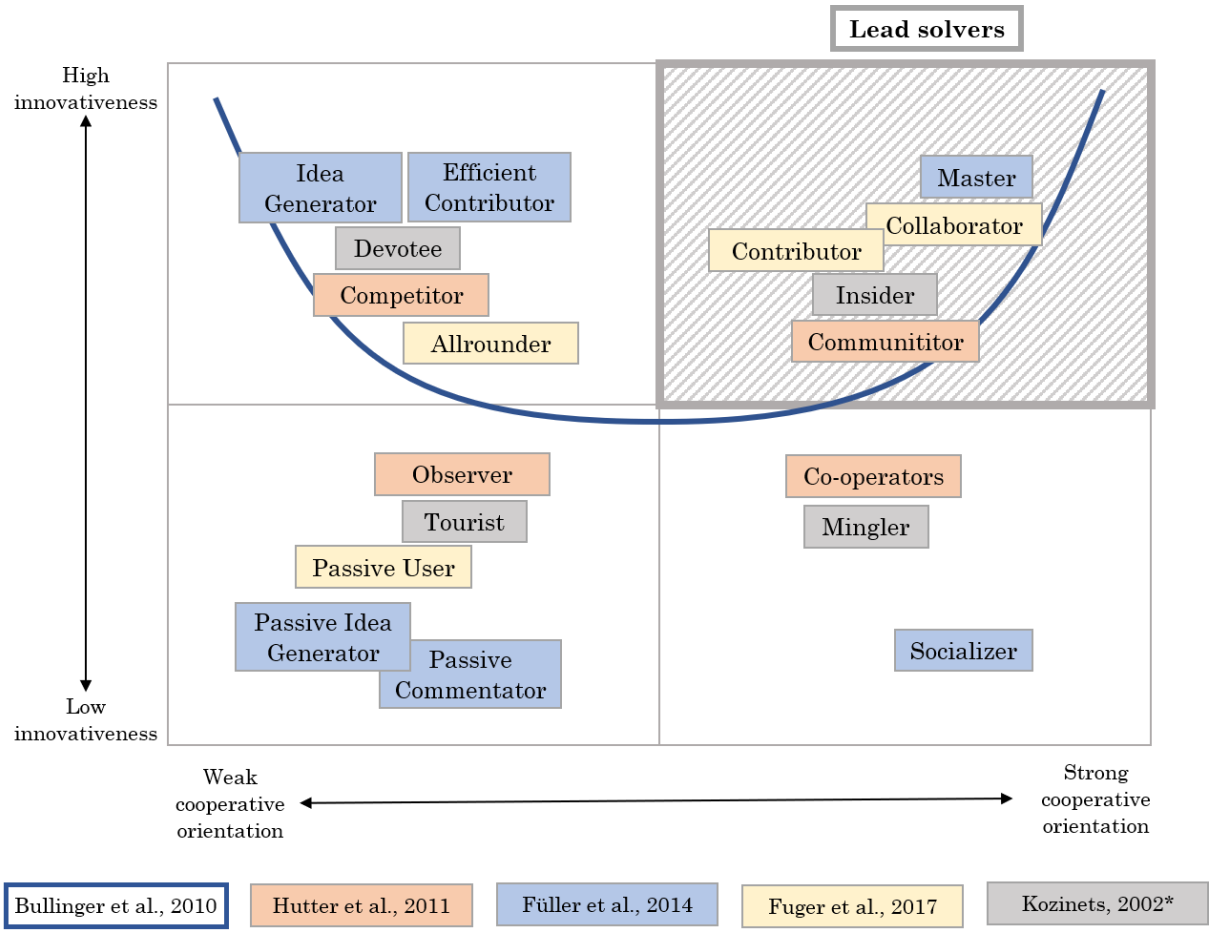
3.7.6 Preliminary user typology with lead solvers

Comparing the results of the reviewed studies on online communities reveals similarities across contexts. First, it is interesting to find stereotypes of users regarding their behavior in that community. No matter what the aim of the community is, we find that a large portion (around 90 %) of users is rather passive and hardly connected to other users. A small group of committed users is regularly active in socializing with other users and thus shaping the culture of a community. It is worth remarking that for some users the aspect of socializing with like-minded peers is more important than the primary goal of the community. In contrast, there are also users that are majorly focused on the respective subject and not so much interested in social exchange. Finally, each community comprises a group of core or key users. Only few people belong to this group. However, these users have a strong influence on both the social network of a community as well as the output.

In the context of contest communities, the latter type of user is crucial for the innovative output and social health of a community. This is also the case in one-time initiatives.

Another interesting aspect is the evolution of context-specific roles in a community. We find different forms of membership life cycles that users go through over time and depending on their contribution. The user roles however remain stable. Knowing about user roles that occur in a specific context thus is crucial to professionally design, build up and manage a community. With regard to innovation and contest communities, it was shown that cooperation besides social aspects is an essential feature to foster innovation, even in a competitive setting. Hence, we should try to identify, attract, and support users that equally contribute to both objectives.

Merging user typologies derived from prior literature into a matrix along two qualitative measures, namely innovativeness (low to high) and cooperative orientation (weak to strong), reveals four quadrants that can guide us in the further steps of analysis (see also Figure 11). Of particular interest is the quadrant in the upper right. All studies revealed user types that are very innovative and at the same time show a high level of cooperativeness. Like the lead user concept in the realm of user innovation, I define users in the fourth quadrant to be *lead solvers*. It is important to note though that only very few users within the community (about 1 %) are among these. In line with findings of Kozinets (1999) who studied online communities in general and Bullinger et al. (2010) who conducted a quantitative analysis, this graphical representation highlights the relevance of the topic and furthermore indicates a more generalizable phenomenon (lead solverness) that deserves further attention.



* Vertical axis: self-centrality with regard to consumption activity (indicating a certain level of expertise/innovativeness); for illustrative reasons used synonymous

Figure 11. Integrated preliminary user typology

3.8 Conclusions and implications for this research

Innovation-contest communities that feature competitive and cooperative elements at the same time represent a new and promising means for (continuous and one-time) idea generation and problem solving with external actors in the context of open innovation. However, only few exploratory studies were conducted yet that started to shed some light on this new phenomenon. Extant literature majorly drew conclusions from single contexts and by applying social network and content analysis based on the user content provided in the form of comments and submissions. While the application of these methods delivered valuable insights into behavioral mechanisms of users, user typologies and innovative outcomes, we still lack a comprehensive understanding of the users in such communities.

We know how users (mainly consumers so far) behave and found distinct user roles in single contexts; we do not know however **why users behave the way they do**.

This is the basis though to derive adequate management models which allows us to handle this new type of community to serve the different stakeholders and interests (the seeking organization, the intermediary, and the user community) in the best way.

Of particular interest are *lead solvers* meaning users that not only deliver highly innovative input, but also contribute to a vivid community culture by proactively engaging in communication and constructive feedback with other users. We have seen that usually only a small fraction of users can be regarded as both innovative and cooperative. Building on prior work from related fields is of help here only to a certain extent. We may draw upon general findings regarding motivation, procedural aspects, and behavioral patterns. However, how these aspects merge in the hybrid context of cooperation and competition is mainly unexplored.

I thus want to explore in detail the phenomenon of *lead solvers* and contribute to the body of literature by answering the following research questions:

RQ1: How to identify lead solvers in a contest community?

RQ2: Why do lead solvers behave cooperatively?

RQ3: What are distinct characteristics and behavioral traits of lead solvers?

Chapter 4

Research design and methodology

4.1 Lead solver framework

Reviewing prior literature led to the identification of so-called *lead solvers* as valuable members in contest communities. Lead solvers are very innovative and at the same time show a strong cooperative orientation. To study the phenomenon of **lead solverness**, my research will be guided by the *lead solver framework* which I will elaborate hereinafter.

The framework has two main dimensions: *innovativeness* and *cooperative orientation*. Subsequently, I will introduce different concepts and theories from related research fields that should guide the framework development process regarding appropriate components. For each aspect, research propositions will be formulated.

4.1.1 Dimension: Innovativeness

Collecting truly creative and innovative ideas and solutions is the foremost reason for firms to engage in open innovation practices and thus only those contest communities will succeed that manage to continuously attract innovative users.

Therefore, we first need to define what constitutes innovativeness on the user level. A user is innovative, if he or she is able to generate useful and novel ideas or solutions (Amabile, 1996). In the context of a contest community, we may assume that selected winners who managed to create highly ranked submissions meet this

criterion. However, it only allows us to identify innovative users ex post. While this approach will be adequate in the case of recurring contests (making sure that innovative users return for other challenges), it is not sufficient to design a contest properly in order to attract new innovative users. We should thus turn our attention also on personality traits and user characteristics that might serve as a proxy. If we know why and how creative persons participate in contest communities in general, this will give us a clue about appropriate platform features and contest design.

4.1.1.1 Creativity

Amabile et al. (1996) argue that creative thinking skills and motivation besides innovation-related expertise (e.g. in corporate R&D departments) are determinants for people to come up with valuable ideas. More specifically, they found that intrinsic trumps extrinsic motivation regarding the stimulation of creativity. Further aspects that facilitate creativity and innovativeness are autonomy and self-determination (Amabile, 2018; Ryan & Deci, 2000). Quite similarly, Csikszentmihalyi (1996) describes how autonomy and intrinsic motivation may lead to a flow experience. Most of the latter aspects seem to be inherently present in an open contest setting where users are free to choose whether they join and how they participate. Motivational aspects, however, can be affected by the organizer when deciding on the incentive regime.

Based on these insights, I derive the following research propositions (*Px.x*):

P1.1 Lead solvers are rather intrinsically motivated.

P1.2 Lead solvers show a high level of autonomy and self-determination.

4.1.1.2 Lead user characteristics

A related field that is interesting to look at in terms of innovative behavior of individuals is *lead user theory*. It has a longstanding track record and describes how external actors (customers and users of a product) may significantly improve the product's success if a firm manages to identify and integrate them into the innovation process, especially in the early phases of new product development (Hippel, 1986; Lüthje & Herstatt, 2004). In fact, it was shown that across

industries these user innovators have been playing an important role in product and process innovation, e.g., semi-conductor industry, medical equipment, outdoor sports, software (Brem et al., 2018). They should thus be considered a valuable source of innovation (see also Figure 12).

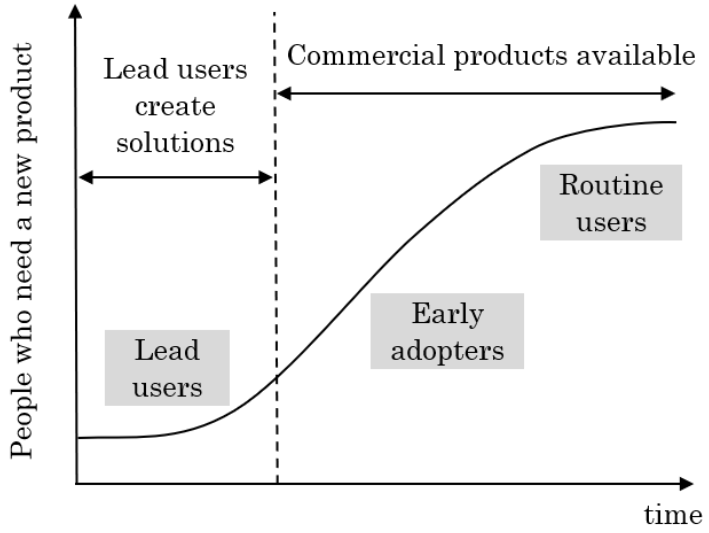


Figure 12. Lead user curve (adapted from Hippel, 1986)

Over the years, scholars have identified several characteristics that are unique to lead users in comparison to ordinary customers or users of a product. Lead users are ahead of a market trend and thus face a need earlier than others (Lüthje & Herstatt, 2004). They are dissatisfied with an existing product and are able to generate a solution to a specific product-related problem by improving or modifying it (Lüthje & Herstatt, 2004). This solution greatly benefits them (Hippel, 1986). In addition, this type of customer or user has enormous consumer knowledge and use experience in the respective domain leading to a high degree of innovativeness as well as a strong internal locus of control (Schreier et al., 2007; Schreier & Prügl, 2008). Lead users adopt new products fast, are opinion leaders and may support the dissemination of new products (Schreier et al., 2007). Franke et al. (2014) remind us though that lead userness should rather be considered a domain-specific attribute than a general aspect of personality. More recently, certain behavioral traits were found in the context of online communities and virtual collaboration. Lead users engage in online communities, are intrinsically motivated, they enjoy sharing knowledge, express needs and talk about use experiences (Franke & Shah, 2003; Jeppesen & Frederiksen, 2006; Sawhney et al., 2005).

With regard to innovation contests, scholars argue that lead users (of a product) differ from contest participants (users in online communities) as the latter only provide solution-related information to a specific problem while lead users go beyond and develop a solution to address their personal need (Lilien et al., 2002). However, crowdsourcing and contest communities represent an interesting environment to search for lead users (Brem & Bilgram, 2015). By delivering high-quality input, participants with winning submissions demonstrate creativity and design skills. The idea description might imply future needs. An evaluation by the community consolidates a relevant need. And finally, commenting and feedback reveals an open and collaborative mindset of a user. Based on these insights, I derive the following research propositions:

P1.3 Lead solvers are familiar with the respective domain in terms of technical expertise or experience.

P1.4 Lead solvers enjoy sharing knowledge and exchanging ideas.

4.1.1.3 Expertise & effort

Expertise/professionalism and effort are other aspects of innovativeness. There is a controversial discussion going on about whether expertise in the specific domain of a contest is beneficial to the innovative outcome or not.

Jeppesen & Lakhani (2010), for example, studied the impact of technical and social marginality on the outcome of science problem-solving contests. They found evidence that success in a contest was positively related to distance from the field at hand by a solver. Furthermore, they showed that female participants who are rather rare to be found in the scientific communities under study performed significantly better than men. We must keep in mind though that this study was focused on scientific problem solving, and not idea generation.

Terwiesch & Xu (2008) quite contrary built up a model for ideation projects which measures performance of a solution as a function of expertise (of a user), his or her effort and luck. Regarding effort, Bockstedt (2016) found that users who upload an entry early, but constantly revise and improve an idea (e.g., after receiving feedback) have a higher chance of winning. The number of submissions in one round however does not have an influence on the quality. In a series of challenges

or in a firm-hosted community however serial ideators are more likely to submit an valuable idea than tourists who stop by for one initiative (Bayus, 2013).

Regarding contest communities, I assume that expertise in the relevant field and effort by users are important determinants for innovativeness. As technical expertise was already covered in the previous section (*P.1.3*), I add one additional research proposition here:

P1.5 Lead solvers make strong effort compared to regular users.

4.1.1.4 Expectancy theory

The level of innovativeness can also be studied through the lens of *expectancy theory* which basically argues that effort and performance of an individual is related to its expectations (on the outcome/reward) (Tedjamulia et al., 2005). In this context, self-efficacy is a characteristic that influences individual behavior. Self-efficacy describes the perceived probability of a person to reach a certain goal (Chiang & Jang, 2008).

A high level of self-efficacy leads to high expectations which in turn results in a strong motivation and effort to fulfill a task. In other words, innovative users with a high performance should have a high level of self-efficacy. Interestingly, it was also shown that people with a high self-efficacy are more cooperative that others (Kerr, 1992).

Another facet of expectancy is the need to achieve. This personality trait was found among people who have a strong desire to reach a certain accomplishment. These kind of users perform better as they constantly challenge themselves (Matsui et al., 1981). They enjoy working hard to make a change and want to excel above others (Ardichvili et al., 2003). Again, it is highly likely to find this characteristic to be present among innovative users.

Based on these insights, I derive the following research propositions:

P1.6 Lead solvers show a high level of self-efficacy.

P1.7 Lead solvers have a strong need to achieve.

4.1.2 Dimension: Cooperative orientation

We have already learned that cooperative user behavior (e.g., via commenting, feedback, and knowledge sharing) is key to a vivid community culture. However, it can also have a positive effect on the overall level of innovativeness.

I thus argue that cooperative orientation and behavior is crucial in contest communities where users can exchange ideas and share knowledge. Feedback and early submission behavior in unblind contest settings is of particular interest as this behavior serves not only a social function, but also increases the quality of the submissions.

4.1.2.1 Social capital theory

On the individual level, *social capital theory* can help to understand why users even in competitive settings talk with and help each other. The social network of a person is referred to as a set of relationships to other people (nodes). Those relationships may be formed by flows of communication or information between those nodes and are represented as ties (Hinds & Lee, 2008). Social capital cumulates as people interact and cooperate for the mutual benefit (Lin et al., 2001). This may happen in both offline and online contexts, such as online communities (see also Figure 13).

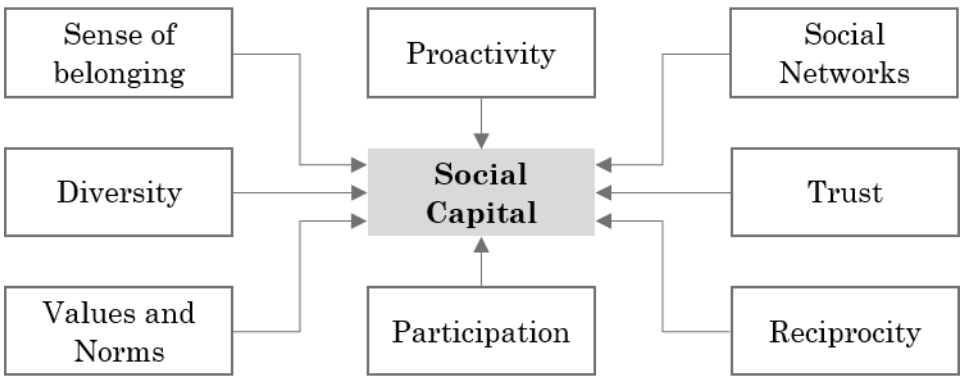


Figure 13. Dimensions of social capital (adapted from Häuberer & Jeřábek, 2011)

In fact, there is an overlap of social mechanisms at work in networks and communities, e.g., reputation, reciprocity, cooperation (Burt, 2000). Thus, scholars argue that users in online communities who interact with other users, support each other and share knowledge, build up social capital and contribute to social wealth

in the respective community (Panzarasa et al., 2009). As contest community platforms provide the means for communication and interaction, we may assume that users behave in a cooperative manner (e.g. via commenting and knowledge sharing) to increase their social capital (Hautz et al., 2010).

Based on these insights, I derive the following research proposition:

P2.1 Lead solvers accumulate more social capital than regular users.

4.1.2.2 Commenting, feedback and submission behavior

Literature tells us that interaction with other people with different backgrounds and professions in the course of an ideation process has a positive effect on the outcome in terms of quality and novelty (Amabile, 1996; Perry-Smith & Shalley, 2003). This is also valid in the context of an online (contest) community where users share ideas, give and receive feedback and get inspiration by other users' content (Perry-Smith & Shalley, 2003).

In addition to the beneficial effects on idea quality, Preece et al. (2004) found that users who engage in commenting activity perceive a greater satisfaction and relevance of their online participation. They also feel more committed to the respective community.

The importance of feedback and early submission of ideas in an open contest setting was discussed earlier. In short, submitting an idea very early in the course of a contest and constantly refining it not only increases the chance to win, it may also inspire other users, evoke reciprocal actions such as feedback and lead to more active participants (Bockstedt et al., 2016; Jeppesen & Frederiksen, 2006; Terwiesch & Xu, 2008). Based on these insights, I derive the following research propositions:

P2.2 Lead solvers are heavily engaged in commenting activities.

P2.3 Lead solvers proactively give feedback to other users.

4.1.2.3 Boundary spanning

The concept of *boundary spanning* offers an alternative view on the cooperative behavior of individuals. Under this notion fall people who manage to build bridges

between different interests, groups or organizations and thus can be regarded as intermediaries (Webb, 1991). Quite naturally, these individuals tend to facilitate cooperation by bringing together diverse people (Obstfeld, 2005).

In the context of a contest community, commenting and giving feedback can be regarded as boundary spanning activities because a relationship between users (within the community at hand) will be established. Boundary spanners may also reach beyond a single community. They usually hold a position in the periphery of the social network as they engage in many communities and are thus able to integrate external users and perspectives from other communities.

Interestingly, Bullinger et al. (2010) found that cooperative behavior and innovativeness correlate quite well meaning that users who show a very cooperative orientation are also very innovative compared to other users. One reason for the high degree of creativity is that boundary spanners are well-interconnected with different groups (outside a specific community), and thus have access to a broad knowledge base (Perry-Smith & Shalley, 2003). They share knowledge across boundaries which in turn enables them to integrate new perspectives for refinement in the idea generation process (Granovetter, 1977).

Dahlander & Frederiksen (2012) studied the effect of boundary spanning activities on innovativeness depending on the position of a user within the social network (core vs. periphery). They analyzed how for most users who are not at the core of the community (usually only few users) but rather find themselves in the periphery, boundary spanning across multiple communities is beneficial to the level of innovativeness in the community at hand.

Based on these insights, I derive the following research proposition:

P2.4 Lead solvers possess boundary spanner characteristics.

4.1.2.4 Social interdependence theory

Cooperation (and competition) between individuals can be also viewed through the lens of *social interdependence theory*. Social interdependence between individuals is present in a case where the achievement of the individuals' goals (which can be different) is affected by each other's actions (Deutsch, 1949; Johnson & Johnson,

2005). Basically, there are two types of interdependencies: *positive* (cooperation: I can attain my goal, if the other person reaches it as well) and *negative* (competition: I can attain my goal, if the other person fails to do so) (Deutsch, 1949).

Social interdependence theory argues that the way in which goals are structured (and thus interdependencies created) determines the interaction behavior of individuals (cooperative or competitive) when creating an outcome (see also Figure 14). Promotive interaction caused by positive interdependence includes mutual help, feedback, the exchange of needed resources (e.g., knowledge, information), trust etc. to support the group's goal achievement. Negative interdependencies, vice versa, lead to competitive behavior, e.g. mistrust, withholding information, discouraging. (Ghobadi & D'Ambra, 2011; Johnson & Johnson, 2005)

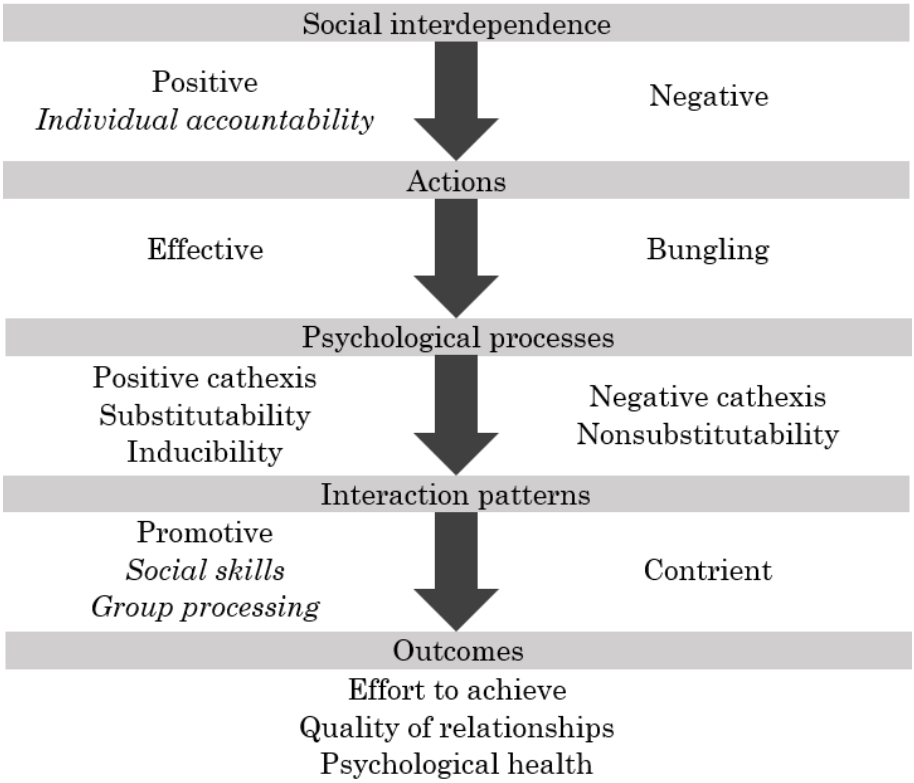


Figure 14. Overview of interdependency theory (adapted from Johnson & Johnson, 2005)

Interestingly, among a broad range of studies cooperative behavior was found to be favorable in aspects like task performance, retention, and persistence. Furthermore, cooperation promotes intrinsic motivation and leads to high levels of commitment, curiosity and interest to learn as well as a strong effort to achieve the common goal. (Johnson & Johnson, 1989, 2005)

There are, however, limitations to this theory. Deutsch (1949) argues that in real life, there are hardly any social situations that are purely cooperative or competitive. Rather, we find a complex mixture of different and sometimes interfering interests and goals. The following situation illustrates this: Basketball players of the same team might cooperate to win a game, within the team though the players compete to be the best player.

Despite the detrimental effects of competitive interdependency, some scholars argue that competition still can be beneficial in some situations and if applied properly (Johnson & Johnson, 1989). In fact, there are some positive effects attributed to competitive settings, such as effectiveness on completing a task, increased self-confidence, enjoyment in competition. Building up relationships with competing participants and learning how to cooperate with others are just two potential indications for a situation in which competition is beneficial to the participants. However, so-called *constructive competition* requires certain circumstances to work: winning should not be the primary driver for participation and thus not winning does not impact my mental health; every participant has a chance to win, at least he perceives it that way, and is thus motivated to achieve the task; there are clear and specific procedures and evaluation criteria and I thus perceive the initiative as fair and transparent.

Contest communities can be regarded as such a real-life environment where remarkably diverse actors with different goals gather. We have learned that this community type facilitates both cooperation and competition and a hybrid setting might be superior to other forms. Regarding interdependencies, we should take into consideration potential goals of participants. For some users, there exists a negative interdependency based on the competitive winner-takes-all setting as only few participants can win a prize; and they will only win it if other users are not among the winners. However, we might find situations of constructive competition. Other users might enjoy spending time in the community, exchanging ideas with other users or learn new things in a challenge. For those users, everyone wins by participating and the common goal of bringing the best solution for the seeking organization on the table is the major focus leading to a positive interdependency.

Based on these insights, I derive the following research proposition:

P2.5 For lead solvers, winning is not the major driver for participation.

4.1.3 Overview framework and research propositions

Studying related literature helped me to develop the *lead solver framework* and derive corresponding research propositions that should serve as guidance for further research (see also Figure 15).

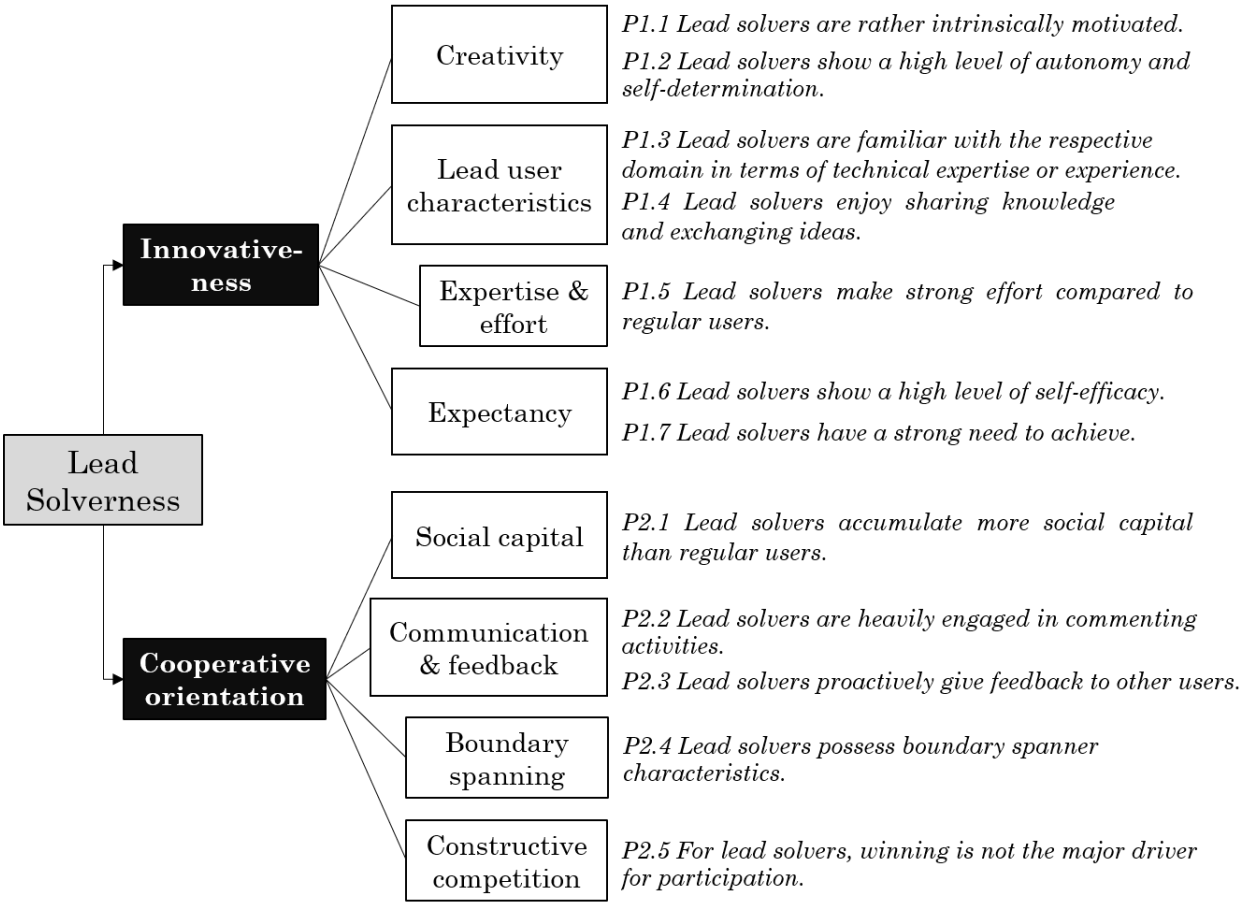


Figure 15. Lead solver framework with research propositions

4.2 Methodological approach

The major objective of this study is to explore user roles in contest communities and, in particular, to understand lead solvers as a valuable user group. For this purpose, I chose a multi-method approach to look at the phenomenon under study from different angles and perspectives (Flick, 2015). In addition, both qualitative

and quantitative methods were chosen to improve the validity of the research results overall (Jick, 1979).

In the following, a brief overview will be presented regarding the general methodological approach (Figure 16). A more detailed description of the methods applied in each study can be found in the respective chapter.

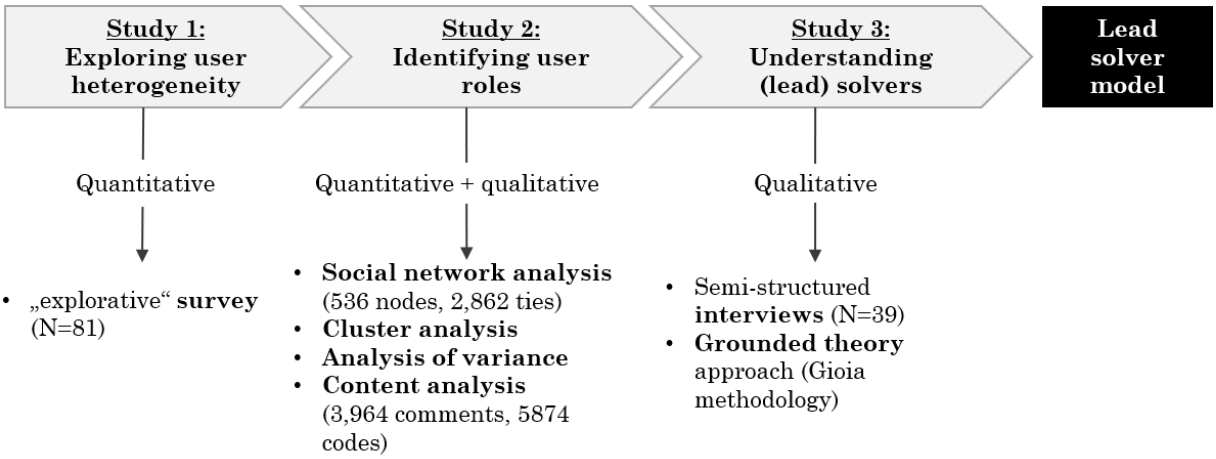


Figure 16. Methodological approach

First, I conducted a rather **explorative survey** with open-ended questions (study 1: N=81; RR=19 %) among the challenge participants to make myself familiar with the community under study and to explore the heterogeneity of users regarding background, motivation, and behavior during the innovation challenge. I wanted to know if the community I chose represents a suitable context to study user roles and lead solverness, e.g., cooperative behavior among users.

The goal of study 2 then was to identify and describe distinct user roles in the contest community based on all (publicly accessible) flows of communication (3,964 comments; 2,862 direct connections). Here, my methodological approach refers to literature where it was found to be effective (e.g., Welser et al., 2011, Gleave et al., 2009). **Social network analysis** based on all directed flows of communication revealed individual network measures. Via **cluster analysis**, it was then possible to find distinct user roles. Finally, I applied **content analysis** and **analysis of variance** to describe the user roles in detail, e.g., specific communication patterns. Applying a similar methodological approach to a different context and coming up with similar results is an important precondition to derive more generalizable results on lead solvers during the analysis.

In study 3, I follow a qualitative research approach to get rich insights into user roles in general, and lead solvers, in particular. I conducted 39 **semi-structured interviews** with representatives of each user group. For further analysis of the textual insights, I chose a grounded theory approach (Gioia methodology) to come up with distinct (lead) solver characteristics to be tested in follow-up studies (Gioia et al., 2013).

4.3 Research setting

The empirical research setting had to meet several requirements to study the phenomenon of lead solverness along the presented methodology.

First, I was looking for an established contest community where it would be likely to find lead solvers. Second, the community had to have a certain size to ensure a broad heterogeneity among users and user behaviors. Third, I needed a real contest setting where I could study lead solver behavior. Fourth, the contest community platform should provide publicly visible and traceable flows of communication and submissions.

All criteria were met in the case of Local Motors' contest community and the Airbus Cargo Drone Challenge which will be introduced in the following sections.

4.3.1 Local Motors and its community

The U.S.-based technology company Local Motors (LM) represents an interesting case for an organization that fully utilizes the concept of co-creation in the realm of (transportation) engineering and industrial design. Starting in 2007, the company managed to design and develop a new car and bring it on the street within two years and at a fraction of cost with the help of an online community of car enthusiasts who collaborated on the vehicle design (Figure 17). By means of web-based toolkits on its platform, engineers, designers, and tinkerers from all over the world voluntarily teamed up to design the exterior, the chassis, and other parts of the vehicle. In so-called challenges, the users of the platform submitted their ideas and jointly developed different car parts on the principles of open source (sharing, collaboration).

Figure 17. The Rally Fighter as the first collaboratively designed vehicle[1]

The community grew rapidly to more than 30,000 users who regularly join to participate in various projects ranging from urban mobility solutions (Figure 18) over electric motorcycles to 3D-printed cars (Figure 19).

Figure 18. Winning design of the Berlin Urban Mobility challenge[2]

With an increase in popularity and media coverage, LM opened the platform and offered its processes as a service to external partners and sponsors that wanted to tap the creative and innovative potential of this community. In specific challenges users submitted solutions to tasks set by seeking organizations, e.g., Domino's Pizza Ultimate Delivery Vehicle, DARPA XC2V, Berlin Urban Mobility Challenge, BMW Urban Driving Experience. In this case, LM acts as intermediary and

[1] https://www.supercars.net/blog/2010-local-motors-rally-fighter/ retrieved 17.03.2017
[2] https://www.foxnews.com/auto/local-motors-3d-printed-car-could-lead-an-american-manufacturing-revolution retrieved 17.03.2017

community manager between “seeker” and “solvers” that organizes and runs the contests.

Figure 19. Design of the first 3D-printed car[3]

Contrary to crowdsourcing, LM fosters collaboration between users as submissions are fully disclosed at the very moment of submission and any registered user may add comments to submissions. Furthermore, community managers and representatives of the seeking organization give feedback and suggestions for improvement while the challenge is active. This proved to be a viable configuration: Prizes attract users to participate and foster competition on the one hand. Collaboration between users, on the other hand, facilitates an enjoyable environment and a positive community culture where people inspire each other and exchange ideas which in the end increases the quality of the entries.

In 2016, LM initiated a spin-off platform called Launch Forth that should focus on the co-creation process and provide innovation services to seeking companies in the form of an innovation-contest community. These days, more than 100,000 users are registered on the platform. Beyond this innovative approach in car design, Local Motors also took on a new and collaborative model to build and sell vehicles. The *Rally Fighter* (Figure 17), for example, is built in decentralized micro factories spread across the U.S. and thus close to potential customers. In addition to the local nearness, customers may also participate in the manufacturing process. In a series of workshops, they can learn how to build their own car.

[3] https://3druck.com/wp-content/uploads/2016/06/olli-self-driving-mini-bus.jpg retrieved 17.03.2017

4.3.2 Airbus Cargo Drone Challenge

In April 2016, LM hosted another prominent design competition on its co-creation platform: The *Airbus Cargo Drone Challenge* (ACDC) in partnership with Airbus Group. Airbus teamed up with LM to learn about co-creation and micro-manufacturing, and thus to leverage the innovative potential of crowds to increase its adaptability. Before this challenge, LM had mainly focused its activities on vehicle design, engineering, and manufacturing. So, the question was whether existing users (with expertise in vehicle design) as well as new users interested in drone technologies would join the challenge and hand in valuable ideas.

Users were invited to submit concepts for a commercial drone to build upon Airbus' Quadcruiser concept (see Figure 20). The concepts had to meet a set of narrow specifications (Figure 21) regarding design configuration, size, weight, payload, operation mode etc. to perform the task of quickly delivering urgent medical supplies in case of an emergency or a disaster.

Figure 20. Quadcruiser concept of Airbus as basis for the challenge[4]

Deliverables included a general brief of the concept (inspiration, explanation of technical details etc.), 3D-view drawings of the drone, graphical and descriptive information about the structural design of the payload and cargo concept as well as an Excel-based frame sheet with geometric and aerodynamic calculations. Consequently, basic skills in industrial design and engineering were required to participate.

[4] http://www.airbusgroup.com/int/en/news-media/commercial-drones.html retrieved 17.03.2017

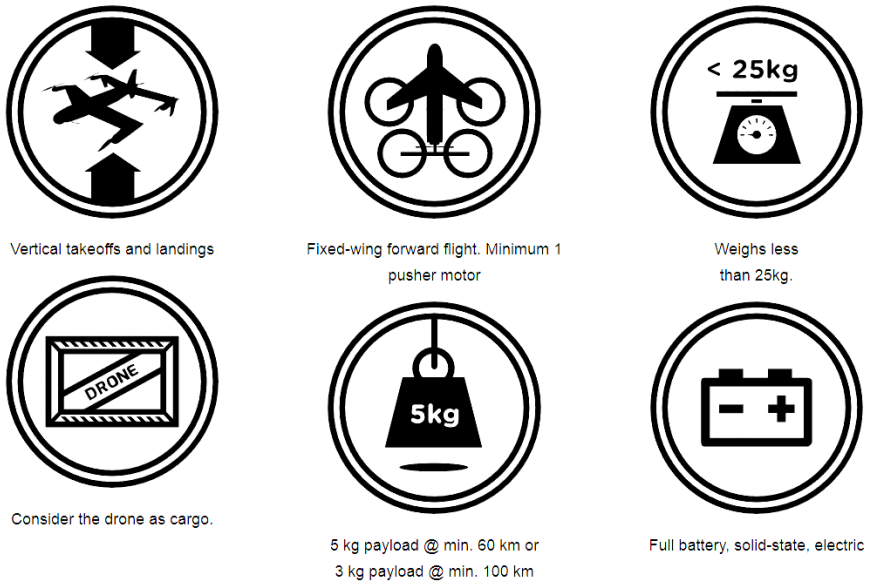


Figure 21. Design specifications for the challenge[5]

Each user had his or her own project page on the platform (see Figure 22). Visiting users could leave comments and get in touch with the creator of any drone submitted to the challenge.

All information regarding the concept is publicly accessible and licensed under non-commercial Creative Commons (CC-BY-NC) from the moment of submission. In case of winning one of the prizes, however, users automatically transfer all related intellectual property to Local Motors and Airbus in return for a cash prize.

Employees both from Airbus and Local Motors could participate in an "out-of-competition-mode". A group of 4-5 Local Motors employees was responsible for the community management (communicate, validate, feedback etc.). Additional community functionalities included a forum to discuss challenge-related issues and two live chat sessions with an expert group where users could ask questions.

[5] https://localmotors.com/dronechallenge/ retrieved 17.03.2017

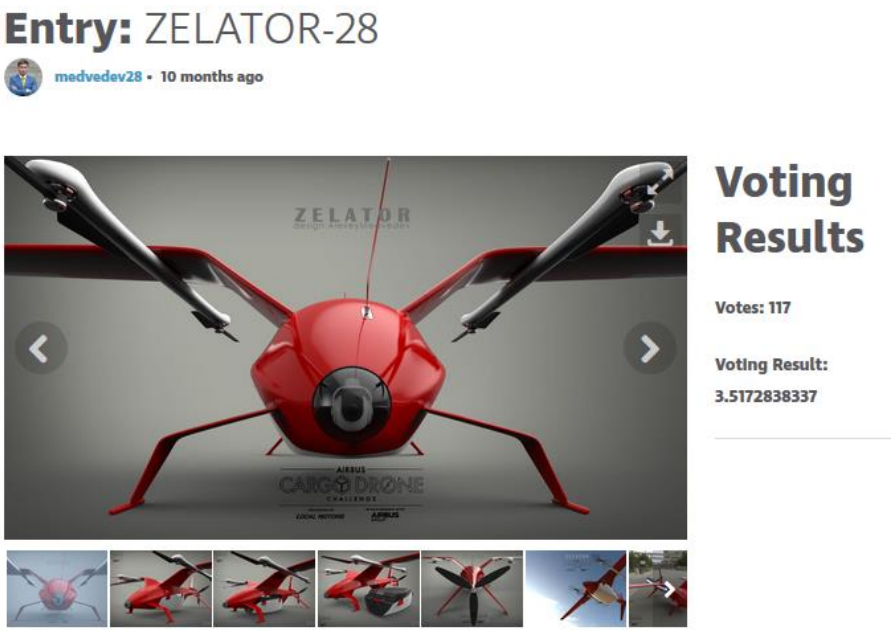


Figure 22. Exemplary entry page within the challenge[6]

Submission was open from April 12th to May 22nd, 2016 (phase 1: 6 weeks). After submission closing, the entries were checked for validity in 3 phases (main deliverables? specific requirements met? frame sheet and performance requirements?) until June 6th (phase 2: 2 weeks). If an entry were invalid in a specific phase, users could work on it and re-submit their concept. With 425 entries, this was the most successful challenge for Local Motors. After validation, 168 contributions (ca. 40 %) made it to the final stage. Finally, expert and community votings were conducted (phase 3: 2 weeks).

In total, contributors could win a US $ 117,500 cash prize that was awarded in three different categories:

- **Main award** (voted by Airbus executives; 1st: $ 50,000, 2nd: $ 20,000, 3rd: $ 10,000 plus trip to Farnborough Airshow),
- **Cargo prize** (voted by cargo industry experts; 1st: $ 15,000, 2nd: $ 5,000, 3rd: $ 2,500,
- **Community prize** (voted by community; 1st: $ 10,000, 2nd: $ 3,000, 3rd: $ 2,000).

The winners were announced on July 13th at the Farnborough Airshow (Figure 23).

[6] https://launchforth.io/medvedev28/zelator-28/ retrieved 17.03.2017

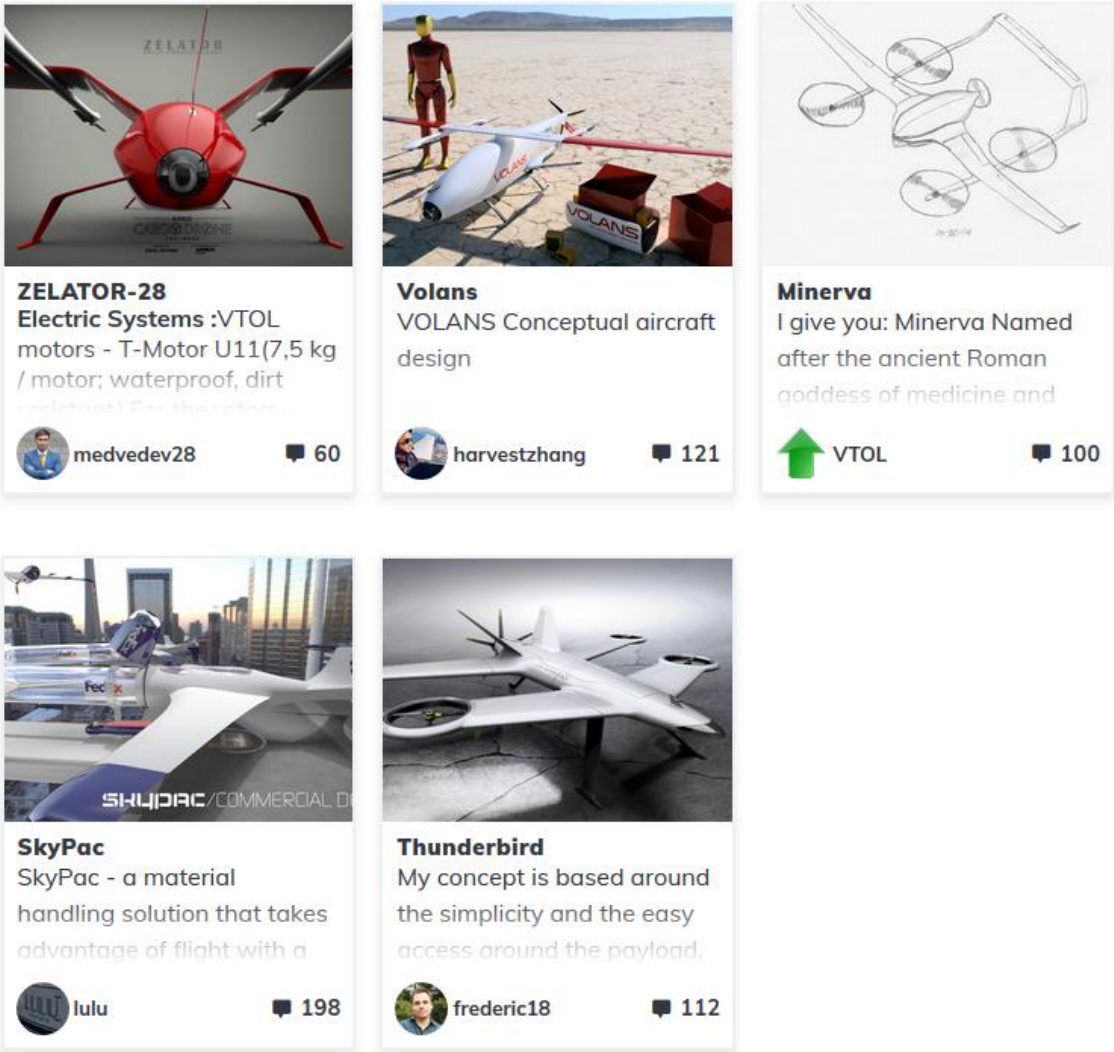


Figure 23. Winning entries of the Airbus Cargo Drone Challenge[7]

4.3.3 Discussion

The case of Local Motors, its huge community and the Airbus Cargo Drone Challenge in particular is of special interest for research in the context of this study for various reasons.

Airbus as a long-standing pioneer and global player in the aerospace industry reached out to an external web platform to gather new ideas and innovative input for its drone-related business activities. This indicates a certain relevance and diffusion of open innovation practices into industries with a strong focus on research and development (R&D).

[7] https://launchforth.io/challenge/airbus-cargo-drone-challenge/125/entries/ retrieved 17.03.2017

The LM platform operates in a niche of rather complex technologies (transportation design and engineering). Thus, like-minded enthusiasts and subject matter experts or professionals like designers, entrepreneurs or engineers (which I assume to be potential lead solvers) are involved in the co-creation processes rather than consumers. In the case of the Airbus Cargo Drone Challenge, the task required a deep understanding of basics in aeronautical engineering and thus the necessary level of proficiency to submit a valid entry was higher than with other LM challenges.

The recurring contest-like challenges spur competition between users to find the best solutions to specific tasks set by seeking organizations. Due to its collaborative community culture (feedback, idea sharing), however, the community is comparable to open-source communities where web users from all over the world gather to jointly tackle problems and develop products. In fact, many projects on the platform were initiated by users. All flows of communication and the submissions are publicly accessible. The platform can thus be referred to as an innovation-contest community where we find both collaborative and competitive elements.

Part III: Finding lead solvers

Chapter 5

Study 1: Exploring user heterogeneity

5.1 Introduction

To make myself familiar with the contest community under study and to test whether this context is suitable to research user roles and lead solverness, I chose to run an exploratory pre-study by means of a survey. The goal was to find out about the heterogeneity of users regarding background, motivation, and behavior during the challenge and hence to better understand the phenomenon of cooperative user behavior in a competitive setting as a basis for further research on lead solvers.

From the basic setup of the challenge, I already knew that the community at hand was a contest community featuring both competitive and cooperative behaviors. Thus, I wanted to find out to what extent collaboration and social interaction between the (rival) participating users had happened.

I chose a survey approach to gather information from as many users as possible in a short period of time. Another reason was that literature provides a range of items from studies on online communities and its users, e.g., motivation, feedback. It would thus be easier to draw conclusions and compare findings with results from related studies.

Preliminary results of this study were published previously (Moritz et al., 2018a; 2019).

5.2 Method and data

5.2.1 Questionnaire development

The standardized questionnaire was developed along Flick's (2015) guideline towards collecting quantitative data. All questions should be formulated in a short, clear, and unambiguous way and serve the overall goal of the study. The questionnaire mostly entailed closed questions. In some cases, respondents could provide additional comments. Wherever possible, I draw on established items from literature (e.g., motivation (Lakhani & Wolf, 2003)).

The survey was organized in three sections: First, I was asking for background information about the person (age, gender, location, education, employment status, income, profession). Then, questions regarding the participation process followed (earlier activities on the platform, motivation to participate, entry setting, commenting, effort on submission, submission, recognition, and compensation).

Finally, I was interested in the perception of the challenge overall. I pretested the questionnaire with participants and researchers and adjusted some minor issues based on the feedback (see also Appendix A).

5.2.2 Data collection and preparation

The web-based survey was online for eight weeks, two months after the challenge had ended (July 13th to September 12th, 2016). To inform the users about the survey, I posted an invitation in the community forum and, in addition, left comments on all project pages to avoid a sampling bias (Fowler, 2014). I offered a gift voucher for the Local Motors web shop that was raffled afterwards to incentivize participation.

425 entries were submitted to the challenge in total. The population size might be different though as some users submitted multiple entries whereas others worked in teams. According to a community manager, at least 422 users were involved. Assuming a population size of 425 thus seems adequate.

I received 81 responses resulting in a response rate of 19 %. 7 questionnaires were incomplete. The data was checked for validity, some items were reduced for

clarification reasons. At the rear part of the survey, I detected a minor nonresponse-bias and reacted by excluding missing values from analysis on a case-by-case basis (Fowler, 2014).

Data was also checked for a self-selection bias by comparing early and late responses. There was no major deviation. I used IBM SPSS to run descriptive analyses.

5.3 Findings

5.3.1 Who are the users? Users' background

All respondents were male. They live all over the world in at least 25 countries. The true number of countries involved is 53 according to Local Motors. However, comparing some of the numbers (sample vs. true) indicates that the share among continents should be nearly constant. Regarding education, the survey revealed that most challenge participants are highly educated (71 % hold a Bachelor, Master or PhD) and rather young (75 % between 18-39).

The respondents represent a variety of income and employment situations. The majority of users considers themselves as engineers and designers followed by tinkerers and inventors. Every second user was new to the LM Community. Data from Local Motors provides an even clearer picture here: 72 % of the challenge participants were new to the community. Detailed results are shown in Figure 24.

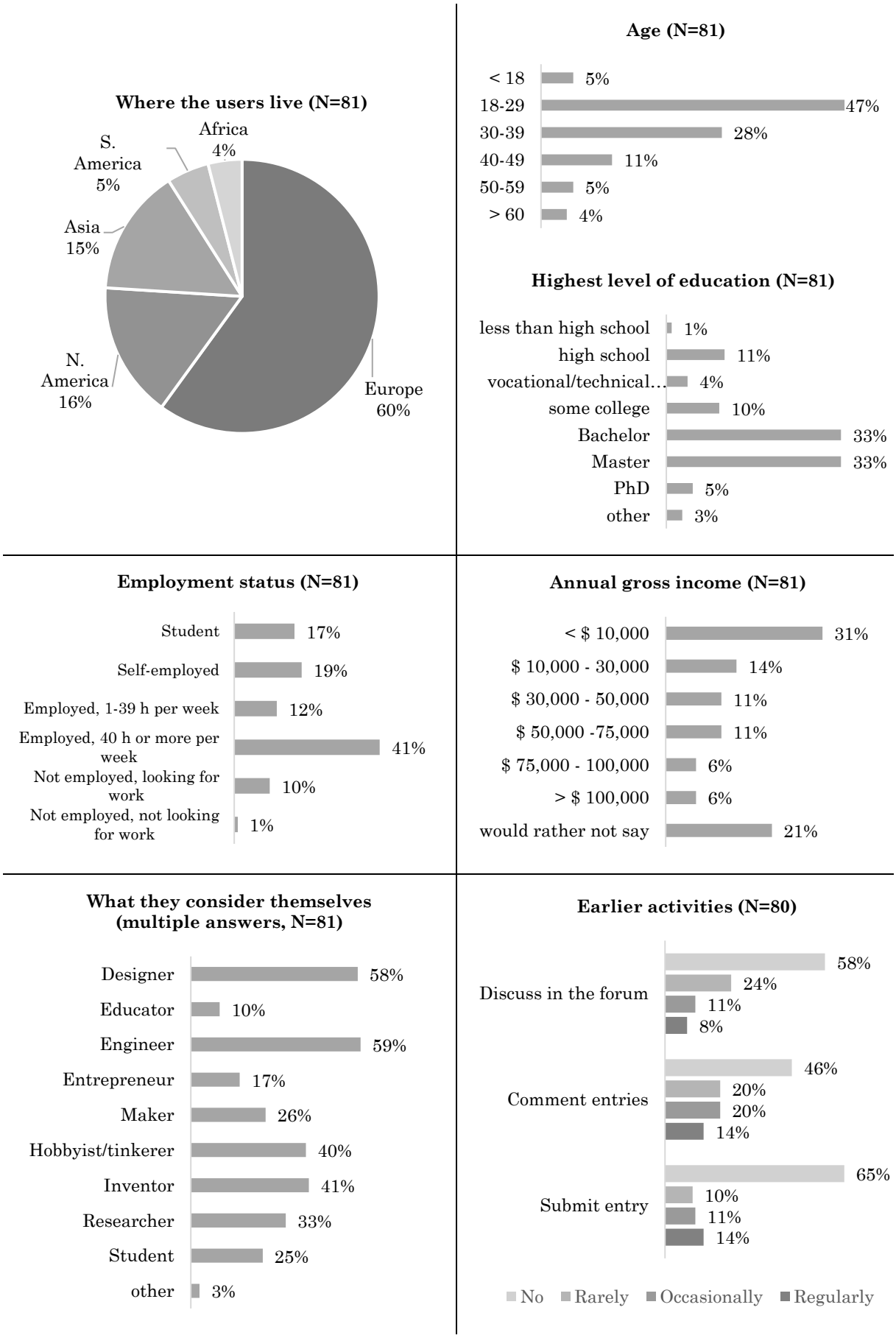


Figure 24. Survey findings on users' background

5.3.2 Why do users participate? Motivation and expectations of users

Participants took part in the challenge for various reasons. I found both intrinsic and extrinsic motivational factors at work. Interestingly, intrinsic elements (solving problems, having fun, and learning) prevail over extrinsic factors (make money, enhance reputation, signal for job) despite the rather competitive setting of the challenge and the high monetary price involved (for details, see Figure 25).

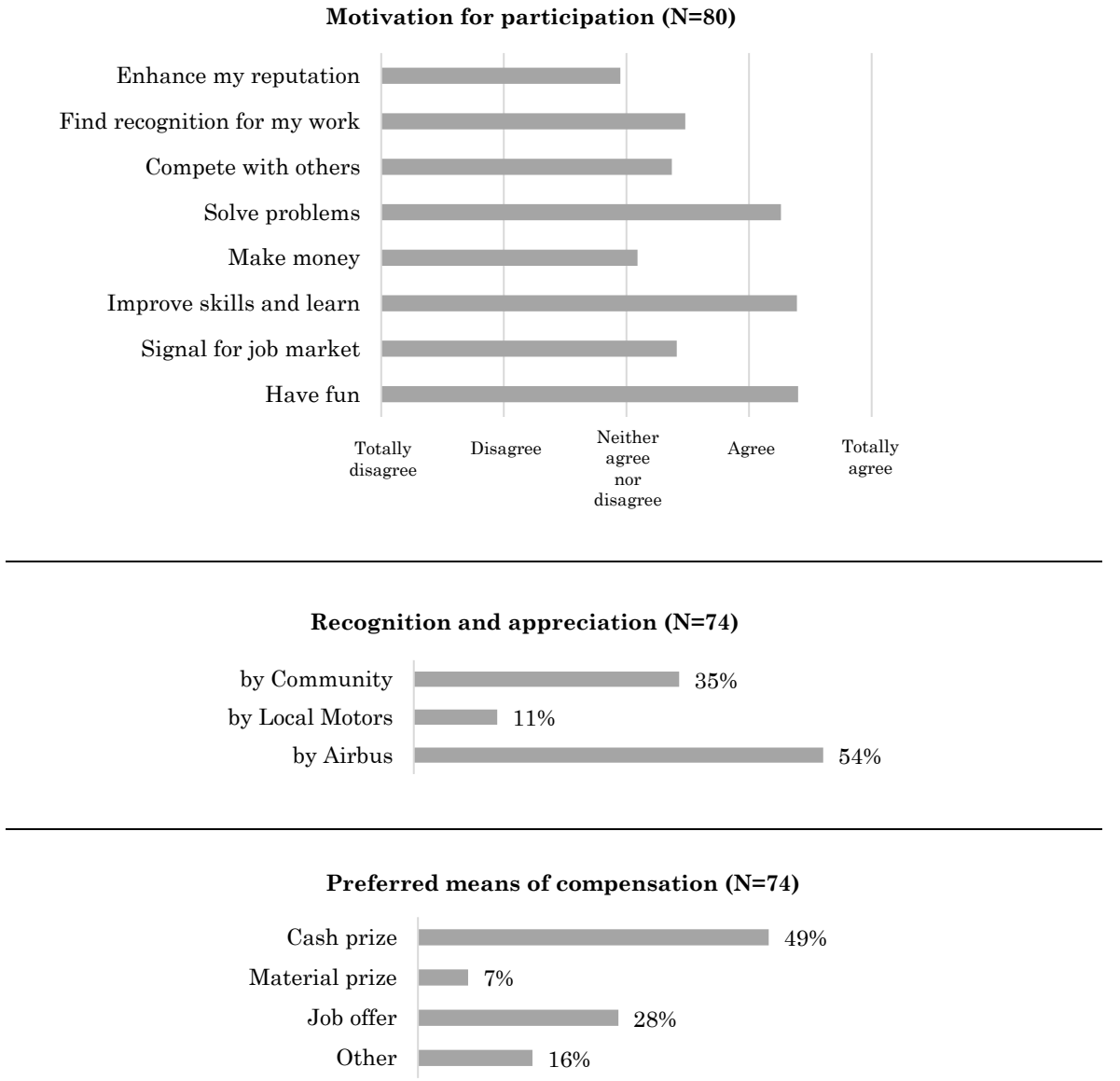


Figure 25. Survey findings on motivation and expectation

Asking for preferred means of compensation, one out of two participants preferred a cash prize over a job offer or a material prize. Participants could provide additional information here. Some claimed a clear *business interest* (e.g., "business

contract", "cooperation with Airbus", "licensing the design"). Others valued the (*learning*) *experience* itself as rewarding (e.g., "compensation was what I learned", "knowledge and experience", "Recognition of community"). Lastly, a *fair distribution* among all contributors was addressed (e.g., "compensation for those who did not win", "fair compensation for all participants and contributors").

Regarding recognition and appreciation, I found that reputation within the community matters. In fact, it is more important to users what their peers think than what the challenge host does. Still, more than half of the respondents wanted their work to be appreciated by Airbus with its high brand reputation.

5.3.3 How do users participate? Behavior and idea generation

In accordance with a mixed set of motivations, I found different behavioral patterns in the process of participation too (Figure 26).

Submission was open for six weeks. While more than one third of the respondents initially uploaded (and thus published) an entry at an early stage of the challenge (week 1-4), another third submitted right before submission closing. Early submission suggests either a collaborative (willingness to share, openness to feedback) or a competitive attitude (defensive publication). Submitting rather late indicates a hybrid strategy: It is too late for other users to pick up my idea, but I want to share my ideas as others did so (reciprocity). These results might be biased by users that were busy to the last or that entered the challenge at a late point in time.

Having in mind the "winner-takes-all" mode, it is remarkable that one out of ten respondents received support from others while creating the entry (e.g., design or calculations). Furthermore, two out of three participants engaged in commenting activities to exchange ideas and get inspiration, to give feedback and to help others with suggestions for improvement. These insights clearly indicate collaborative behavior among a large portion of users.

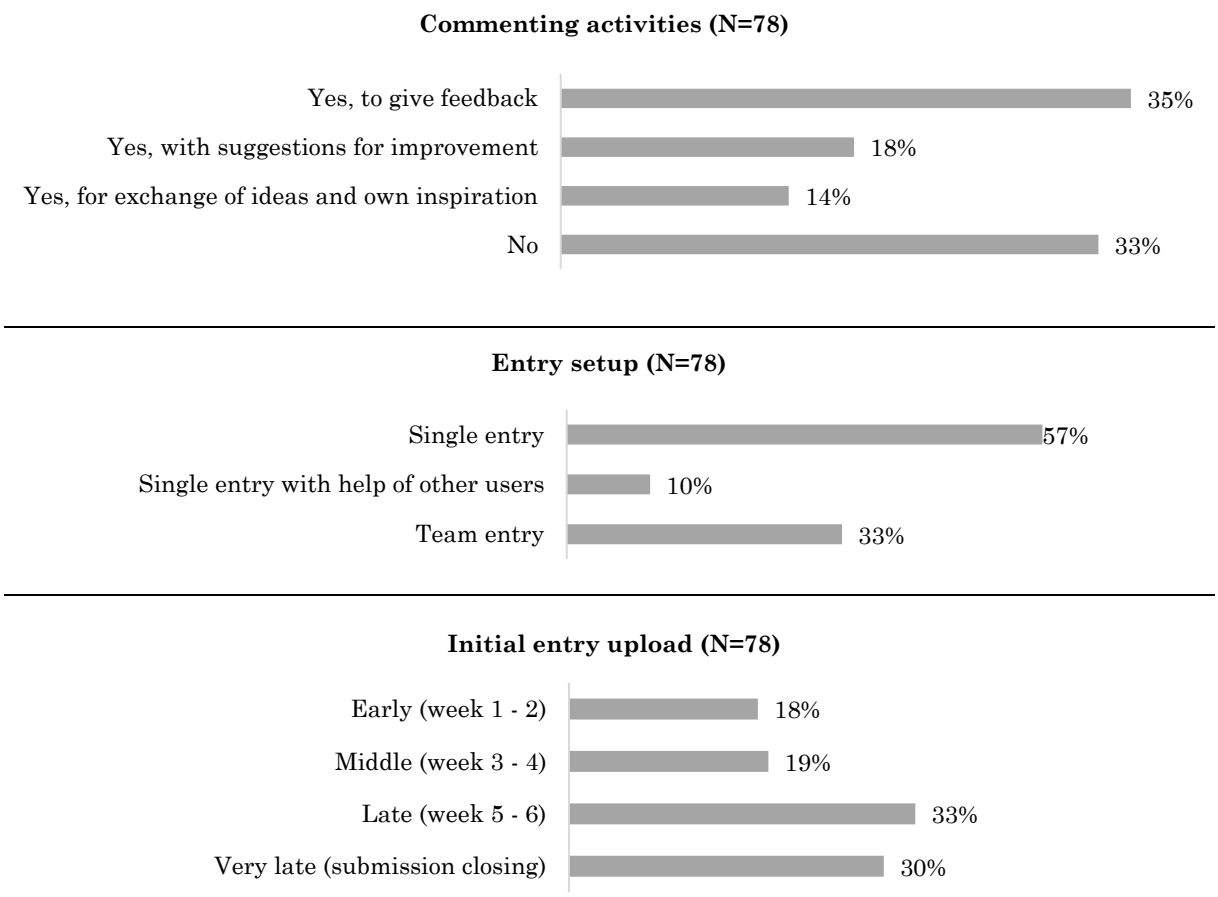


Figure 26. Survey findings on communication and submission behavior

5.4 Discussion and implications

While the challenge setup suggests a rather competitive environment (few monetary prizes), the platform and the process of participation enabled cooperation among users (publicly visible entries, commenting and feedback). Accordingly, the results of the survey revealed that we find both, collaborative and competitive behavior of users. Hence, the contest community under study is suitable for further research on user roles.

A large number of users revealed their work early for feedback, helped other contestants to improve their entry and seeks recognition by the community. We also find rather passive and competitive users who submitted late and did not engage in social interaction.

Differences in behavioral patterns might be rooted in users' personality, experience, and situation. In line with literature in the field of innovation contests,

we have seen that participants greatly differ regarding their individual context and motivation to participate. Thus, the challenge community represents a group of users with great heterogeneity which is worth further studying to uncover distinct types or roles of users, describe and understand these and design contests and platforms accordingly.

Starting from this exploratory study that gave us some first and interesting insights into LM's contest community, I wanted to dive deeper and better understand the community. Why would users share knowledge, help others to improve their entry and submit their ideas early so that other can see them? This kind of behavior seems counterintuitive at first sight. Another interesting question is whether the latter behavior can be observed among rather innovative users or even among a group of users who behave in a similar way. This at least is what research from Bullinger et al. (2010) and Hutter et al. (2011) tells us. Finally, being able to group users who behave similarly into user types or roles would help us to better understand the community and to address the different users with adequate measures.

Chapter 6

Study 2: Identifying user types

6.1 Introduction

In study 1, I uncovered a wide variety among challenge participants regarding background, motivation, and behavior. Thus, it is hard to derive implications for managing and interacting with users. The question arises whether it is possible to find distinct roles of users that behave and interact in a similar way.

If it would be possible to segment users of an online community or to identify key users, lead solvers in our case very early or simultaneously, community managers would be able to develop adequate strategies to find, attract and manage these (e.g., incentive, facilitation, communication). A very promising approach here is to investigate the communication patterns of users, for example via social network, cluster or content analysis (e.g. Hautz et al., 2010, Koch et al., 2013, Füller et al., 2014, Fuger et al., 2017).

In LM's contest community, all entries and flows of communication (comments between users) are publicly accessible and visible; private messaging was disabled. Results of the community voting and a list of the final winners were published too. Thus, there is a rich data basis to draw from for further analysis.

The goal of this study is to identify distinct user roles based the individual communication and submission patterns. User role assignments can then afterwards be used to address users of the respective groups for further analysis and insights on the individual user level. As a side-effect, this methodology can

also be further developed to identify user of a certain group in an early stage of a contest.

Preliminary results of this study were published previously (Moritz et al. 2018b).

6.2 Methodological approach

I applied a mix of quantitative and qualitative methods to identify and characterize user roles. This combination is suitable to provide a comprehensive understanding of the topic under study and to strengthen the reliability of the results (Flick, 2014). Linking social network and cluster analysis with content analysis was found to be a useful approach to identify user roles (e.g. Welser et al., 2011, Pfeil et al., 2011, Gleave et al., 2009).

The first step was to extract all directed flows of communication between users for **social network analysis** resulting in individual network measures of every single user that left or received at least one comment. Among these measures were: *in-degree centrality* (number of incoming messages), *out-degree centrality* (number of outgoing messages). Adding the *number of ideas* each user had submitted to the challenge resulted in three measures as input for **cluster analysis**.

Then, I applied **analysis of variance** (ANOVA) to compare the average *quality of ideas* based on the result of the community voting and *betweenness centrality* (which is a measure to identify important and influential actors of a network) between the identified groups.

Finally, I conducted a **qualitative content analysis** based on all comments left to retrieve individual communication patterns. The goal was to doublecheck the results of the cluster analysis and see whether I would find distinct communication patterns between different groups of users and describe differences between them in more detail.

6.3 Procedural aspects and preliminary results

6.3.1 Social network analysis

6.3.1.1 Method and data

Social network analysis (SNA) is an effective quantitative method to study social phenomena like community structure and individual behavior of actors within a network based on metrics and structural positions (Hinds & Lee, 2008). Social media and online communities, in particular, offer plenty of data for analysis as social interaction occurs in the digital sphere with traceable records and, thus, new insights into communities can be derived (Gleave et al., 2009). SNA recently has been adopted by researchers in the field of innovation communities too to study user roles and community mechanisms (e.g. Hautz et al., 2010, Hutter et al., 2011, Füller et al., 2014).

The challenge community can be considered a social network consisting of *nodes* (users) and *ties* (flows of communication between the users) that represent relationships between social entities (Wasserman & Faust, 1994, Prell, 2015). Interactions between users via commenting enable social mechanisms such as reputation, reciprocity and mutually beneficial interactions (e.g. new social contacts, feedback, exchanging ideas, support) (Panzarasa et al., 2009).

The analysis considered the individual communication behavior of users (actor-based network measures). They could receive comments on their project page, give answers with/without tagging a certain user and leave comments at other entries. To comment, users had to log in with their username, thus I was able to assign every comment given to a user. This was the only way users could directly communicate with each other inside the challenge platform. All commenting activities were publicly accessible.

A user can be a source and a target of communication. If a user leaves a comment at someone else's entry or replies directly to an incoming message, he is the source and, vice versa, a user is the target if another user comments at his or her own entry page or replies directly. A (directed) tie between two users was established

as soon as one comment had a source and a target following a weak notion of a social relationship (Granovetter, 1977).

In contrast, a strong notion would require a reciprocal act (message and answer) for a relationship to be formed. By following the latter approach, directional ties would be transformed into undirected ones during SNA and thus important information about different user behaviors would get lost.

The network under study had a low average strength of a directed tie of 1.39 (ratio of all comments sent (3,964) and number of directed ties (2,862)) and 97 % of ties had a strength (= number of messages along a certain tie) of 3 or less. Adopting a stricter definition of a social connection would have minimized the number of ties dramatically and result in isolated users and a reduced connectivity overall. Thus, I chose the weak definition to retain directionality of ties and to cover as many ties as possible (Panzarasa et al., 2009).

The analysis focuses on those phases of the challenge where communication via commenting was an important means for interaction and collaboration (from submission in phase 1 to voting in phase 3). During that time, **536** users (**no. of nodes**) were engaged in communication by either sending and/or receiving at least one of 3,964 comments in total. Users who did not comment at all and who did not receive at least one message could not be considered. Comments by officials from Local Motors or Airbus (e.g., community managers, employees of the sponsor) were removed from the analysis.

The directionality of communication flows (in-degree centrality, out-degree centrality) is an important measure to distinguish user types, thus, only those comments could be considered for analysis that had a clear target (entry of a certain user or direct reply to a post via reply button). Removing undirected ties (1,082) and self-loops (source = target) from the dataset led to a remaining number of 2,862 directed ties (see also Table 3).

Finally, I took out all ties with a strength > 1 (more than one message from the same source to the same target) which simplifies analysis and foregoes biases by outliers leaving **1,866 single directed ties** to be considered for social network

analysis. UCINET 6 was used to calculate individual network measures (Borgatti et al., 2002).

Table 3. Overall network metrics

Metric	Value	
Nodes (users)	**536**	
Ties (total)	3,964	
Average strength of a tie	1.39	
Share of tie with strength < 3	97 %	
Undirected ties and self-loops		-1,082
Directed ties	2,862	
Directed ties with strength > 1		-996
Single directed ties	**1,866**	

Actor-based network measures based on directed ties define different structural positions that are important to identify user roles. *In-degree centrality* or degree prestige refers to the number of messages directed to a user. A high number of incoming messages indicates that a user can draw other users' attention with creative and inspirational ideas. *Out-degree centrality* considers the number of outgoing messages by a user and describes how actively someone participates in communication with other users. (Prell, 2015)

6.3.1.2 Results of social network analysis

Analysis of the network revealed a structure of the community under study that is comparable to similar studies in the field of innovation communities (Füller et al., 2014, Hautz et al., 2010). Figure 27 illustrates the network structure.

We can observe that few nodes in the center are intricately linked and communication is dense while a large group of users in the outer areas communicated rather little and is thus poorly connected. In fact, most users commented once and did not engage further in communication with others. Obviously, users differ in their communication and interaction behavior which calls for further consideration.

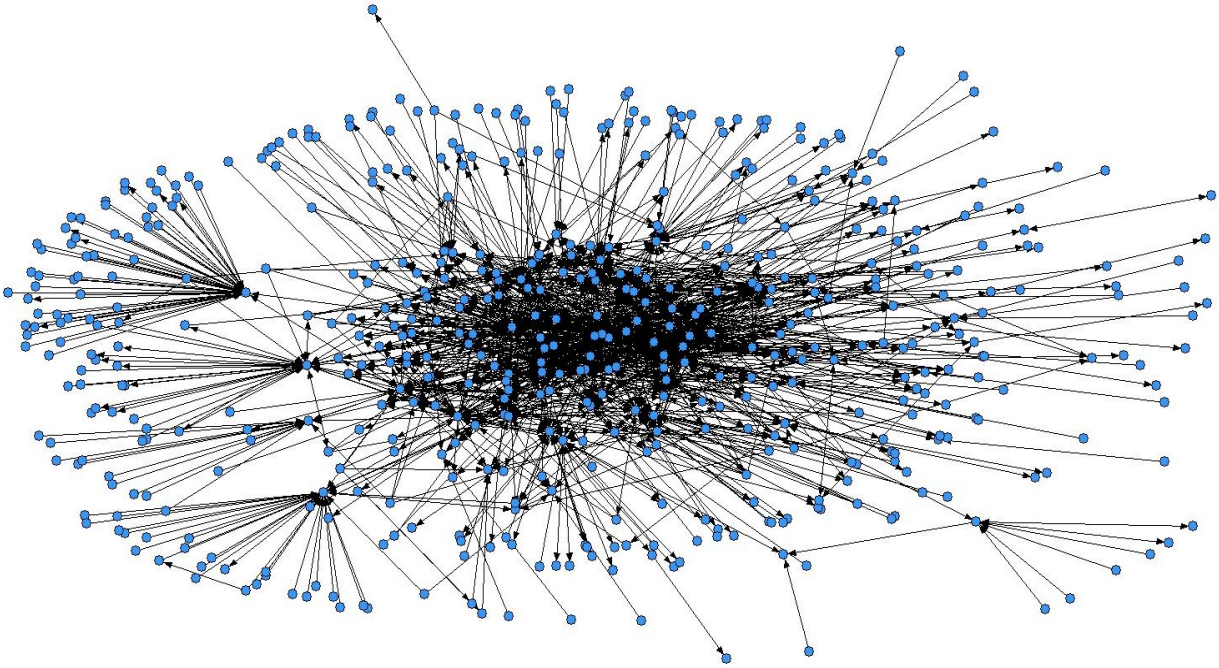


Figure 27. Graphical representation of the network structure

Descriptive statistics of the network confirmed these preliminary results (Table 4). In addition to the actor-based measures (*in-degree centrality*, *out-degree centrality*), I added the *number of entries* per user as previous studies found that this value significantly differs among users (e.g. Hautz et al., 2010).

On average, a user sent and received about 3 comments to and from different users (single directed ties) and submitted 0.5 entries (mean values). Looking at other statistics tells us though that the average user is not representative. With a median of 1 (*in-degree*, *out-degree*) and 0 (*no. of entries*), respectively, we know that a large number of users did not communicate and did not receive any comments. Even more strikingly, many users of the network did not submit an entry. High standard deviations support the fact that users differ greatly regarding their behavior. The maximum number of relationships that certain users formed were: 51 by incoming messages from single users and 115 by outgoing messages to single users, respectively. A high value of indegree-centrality represents a user whose entry caught attention by many people, whereas a node with a high out-degree centrality may be characterized as an active socializer and collaborator.

In addition, *Pearson's skewness coefficient* (based on the difference between mean and medium) indicates an asymmetric distribution around the mean value which

can be interpreted as user heterogeneity (values range from -3 to 3; 0 is a symmetric distribution).

Table 4. Descriptive statistics of the network

Measure	Mean	Median	Standard Deviation	Variance	Pearson Skewness coeff.	Min.	Max.	Total
In-degree	3.48	1	6.83	46.78	1.09	0	51	1,866
Out-degree	3.48	1	9.89	97.97	0.75	0	115	1,866
No. of entries	0.5	0	0.87	0.76	1.73	0	12	269

Another approach to check whether users differ in their communication behavior is to analyze the distribution of the network measures overall (degree distribution). In fact, literature tells us that most real-world networks (e.g. World Wide Web, cellular networks) follow a power-law function and are thus called "scale-free" (Albert & Barabási, 2002, Panzarasa et al., 2009). A "scale-free" network comprises a large group of nodes with hardly any connections while few nodes are well-connected with a number of ties far above average. The latter thus serve as hubs that hold the network together.

For directed networks, the (in-/out-)degree distribution follows the notion (Panzarasa et al., 2009):

Equation 1. Power-law function of „scale-free" networks

$$p(k^O) \sim (k^O)^{-\tau} \qquad \tau = const.$$

$$p(k^I) \sim (k^I)^{-\tau} \qquad \tau = const.$$

$p(k^O)$ and $p(k^I)$ represent the fraction of nodes (users) with an out-degree k^O and in-degree k^I, respectively. Figure 28 and Figure 29 illustrate the empirical degree distributions of the network under study. The linear behavior in a double logarithmic scale indicates an exponential distribution. The exponent τ is 1.08 for the out-degree distribution and 1.31 for in-degree, respectively. A value of τ that is lower than 2 is characteristic for heterogenous structure of a network (Albert & Barabási, 2002).

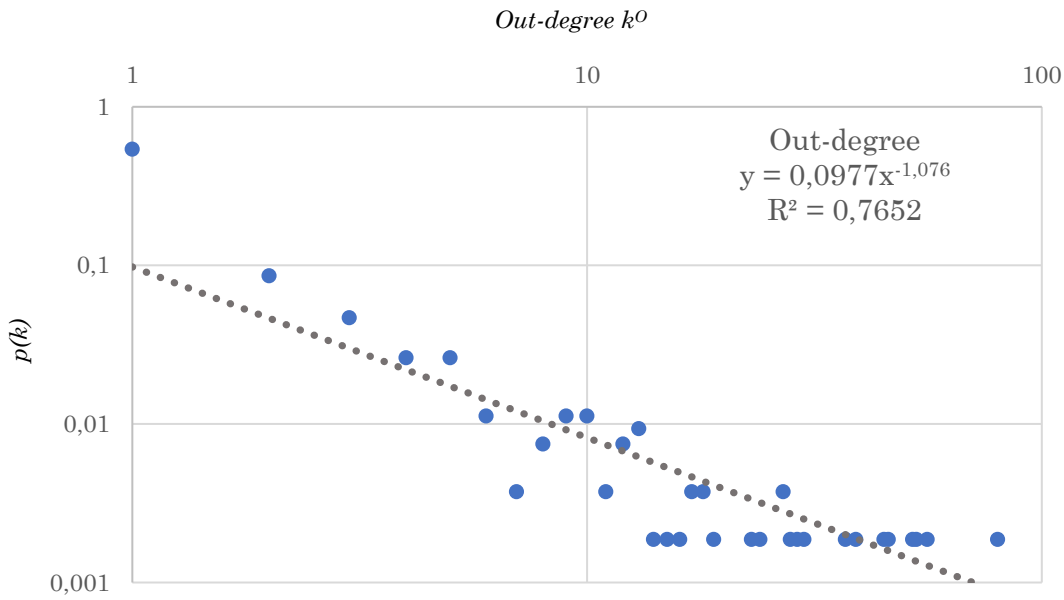


Figure 28. Out-degree distribution on a double logarithmic scale

We can observe for both, in-degree and out-degree distribution, that a major fraction of users was hardly engaged in communication (e.g., $p(k^O) = 0.54$ for $k^O = 1$; $p(k^I) = 0.22$ for $k^I = 1$), while a very small number of users established a comparably large number of relationships (e.g., $p(k^O) = 0.002$ for $k^O = 115$; $p(k^I) = 0.002$ for $k^I = 51$). In other words, 54 % of all users ($p(k^O) = 0.54$) wrote one directed comment ($k^O = 1$), while only 0.002 % sent a message to 115 other users.

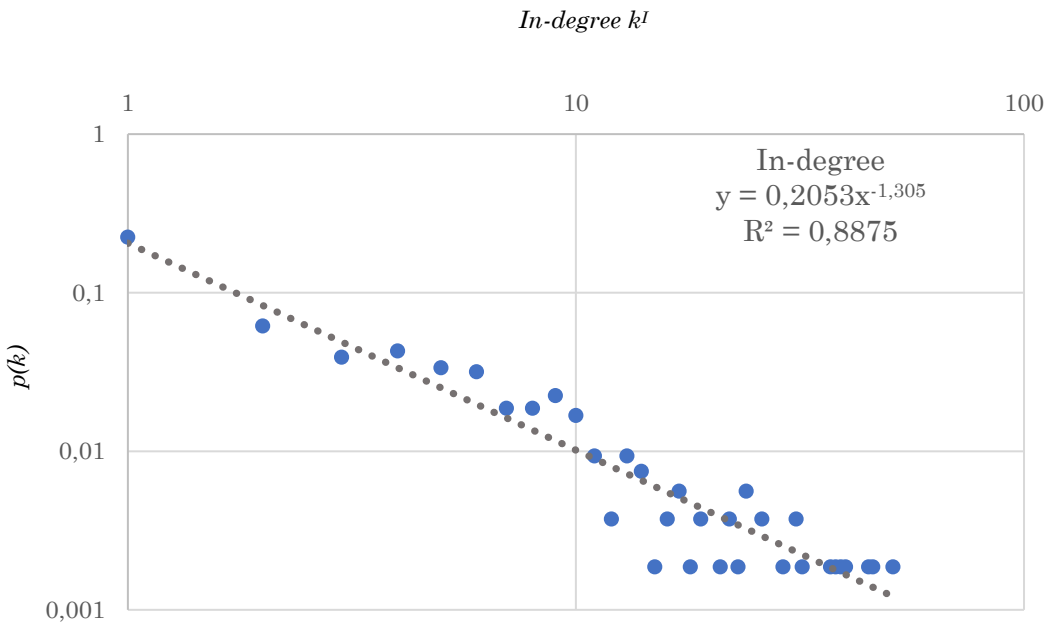


Figure 29. In-degree distribution on a double logarithmic scale

To conclude, social network analysis revealed that users significantly differ regarding their interaction and contribution behavior. Some users are highly involved in communication while others are rather passive. We also have learned that many users did not even submit an idea, but still were continually active in commenting.

The question arises whether distinct user types exist that can be clearly differentiated among actor-based network measures (in-degree and out-degree centrality) and the number of submitted entries.

6.3.2 Cluster analysis

6.3.2.1 Method and data

A promising approach to identify groups from data are cluster analysis techniques. Scholars in the realm of the topic under study recently have shown how cluster analysis can be a powerful means to find distinct user roles and social network types (e.g., Fiori et al., 2007, Brandtzæg, 2012, Füller et al., 2014, Fuger et al., 2017) .

In general, cluster analysis is a statistical method that sorts data into similar groups. The goal is to gather in groups objects with a minimized statistical variance of variables (distance measures) and to delineate these groups against others with maximized variance between them (Ketchen Jr & Shook, 1996).

There are two generic approaches: **Hierarchical** and **non-hierarchical clustering**. Hierarchical clustering algorithms perform a series of steps to build up a tree-like structure by either adding or removing objects from groups (see also Figure 30). It does not require a specific number of clusters beforehand. To work properly, however, these techniques require a basic understanding of the structure of the sample before clustering to choose the best fitted algorithm. Another disadvantage is that algorithms run only one cycle on the data. Thus, there is no reassignment in the case of a misfit. (Ketchen Jr & Shook, 1996)

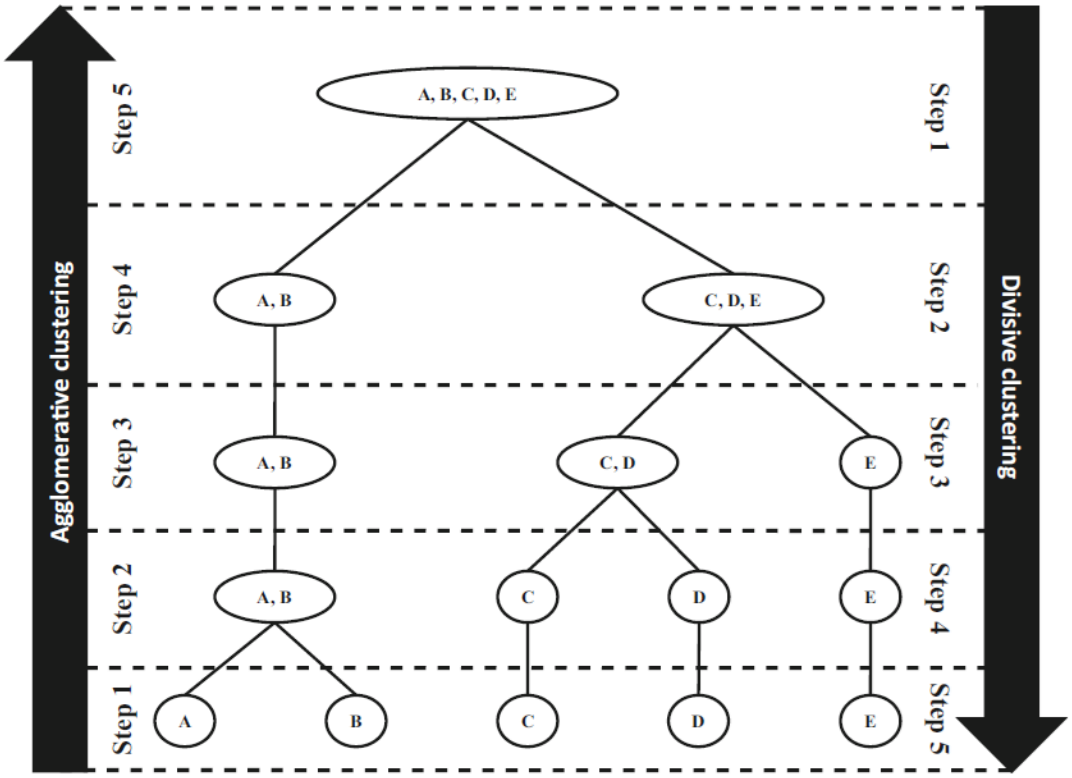


Figure 30. Hierarchical clustering: agglomerative (left) and divisive (right) approach (Sarstedt & Mooi, 2014)

Non-hierarchical techniques, on the other hand, group objects into a specific and predefined number of clusters. Each object will be assigned to one of the initial cluster centroids that is the nearest neighbor based on the input variable(s). With more and more objects in the clusters, cluster centroids are recomputed, and cluster memberships of objects may change.

This process iteratively runs until an additional object does not change clusters anymore (see also Figure 31). Due to its dynamic and iterative nature, non-hierarchical clustering is superior to hierarchical approaches; however, this is only the case if the number of clusters can be specified a priori. Obviously, this is not the case when exploring a new data set where one does not know how many clusters are suitable. (Ketchen Jr & Shook, 1996)

To sum up, hierarchical and non-hierarchical clustering algorithms both have flaws if solely applied. Thus, a combination of both is recommended to ensure validity and stability of results. IBM SPSS was used for cluster analysis.

I chose a two-step procedure as proposed by Punj (1983) and Ketchen (1996):

1. Hierarchical cluster analysis:
    - Aim: Find adequate number of clusters
    - Input: Nodes with variables {In-degree (IN); Out-degree (OUT); No. of entries (NO)}
    - Algorithm: *Ward's minimum variance*
    - Choose suitable number of clusters via *elbow criterion*
    - Results: Number of suitable clusters *k*
2. Non-hierarchical clustering (*k-means*):
    - Aim: Cluster solution with high validity
    - Input: best-fitted *k* calculated via VRC, initial cluster centroids (mean values of hierarchical clustering with *k* clusters)
    - Algorithm: *k-means*
    - Results: Final cluster solution

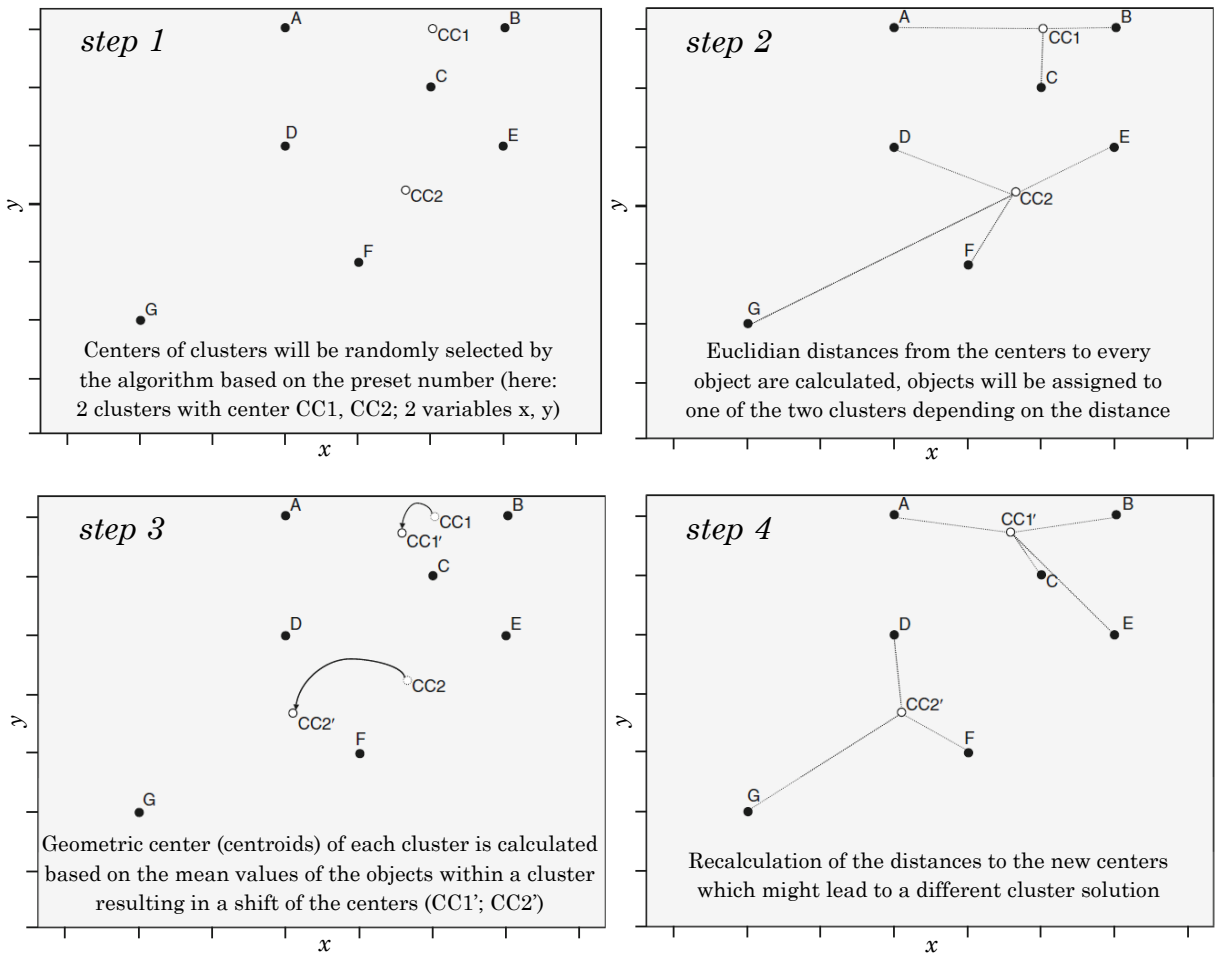


Figure 31. Non-hierarchical clustering (k-means) procedure (Sarstedt & Mooi, 2014)

1. Hierarchical clustering:

First, I ran hierarchical clustering to find an adequate number of clusters. The values of the input variables (in-degree IN, out-degree OUT, no. of entries NO) for each object (user) of the data set were standardized (z-scores with mean $\bar{x} = 0$ and standard deviation s = 1) to make them suitable for data analysis (Sarstedt & Mooi, 2014).

Equation 2. z-transformation to standardize variables

$$z_i = \frac{(x_i - \bar{x})}{s}$$

Ward's minimum variance method based on the squared Euclidian distance (see also Figure 32 and Equation 3) was applied as agglomerative clustering algorithm (Ward Jr, 1963).

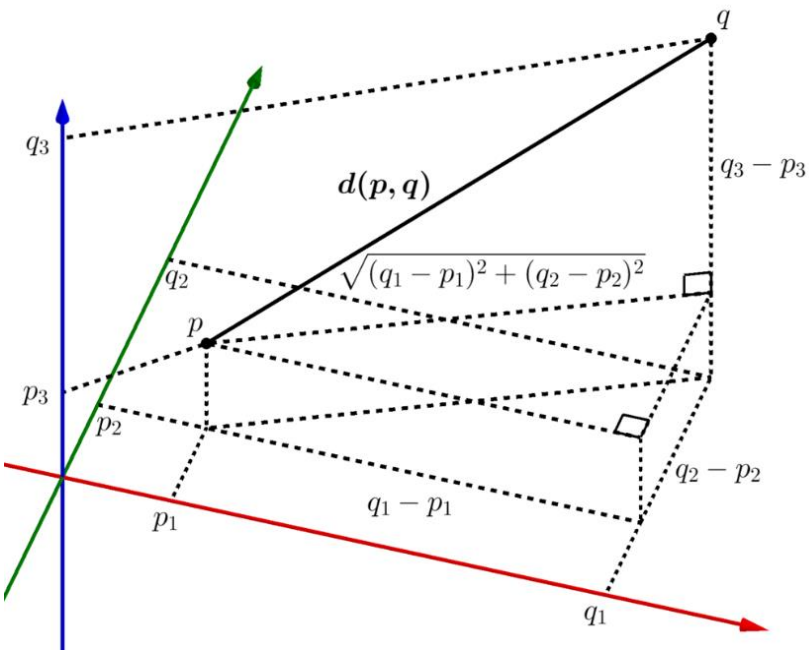


Figure 32. Illustration of Euclidian distance between two points p, q with n=3 dimensions (Kmhkmh, 2020)

Equation 3. (a) Euclidian distance and (b) squared Euclidian distance between two objects (node p and q) with 3 standardized variables (I; O; N)

$$(a) \qquad d(p,q) = \sqrt{(z_{p_I} - z_{q_I})^2 + (z_{p_O} - z_{q_O})^2 + (z_{p_N} - z_{q_N})^2}$$

$$(b) \qquad d^2(p,q) = (z_{p_I} - z_{q_I})^2 + (z_{p_O} - z_{q_O})^2 + (z_{p_N} - z_{q_N})^2$$

Ward's minimum variance method can be described as follows: At the beginning, each object is a cluster in itself (a single node with a standardized value for in-degree, out-degree, and no. of entries, e.g., user 1: IN = 2; OUT = 3; NO =1).

In this initial situation, the total variance or sum of squares is 0 with a maximum of homogeneity in the clusters as each object is the center of its cluster. A fusion of two clusters results in a decrease of homogeneity of classification which is expressed by an increase of variance (within-group sum of squares).

Then, step by step the clustering algorithm fuses pairs of clusters where the merger leads to a minimum increase in total-cluster variance ("merging cost") until finally all objects form one cluster. In other words, the aim is to minimize the decrease of homogeneity over all groups when merging two clusters.

The procedure of clustering algorithm using *Ward's minimum variance* method is:

Start: Fine partition (each object forms a cluster). The total cluster variance V is 0 at this point.	
1. Compute cluster means of all clusters g for each variable k {IN; OUT; NO}. (Equation 4)	$\bar{z}_{gk}$
2. Compute change of variance for every possible pair of clusters. (Equation 6)	ΔV
3. Merge the pair with a minimum increase of variance in the newly formed cluster (in this case C_g and C_h).	ΔV_{min} $\rightarrow (C_g \cup C_h)$
Resulting in a new partition with a total cluster variance V (Equation 7):	$V_1 = V_0 + \Delta V_{min}$
4. Is more than one cluster left?	Yes
No ↓ End.	

Figure 33. Procedure of hierarchical (agglomerative) clustering with Ward's minimum variance method

Equation 4. Mean values of variable k in cluster C_g with i objects

$$\bar{z}_{gk} = \frac{1}{n_g} \sum_{i \in C_g} z_{ik}$$

n_g: *number of objects in cluster* C_g

z_{ik}: *standardized value of variable k of object i*

$\bar{z}_{gk}$: *mean of variable k in cluster* C_g

Equation 5. Sum of squares (variance V_g) of cluster C_g

$$V_g = \sum_{k=1}^{m} \sum_{i \in C_g} (z_{ik} - \bar{z}_{gk})^2$$

Equation 6. Change of variance by merging Cluster C_g and C_h

$$\Delta V(C_g \cup C_h) = \frac{n_g * n_h}{n_g + n_h} \sum_{k=1}^{m} (\bar{z}_{gk} - \bar{z}_{hk})^2$$

Equation 7. Total variance (within-groups sum of squares)

$$V = \sum_{g=1}^{G} \sum_{k=1}^{m} \sum_{i \in C_g} (z_{ik} - \bar{z}_{gk})^2$$

The results of the clustering process can be illustrated in a scree plot where the number of clusters over the increase in variance is displayed (Figure 34). To decide on an appropriate clustering solution (number of clusters) for subsequent k-means clustering, I relied on the elbow method.

As a stopping rule (*elbow criterion*), one aims at a distinct break in the scree plot where adding another cluster will not significantly decrease the coefficient (sum of the squared errors) (Ketchen Jr & Shook, 1996).

As the number of clusters increases, the sum of squared errors decreases until, finally, each case forms its own cluster with a sum of 0. The goal is to find a number of clusters which has a low coefficient and still is appropriate for further analysis. Interpreting the scree plot suggests a 3-,4- and 5-cluster solution to be suitable.

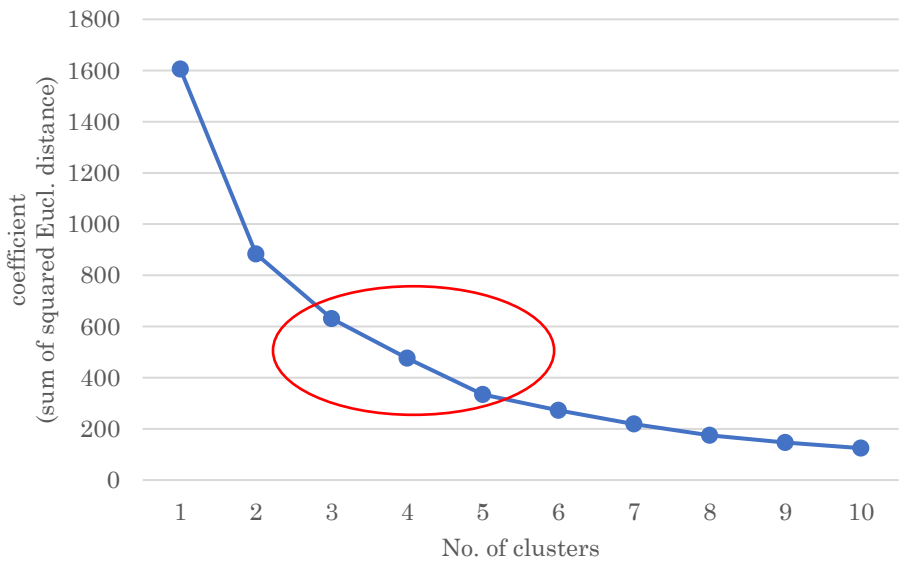


Figure 34. Scree plot of hierarchical clustering for cluster solutions n = 1…10 (Ward's method)

To test the stability of this solution, I also applied the *single linkage method* as an alternative clustering algorithm with variables k {IN; OUT}. In this case, clusters are formed and merged along nearest neighbors from different clusters (also based on the squared Euclidian distance). Figure 35 suggests a similar result like *Ward's method* (3-, 4-, 5-cluster solution).

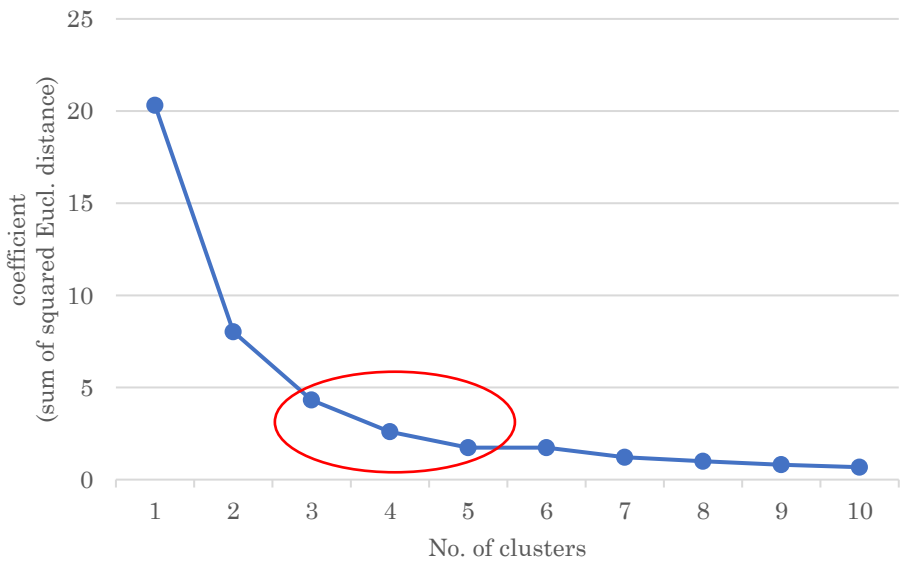


Figure 35. Scree plot of hierarchical clustering for cluster solutions n = 1…10 (single linkage method)

To sum up, hierarchical cluster analysis led to viable cluster solutions with k = 3, 4 or 5 clusters.

2. Non-hierarchical clustering (*k-means*):

Next, I conducted non-hierarchical clustering (*k-means* method) for all viable solutions (k = 3, 4, 5) to finally decide on the most appropriate number of clusters. The *k-means* algorithm minimizes the within-cluster variation by constantly re-assigning cluster membership until an optimal solution is found for the preset number of clusters (see also Figure 31). (Ketchen Jr & Shook, 1996)

The best cluster solution can be identified by applying the *variance ratio criterion* (VRC) by Calinsky and Harabasz (1974). The VRC can be calculated with:

Equation 8. Variance ratio criterion (VRC) for a solution with n objects and k segments

$$VRC_k = \frac{\frac{SS_B}{k-1}}{\frac{SS_W}{n-k}}$$

$$SS_B: sum\ of\ squares\ between\ segments$$

$$SS_W: sum\ of\ squares\ within\ segments$$

$$n: number\ of\ objects$$

To compute the test statistic, I ran a one-way analysis of variance (ANOVA) with the results of each *k-means* clustering solution for k = 2, 3, 4, 5, 6 (Sarstedt & Mooi, 2014). The VRC is equivalent to the F-value (or rather the sum of the F-values of all variables), so it can be easily extracted from the ANOVA result. The test statistic ω_k was computed as follows:

Equation 9. Test statistic ω_k

$$\omega_k = (VRC_{k+1} - VRC_k) - (VRC_k - VRC_{k-1})$$

We are looking for a cluster solution k that minimizes ω_k (in this case k = 4 with ω_k = -388). Thus, I chose a 4-cluster solution to be suitable for further analysis (Table 5).

Table 5. Results of VRC and ω_k *for k = 2…6*

k	VRC	ω_k
2	1461	-
3	1777	101
4	**2194**	**-388**
5	2223	-257
6	1995	-

It was already mentioned that *k-means* requires k (number of clusters) to be preset. Furthermore, *k-means* works best if it has an initial data set to start from. This data set comprises the mean values of each variable (centroids) from a 4-cluster solution obtained by the hierarchical clustering method (Table 6).

Table 6. Results of hierarchical clustering (Ward's method; k=4) as initial centroids for k-means

Variable	C1	C2	C3	C4
In-degree (mean)	0.44	5.15	27.78	24.5
Out-degree (mean)	1.51	2.34	36.17	26.75
No. of entries (mean)	0	1.11	1.22	7.0

With that data input, I could run the final *k-means* cluster analysis (k=4, 10 iterations, centroids).

6.3.2.2 Results of cluster analysis

The results of the cluster analysis are shown in Table 7. Graphically interpreting the mean values of the clusters supports the assumption that certain types or roles of users exist (Figure 36). These groups differ among their communication and contribution patterns.

Table 7. Results of final k-means clustering (k=4; 10 iterations; centroids)

	Cluster 1		**Cluster 2**		**Cluster 3**		**Cluster 4**			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Total	F-value
In-degree	**1.11**	1.58	**9.74**	3.59	**34.83**	9.99	**25.30**	9.94		797.15 $p<0.001$
Out-degree	**1.17**	1.07	**6.10**	4.76	**77.33**	26.00	**23.50**	11.71		873.32 $p<0.001$
No. of entries	**0.31**	0.50	**1.15**	0.6	**1.17**	0.37	**2.40**	2.73		74.68 $p<0.001$
No. of observ.	442		68		6		20		536	
% of observ.	82.5		12.7		1.1		3.7		100	

Results from SNA and cluster analysis based on the communication and contribution behavior of users revealed 4 distinct user groups or types of users in the community under study.

What we know so far is that a large group of users was rather passive (cluster 1), while a small number of users was highly engaged in communication (cluster 3). The latter received a lot of attention by other users, but even more interestingly they were extremely outgoing towards other users. In cluster 4, we find highly active users with more than one entry in the challenge and many relationships to others. Further analysis is necessary to better understand these groups and find specific characteristics that define them.

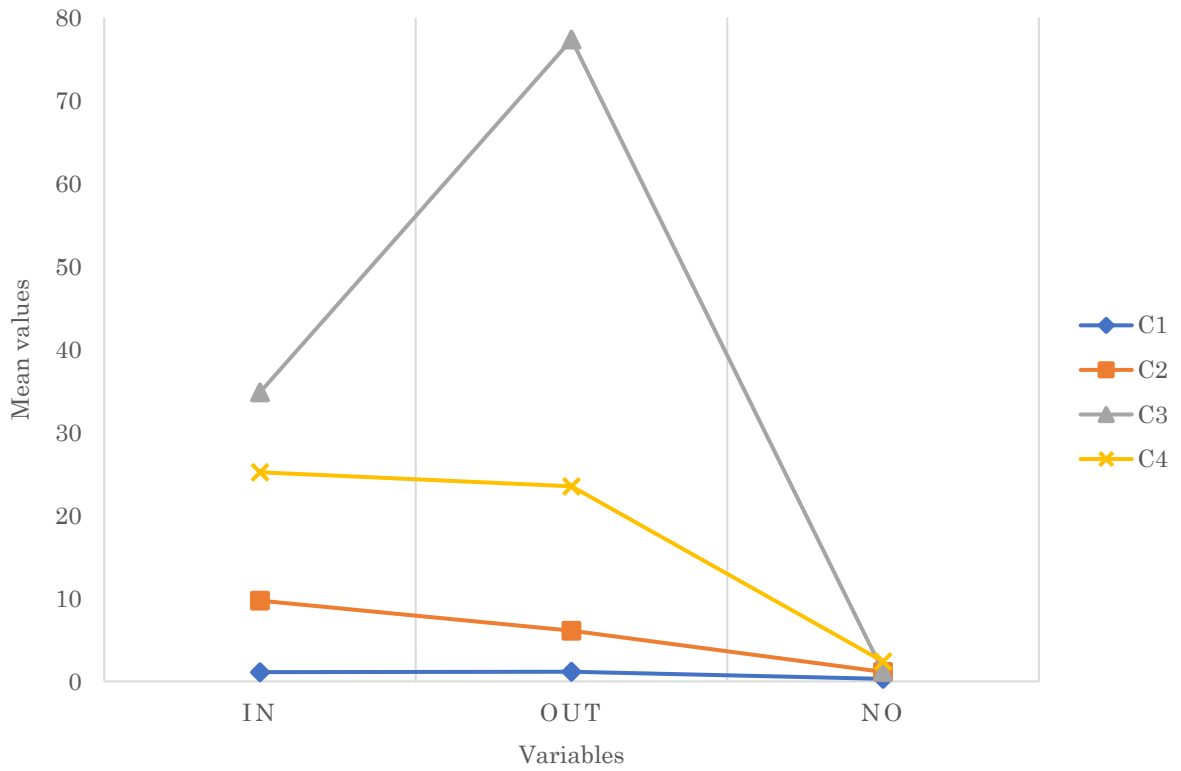


Figure 36. Cluster solution with k-means and k=4

6.3.3 Analysis of variance

6.3.3.1 Method and data

Based on preliminary results of SNA and cluster analysis I studied if and how the identified user groups differ among additional variables. In particular, I took into account the *quality* of the submitted concepts and the *structural betweenness* of users as an additional network measure.

The quality of the entries is represented by the publicly accessible results of a community voting process in the course of the challenge. Users could vote on

entries by means of a five-star rating scheme resulting in a ranking of entries with values between 1.0 and 3.76. Even if the community voting process was prone to bias, it still might serve as a good proxy to the quality of entries as it can be regarded a form of social evaluation (Csikszentmihalyi, 1996, p. 23). I checked whether the winning entries chosen by the expert jury did also perform well in the community voting. All winning entries (based on expert jury evaluation) were found among the top ten in the ranking of the community voting.

Out of 269 submitted entries 154 were valid for further evaluation by the community and the expert jury. As the number of valid entries with a voting result is not consistent with the network data (e.g., users without a (valid) entry), this measure could not be considered for cluster analysis. Thus, the voting result of an entry was used for an ANOVA to check whether the (average) quality of the concepts differs among the 4 clusters.

Analysis of variance (ANOVA) is a statistical test that can be used to examine differences in the mean between two or more groups. More formally, it tests the null hypothesis that the means of the groups regarding a dependent variable are equal. A rejection of the null hypothesis leads to the alternative hypothesis which states that the means of at least two groups differ significantly. A test statistic (F-value) is calculated based on between-group variation and within-group variation and compared against a critical value for $\alpha = 0.05$. If the test statistic is greater than the critical value with $p < 0.05$, the null hypothesis must be rejected. As assumptions for a standard ANOVA were not met in the data set under study (e.g., limited homogeneity of variances between groups and unequal sizes), I thus relied on the *Welch technique* that uses modified test statistics. This approach is quite robust if assumptions for ANOVA are violated. (Sarstedt & Mooi, 2014)

6.3.3.2 Results

The results of ANOVA regarding the quality of entries revealed that the null hypothesis has to be rejected (*Welch's* $F(3, 19.98) = 12.00$, $p < 0.001$) which indicates that at least two clusters significantly differ from each other (Table 9). Looking at the mean values, we find differences of quality between the clusters.

Furthermore, the structural position of a node within a network can be a powerful measure to identify influential actors. It is represented by the *betweenness centrality* which unlike individual network measures (in-degree, out-degree) considers the position of a node within a network of nodes. Betweenness centrality basically describes how many times a node is in a position where the shortest path between two other nodes passes through this node. In other words, it is a measure for the influence of a node and control over the flow of information within a network (gate keeper). (Prell, 2015)

I conducted another ANOVA with the variable *betweenness centrality* to check whether I would find differences in the average structural positions of users between the clusters. The values for betweenness centrality of each node were collected during SNA. Once again, I ran *Welch's* modified test as the variances between the clusters were not homogenous.

The result of the analysis is quite clear: The null hypothesis of equal means of the clusters has to be rejected (*Welch's* $F(3, 18.69) = 34.71$, $p < 0.001$). At least two of the clusters differ significantly regarding the average betweenness centrality of the users in those clusters (Table 8).

Table 8. Results of ANOVA with variables idea quality and betweenness

	Cluster 1		**Cluster 2**		**Cluster 3**		**Cluster 4**			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Total	*F*-value
Idea quality: Community evaluation (max.score=5.0)	**2.46**	0.3	**2.82**	0.37	**3.04**	0.6	**2.92**	0.5		12.00 $p<0.001$
No. of observ.	70		59		6		19		154	
Structural position: Betweenness centrality	**32.70**	150.65	**1,103.56**	1,279.87	**15,282.36**	1,203.72	**6,282.27**	3,719.94		34.71 $p<0.001$
No. of observ.	442		68		6		20		536	
% of observ.	82.5		12.7		1.1		3.7		100	

Considering the quality of entries and the structural position of users led to a better understanding of the 4 user groups. Users in cluster 1 are not only passive

regarding their contribution and communication behavior which is supported by the low mean of betweenness centrality; those users who submitted a valid entry also received a rather low score in the community voting in comparison with users from the other groups.

Once again users of cluster 3 stood out: On average, their entries received the best results in the community voting. A high average betweenness indicates that these users play an important role within the network. Not only did they communicate far more than others, but their structural position also indicates that they have a strong influence on the flow of information within the network. Cluster 4 deserves further attention too in particular as 3 of the 4 winners of the challenge could be found here. They deliver high quality results and at the same time are quite substantially contributing to the communication in the network.

So far, the analyses of the community under study relied on quantitative techniques to identify different types of users. We know that the quality of entries varies between user groups and we also know that there are differences in the communication behavior from the number of in- and outgoing messages and the structural position of the users.

Information so far is not sufficient though to really understand what defines a user role or type and who is in which group for what reason. Thus, a qualitative approach that considers the individual communication behavior in terms of content is necessary to better understand the distinguishing characteristics of users and user groups.

6.3.4 Content analysis

6.3.4.1 Method and data

To explore the communication behavior of users, I relied on a qualitative **content analysis**. This approach is suitable to analyze and reduce a large amount of textual material in a formalized way by using categories within a coding frame and, thus, enables a systematic access to the meaning of data (see also Table 9). (Flick, 2014)

Table 9. Generic process of qualitative content analysis (Flick, 2014)

Generic process of a content analysis
1. Define research question
2. Select coding material
3. Build coding frame
4. Segment material
5. Trial coding
6. Evaluate and modify coding frame
7. Analysis
8. Present and interpret results

Define research question:

The aim of the content analysis is to understand how users in the community under study communicated overall in the course of the challenge (nature of the comments, e.g., feedback, socializing) and based on these findings to check whether we would find differences among the user groups identified previously. If we know that users' commenting behavior differs, this will help us to increase our understanding of those groups.

One distinguishing element could be the attitude towards collaboration. Results of study 1 revealed for example that many users comment to give feedback and help other users to enhance their entries.

Select coding material and segment material:

The textual data to be analyzed comprises all publicly accessible comments that were left by users on the entry pages. Thus, the first step was to collect those comments from all individual entries. It was possible to follow back each comment to the user that sent it. The general forum was not considered for analysis as it contained common topics that were not related to users or their entries.

Each user that submitted an entry had a publicly accessible project page where all relevant information about the concept was posted (pictures, schematics, textual description). On these pages, other users could comment on the idea or other issues (feedback, appraisal, asking questions etc.). The entry owner himself could (directly) reply on comments, too.

In total, 8,553 comments from 536 users on 269 entries (total number of entries: 425) were registered during the challenge. For this analysis however, not all comments were relevant. I focused on those messages that were posted by users (not employees of Local Motors or Airbus) while submission was open (phase I-III) to study the communication behavior.

It is important to note that not all entry owners engaged in communication (37 % did not receive any comments) and that not all commenting users had entries themselves. In fact, 58 % of commenting users did not have an entry on their own.

Removing irrelevant messages and excluding messages between users and community managers led to a remaining sample size of **3,964 comments** by users (46 % of total number of comments) while the challenge was active (phase I: 1,495 (17 %); phase II: 721 (18 %); phase III: 1,748 (20 %)).

Build coding frame, trial coding and modifying coding frame:

As initial coding frame, I relied on previous research by Füller et al. (2014) who followed a similar approach in another context. Initial coding of 200 randomly chosen comments along 6 established categories (*Critiques*, *Support/motivation*, *Constructive suggestion*, *Asking questions*, *Gossiping*, *not applicable*) did not turn out to be sufficient for this context. I thus added more categories after negotiation with a second coder.

The preliminary coding frame contained 14 categories (Table 10). Once again, two coders analyzed another set of 300 comments with the updated coding scheme which turned out to be satisfying to cover the nature of all comments.

Testing for intercoder reliability enhances the quality of the results and reduces biases during the coding process (Cohen, 1960). Two coders independently analyzed a set of 300 comments. Comparing the assignment of codes led to a sufficient quality (276/300 identical code assignments; Cohen's Kappa: 91 %). Final coding of all comments thus could be conducted by one person.

Table 10. Final coding scheme

No.	Category	Description	Direction	Examples
1	*Critiques*	Disapproval	Inbound	"Nothing new", "design could be better", "it is plagiarism"
2	*Support/ motivation*	Approval	Inbound	"Amazing job!", "Beautiful work", "Great design"
3	*Feedback*	Approval with details	Inbound	"I like the idea of the active cooling mechanism", "interesting approach to VTOL requirements", "I love the single bladed rotors"
4	*Accepting feedback*	Agreeing with feedback or suggestion for improvement	Outbound	"you're right, this effect does not give sufficient lift", "absolutely right, the CAD model is definitely not as good as it could be", "Good point. That would make it more simple"
5	*Defending idea*	Defending idea after critique/feedback	Outbound	"I had thought in that direction, but…", "we had to make a choice between conceptual design and engineering design", "but I needed a design to fit the brief"
6	*Constructive suggestion*	Detailed suggestions for improvement	Inbound	"Adding end plates can increase your stability", "Add a simple servo"; "Check this gear arrangement"
7	*Asking question*	Asking idea-related questions	Inbound	"What is your design stall speed?", "Where is the prop pusher?", "How does that affect stability?"
8	*Asking for feedback/help*	Asking other users for feedback or advice	Outbound	"Any advice where to start?", "What do you guys think?", "Which landing gear combo does the community think is best?"
9	*Gossiping*	Not related to idea	Inbound/ Outbound	"Good luck", "Wish you the best", "I have voted"
10	*Thanking*	Thanking as a reaction to support/feedback	Inbound/ Outbound	"Thank you for your interest", "Thanks", "Thanks a lot for the feedback"
11	*Not applicable*	No meaning / not codable	-	"piggy piggy", ":D", "tq macha"
12	*Explaining details*	Elaborating on details of the idea	Outbound	"Brighter colors keep the temperatures down", "only the center segment swivels", "Box on the right is 2mx0,5m"
13	*Offering help*	Offering or providing help for idea elaboration	Inbound	"Is there something I can help with?", "Can I help you in some way", "If you are interested, we can discuss pivot wings"
14	*General comment*	Not idea-related comments	Inbound/ Outbound	"roger that", "Updated", "I know, it's almost finished"

Analysis:

Some comments were noticeably short, others rather long covering various aspects. Thus, one comment might fall under more than one category. Coding all 3,964 comments (directed and undirected messages) led to a total number of **5,874 codes** assigned. Preliminary results of the coding process are shown in Table 11.

Table 11. Preliminary result of coding

Code	Category	%	No.
1	*Critiques*	1.0	59
2	*Support/motivation*	18.1	1.063
3	*Feedback*	19.8	1.165
4	*Accepting feedback*	2.6	154
5	*Defending idea*	1.1	64
6	*Constructive suggestion*	7.0	409
7	*Asking question*	5.2	305
8	*Asking for feedback/help*	2.6	154
9	*Gossiping*	8.7	511
10	*Thanking*	15.8	926
11	*Not applicable*	0.5	31
12	*Explaining details*	13.0	764
13	*Offering help*	1.9	114
14	*General comment*	2.6	155
	Total	100	5.874

To simplify analysis and enhance the clarity of results, I merged some of the categories that were similar. *Gossiping* (Code 9) and *General comment* (Code 14) was merged to *Gossiping*; *Feedback* (Code 3) and *Constructive suggestion* (Code 6) to *Feedback*; *Accepting feedback* (Code 4), *Defending idea* (Code 5), and *Explaining details* (Code 12) to *Reaction to feedback*. I also removed comments that were not applicable (*n. a.* (Code 11). Finally, 9 categories were left for further analysis. The results after merging are shown in Table 12.

Table 12. Final results of coding with merged categories

Category	%	No.
Critique	1.0	59
Support/motivation	18.2	1,063
Asking questions	5.2	305
Thanking	15.8	926
Offering help	2.0	114
Asking for feedback	2.6	154
Gossiping	11.4	666
Feedback	26.9	1,574
Reaction to feedback	16.8	982
Total	100	5,843

6.3.4.2 Findings

Overall, the community culture seems to be very inspiring and positive as we find hardly any negative comments (note: I did not find any evidence for removed comments by moderators due to inappropriate content). Even more strikingly, nearly half of all comments were of cooperative nature in the sense that the purpose of communication was to jointly improve the quality of entries (see Figure 37). This is surprising given the fact that the challenge mode was rather competitive.

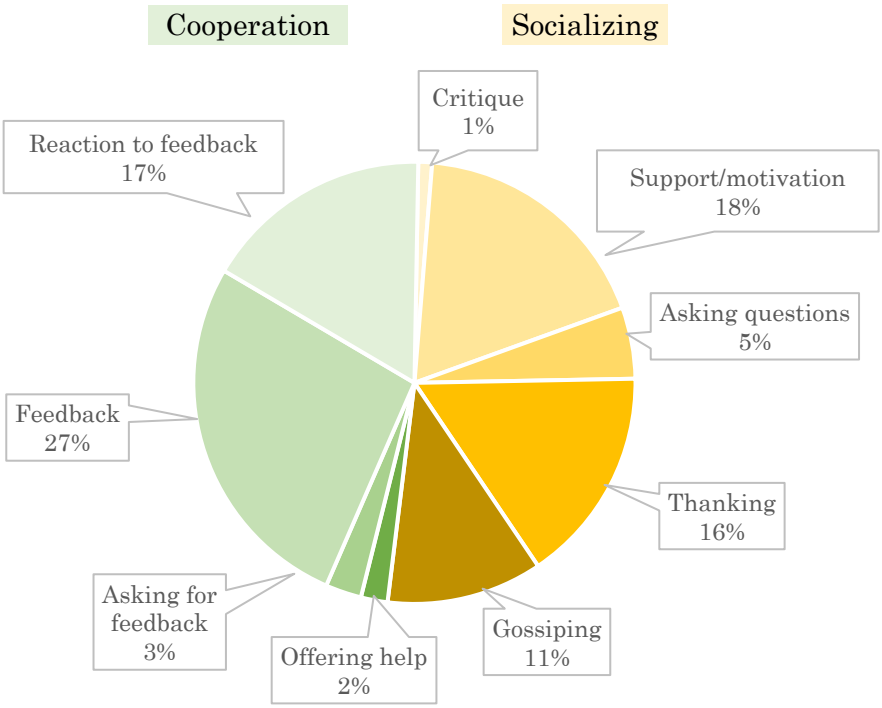


Figure 37. Distribution of codes: Collaboration vs. socializing

To this point, content analysis did not differentiate between users or user groups. The communication pattern retrieved is rather an overall picture of the community culture. Thus, the next step was to check whether we would find distinct patterns of the users of the 4 identified clusters. In other words, I wanted to find out if the distribution of codes varies among the user groups.

To test for differences between the clusters, I had to rely on non-parametric testing via χ^2-test of independence between groups as the variables (codes) are following a nominal scale. In this case, I tested for homogeneity between clusters and code distribution. (Sarstedt & Mooi, 2014)

The null hypothesis states that the distribution of codes between the clusters is identical. Subsequently, the alternative hypothesis is that at least two clusters significantly differ regarding the distribution of codes. In other words, the test checks if the distribution of codes and the assignment to a cluster are independent.

The test statistic χ^2 is calculated along Equation 10:

Equation 10. Non-parametric testing of homogeneity with χ^2

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}}$$

$$r: rows\ (number\ of\ codes)$$

$$c: columns\ (number\ of\ clusters)$$

$$O_{i,j}: observation\ (value\ of\ code\ i\ in\ cluster\ j)$$

$$E_{i,j}: expected\ value\ of\ observation\ (code\ i\ in\ cluster\ j)$$

Chi-square testing requires certain assumptions: the number of observations should be more than 30 (n > 30); the expected cell counts E should be greater than 1 ($E >= 1$) and at least 80 % of E's should be greater than 5 ($E >= 5$). All requirements were met. *Pearson* χ^2 test led to the rejection of the null hypothesis and thus confirmed that at least 2 of the 4 clusters significantly differ among communication patterns ($\chi^2(24) = 383.76, p < 0.001$). The distribution of codes in the clusters can be found in Table 13.

Table 13. Distribution of code categories across clusters

	Cluster 1		**Cluster 2**		**Cluster 3**		**Cluster 4**		**Total**	
Category	%	No.	%	No.	%	No.	%	No.	%	No.
Critique	1.9	25	0.9	12	0.3	5	1.1	17	1.0	59
Support/motivation	19.5	263	14.4	199	23.3	374	15.1	227	18.2	1,063
Asking questions	8.1	109	5.2	72	3.4	54	4.6	70	5.2	305
Thanking	13.0	175	23.4	323	7.3	118	20.6	310	15.8	926
Offering help	1.6	22	1.4	19	3.5	57	1.1	16	2.0	114
Asking for feedback	1.7	23	2.1	29	4.4	71	2.1	31	2.6	154
Gossiping	12.0	162	9.3	128	12.1	194	12.1	182	11.4	666
Feedback	30.5	412	22.5	311	30.6	492	23.8	359	26.9	1,574
Reaction to feedback	11.7	158	20.9	289	15.0	241	19.5	294	16.8	982
Total	100	1,349	100	1,382	100	1,606	100	1,506	100	5,843
Pearson χ^2	383.76	p<0.001								

A graphical representation supports the results of the analysis (Figure 38). We find deviations between groups in both the *socializing* code categories (e.g., Support/motivation, Thanking) as well as in the *collaboration* sector (e.g., Asking for feedback, Feedback).

Cluster 2 and 4 show a similar pattern just as cluster 1 and 3 in some areas. We should keep in mind though, that these patterns refer to the share of codes assigned over all codes assigned in each cluster.

While in cluster 1 comments of 442 users led to 1,349 codes, nearly the same number of codes (1,606) was created in cluster 3 by messaging activities of only 6 users. A detailed discussion of the communication patterns will follow in the next section.

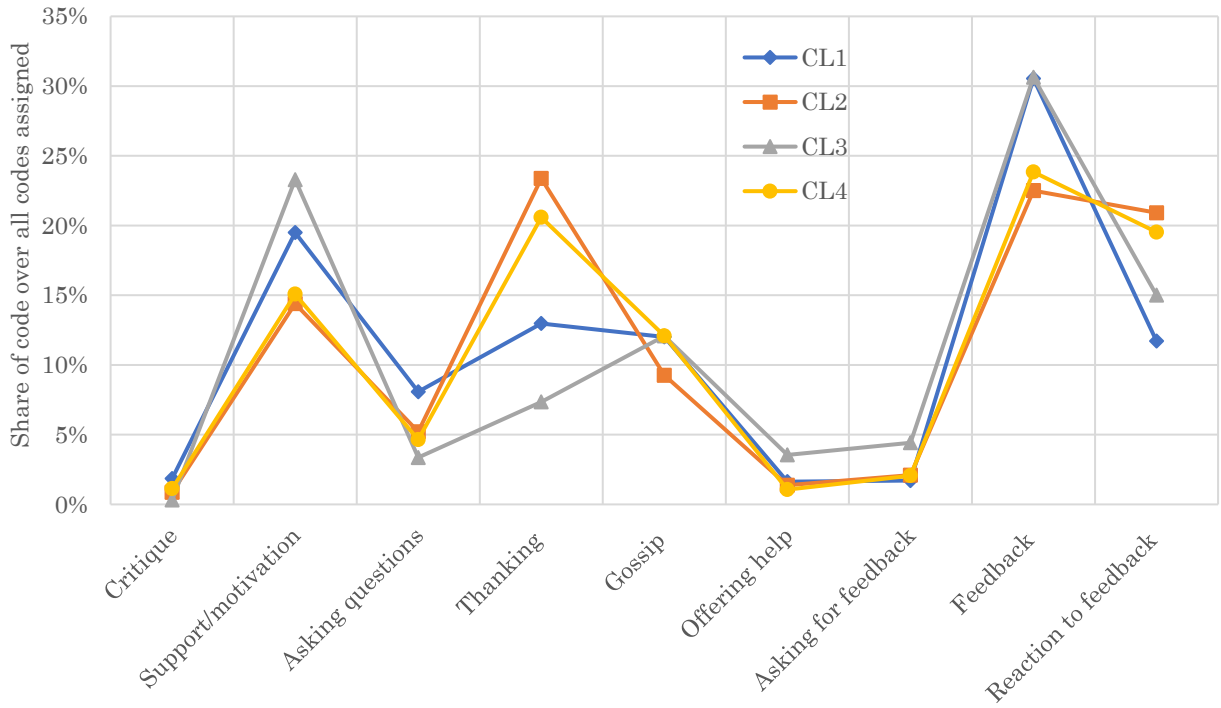


Figure 38. Communication patterns across clusters

6.4 User types

In the following, an attempt will be made to develop a user typology based on the results of the previous analyses and elaborate on specific characteristics of each user group. Wherever suitable, egocentric networks and exemplary comments of representative users of each group shall illustrate the descriptions.

6.4.1 Cluster 1: Lurkers & Quiets

6.4.1.1 Results

The vast majority of users (442; 82.5 %) was assigned to the cluster of *Lurkers & Quiets*. Users in this group were rather passive and communicated little if at all. An average user sent one comment to another user and received one by someone else (see also Figure 39).

Only few users submitted an idea which is interesting as many users commented without being an active participant of the challenge. In fact, only 70 users out of 442 in this group had a valid entry. The average quality of the entries was the lowest compared to the other clusters (2.46/5). With respect to the network structure, *Lurkers & Quiets* were located rather in the peripheral areas expressed by extremely low betweenness centrality.

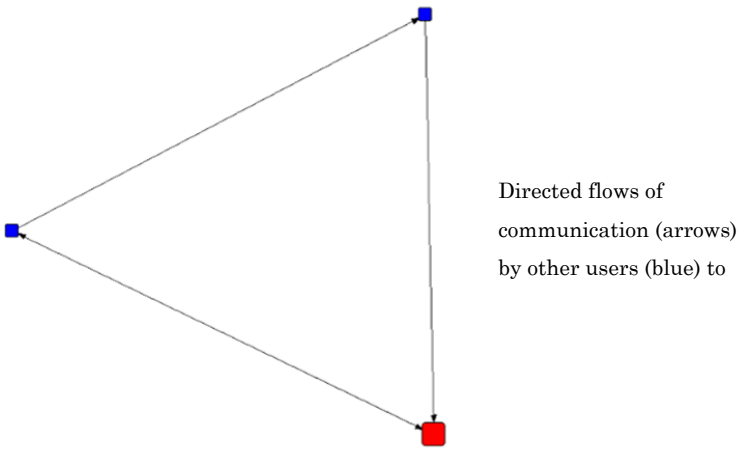


Figure 39. Egocentric network of an average user in cluster 1 (Lurkers & Quiets) (ID18: IN 2; OUT 1; NO 1)

Those users who engaged in communication however were very supportive, asked more questions and gave more feedback than other user groups (Figure 40).

A few exemplary comments illustrate this:

Support/motivation:

> *ID36 (no entry): "wow! I just checked out your report! amazing work guys. outstanding!"*
>
> *ID75 (no entry): "You've done a great job, keep going!!!"*
>
> *ID482 (not valid): "I was able to take a gander at the design brief pdf file, nicely done!"*

Asking questions:

ID292 (no entry): "Nice overall design. But... I was about to participate in this challenge and I am pretty sure it wasn't allowed to use moving parts. Did they change this requirement?"

ID328 (valid entry): "What is the software you have used for the aerodynamics?"

ID404 (not valid): "Does having the looping of the wings go slightly back help the areo at all?"

Feedback:

ID51 (no entry): "In my opinion this is a good solution: the stops to land on the wings. This can save from destruction by the body during landing. Most springs turns."

ID103 (no entry): "I like this drone because the lifting propellers are at the extremities. Less interference with wings but don't you think you lose roll stability"

ID212 (not valid): "I think your design and engines layout really logical, energy efficient, simple. And certainly, it is possible to continue flying with one engine if others be disconnected."

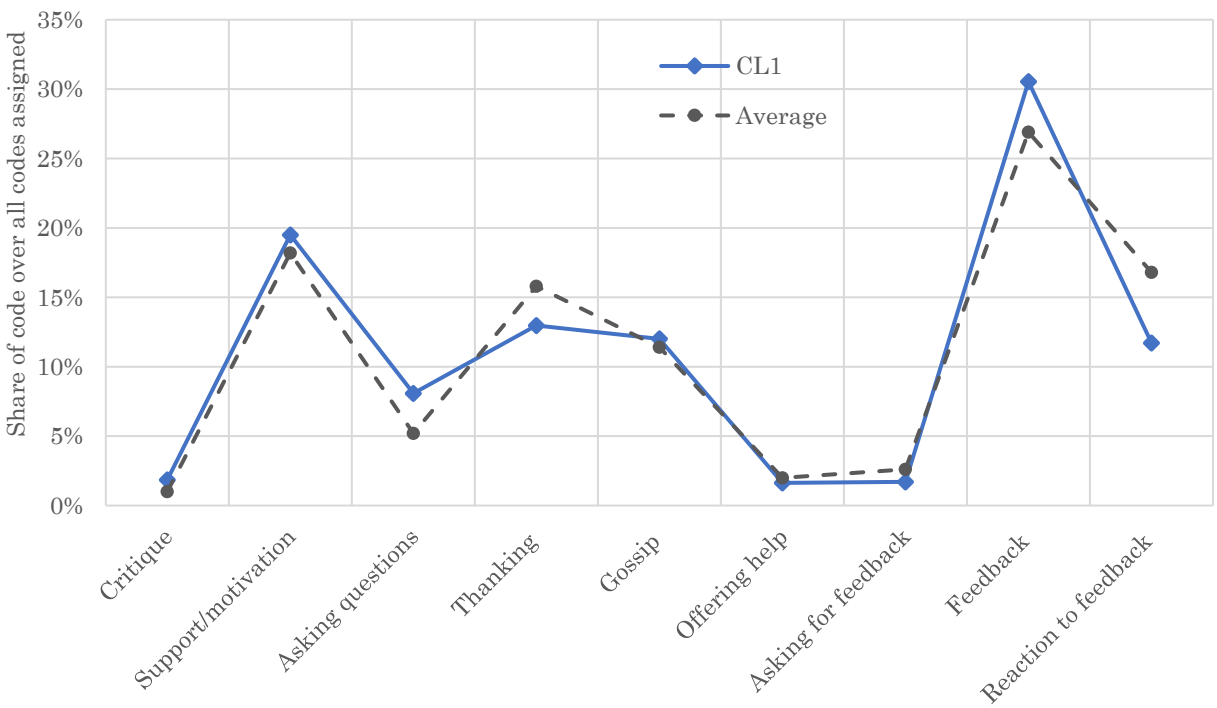


Figure 40. Communication pattern of cluster 1 (Lurkers & Quiets)

6.4.1.2 Discussion

The user type *lurker* is well known and found in other online communities (e.g. Sun et al., 2014, Nonnecke et al., 2004). *Lurkers* usually add up to the majority of users in online communities (around 90 %) which makes them an interesting object of study (Sun et al., 2014). Lurking can be interpreted as another form of participation as the process of passive observation seems to meet certain needs of users (Nonnecke & Preece, 2001). Another explanation is to consider lurking as an initial temporary phase where new users get used to the community and its culture. Other reasons include environmental (e.g. poor functionality, lack of reciprocity), personal (introversion, lack of self-efficacy), relationship (low verbal and affective intimacy with other users) and security (privacy) issues (Sun et al., 2014). Füller et al. (2014) identified rather passive users (*passive commentators* and *passive idea generators*) also in the context of contest communities. Like *lurkers* these passive users represent a large portion of the community.

The context at hand is special in the sense that *Lurkers & Quiets* were not completely silent as they could not have been considered for analysis otherwise. Still, they show similar characteristics to the concept of *lurkers* in general as many users did comment but not submit an entry (58 %), while others submitted an entry and received comments but did not reply. Furthermore, the challenge task was rather complex and requiring a certain technological skill level in the field of engineering and design. Thus, the threshold for participation was rather high. We also must bear in mind that the challenge setting in the community under study provokes competitive behavior.

Based on insights from prior literature and the specific conditions of this community, users of this group might fall under this user category for the following reasons:

- A user wants to learn by observing and commenting of entries.
- A user has limited proficiency to submit an entry.
- A user is not interested in social exchange (e.g., because of a competitive attitude).
- A user has a perceived lack of competency to give feedback (low self-efficacy).

- A user is new to the community.
- A user cannot participate in communication (e.g., cultural or language barriers).

6.4.1.3 Implications

Despite the passive behavior and the rather low quality of the entries this group is still important due to its sheer size. The overall innovative and social/cooperative potential of the community would increase if users of this group could be enabled to submit ideas and activated to participate in communication. Potential levers to address these issues are community management, challenge setup, price regime, website functionalities and tutorials. Further investigation is necessary though to fully understand why *Lurkers & Quiets* behave in the way they do.

6.4.2 Cluster 2: Coys

6.4.2.1 Results

The second biggest group (68; 12.7 %) is labelled as *Coys*. Entries of users of this group caught some attention by other users (In-degree: 10). Most users submitted at least one entry out of which 59 were valid for evaluation. However, they were rather passive in terms of outgoing communication (Out-degree: 6) and thus poorly connected within the network with a comparably low betweenness centrality. Figure 41 illustrates the egocentric network of an average user. Idea quality on average was higher than in cluster 1, but still low in comparison to cluster 3 and 4 (2.82/5).

The communication pattern supports this rather passive attitude (see Figure 42). Interestingly, the patterns of cluster 2 and 4 are nearly identical. The share of the codes *Thanking* and *Reaction to feedback* was higher while *Support/motivation* and *Feedback* was lower than in other groups. They reacted if someone commented on their entry but did not give much feedback to others or engage in gossiping.

A few exemplary comments:

Thanking and *Reaction to feedback*:

ID8: "Thank you. At the moment it is just a divertissement. I wonder if some engineer could evaluate this wing.;)"

ID65: "Hi, Thank you for the suggestion... Yes, definitely, we are considering your suggestion...We will perform FE Analysis to check the structure..."

ID209: "Thank you XX for your comment and like. Actually, the sixth lifting motor's are surrounded by a very light plastic supporting parts. These parts give a nice imperialic look and also a very good job during lifting and best horizontal flaying control. Regards"

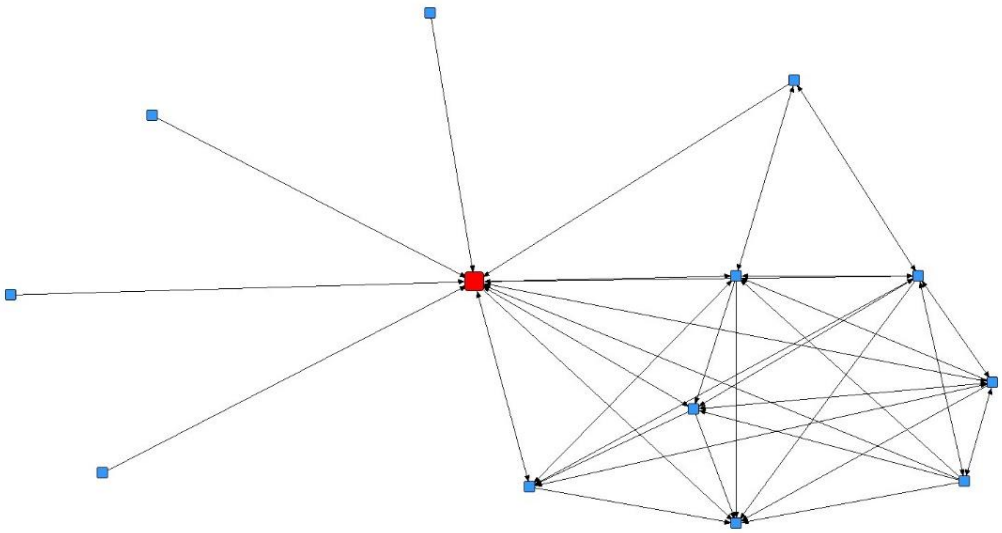


Figure 41. Egocentric network of an average user in cluster 2 (Coys) (ID44: IN 11; OUT 6; NO 1)

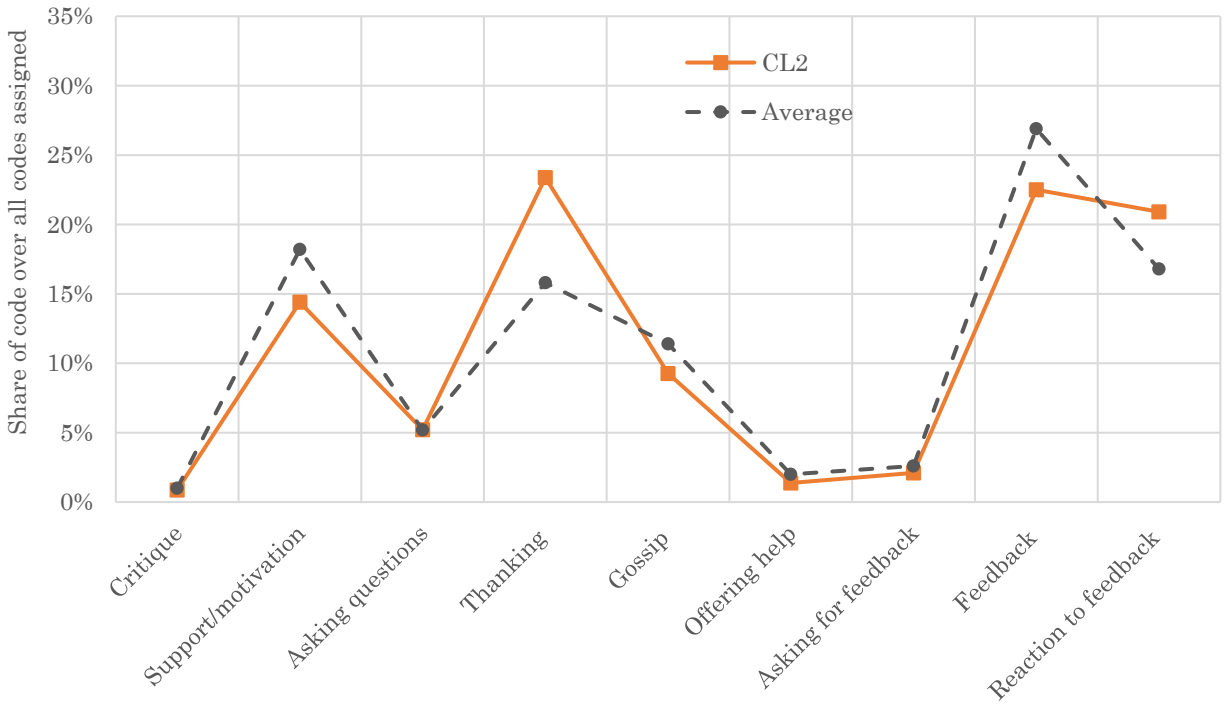


Figure 42. Communication pattern of cluster 2 (Coys)

6.4.2.2 Discussion

We find similarities between *Coys* and *Lurkers & Quiets* regarding a general passivity. However, they seem to have a certain skill level that enables them to submit valid entries with a higher quality. Füller et al. (2014) and Fuger et al. (2017) discovered this user type in other contexts as well (*passive idea generator*, *allrounder*). It is unclear why this group is rather passive. Furthermore, the communication pattern of *Coys* is nearly identical to cluster 4 which leaves room for further study.

Building on reasoning in cluster 1, *Coys* might be part of this cluster due to the following reasons:

- A user is not interested in social exchange (e.g., because of a competitive attitude).
- A user has a perceived lack of competency to give feedback (low self-efficacy).
- A user is new to the community.

6.4.2.3 Implications

As the second biggest group *Coys* deserve further attention just as *Lurkers & Quiets*. The innovative and social potential is higher than in cluster 1. Users in this group are able to deliver valid entries and, in some cases, submitted more than one entry. The question remains why they are so passive and how they could be inspired to engage more in communication. If, for example, users were new to the community, community management could address passivity by giving them an introduction to the values and culture of the community. Further analysis should check whether users of cluster 2 and 4 are somehow interrelated.

6.4.3 Cluster 3: Stars

6.4.3.1 Results

Stars can be considered a small group of key users in the challenge community under study (6; 1.1%). Their designs were extremely popular (In-degree: 35) and the quality was the best among all clusters (3.04/5). 1 out of 4 winners was part of this group. *Stars* were highly engaged in commenting activity (Out-degree: 77) and

seem to have a very collaborative attitude. They also took a very influential position within the network indicated by a remarkably high value for betweenness centrality.

The egocentric network of an average user illustrates just how popular, interconnected and thus influential those users were (Figure 43).

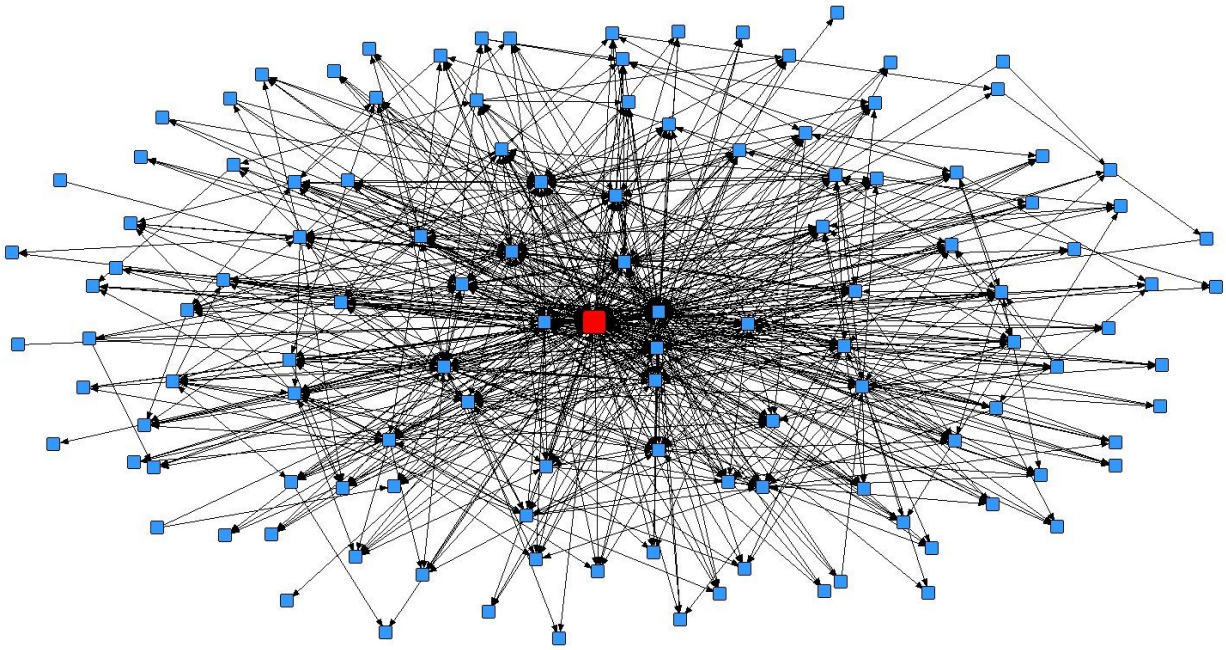


Figure 43. Egocentric network of an average user in cluster 3 (Stars) (ID177: IN 45; OUT 108; NO 1)

More than users of other groups, *Stars* supported other users, offered help, gave feedback, and actively asked others for feedback on their own entries (Figure 44).

Some exemplary comments of *Stars*:

Offer help:

> *ID175: "Some possible designers in no particular order..... @xx, @xx, @xx, @xx, @xx, @xx and there are probably more I forget now"*
>
> *ID355: "@xx is there something I can help with? Do you want to have a quick skype?"*

Asking for feedback:

> *ID177: "Maybe not, still good in a portfolio, I like the way that you have presented your drone with the blue ;) If you have time can you tell me what you think about my concept ;)"*

ID355: "Hey I'd be really happy if someone with your mindset would find the time to comment on my entry. Your stuff really looks tight from the ground perspective - thumbs up! "

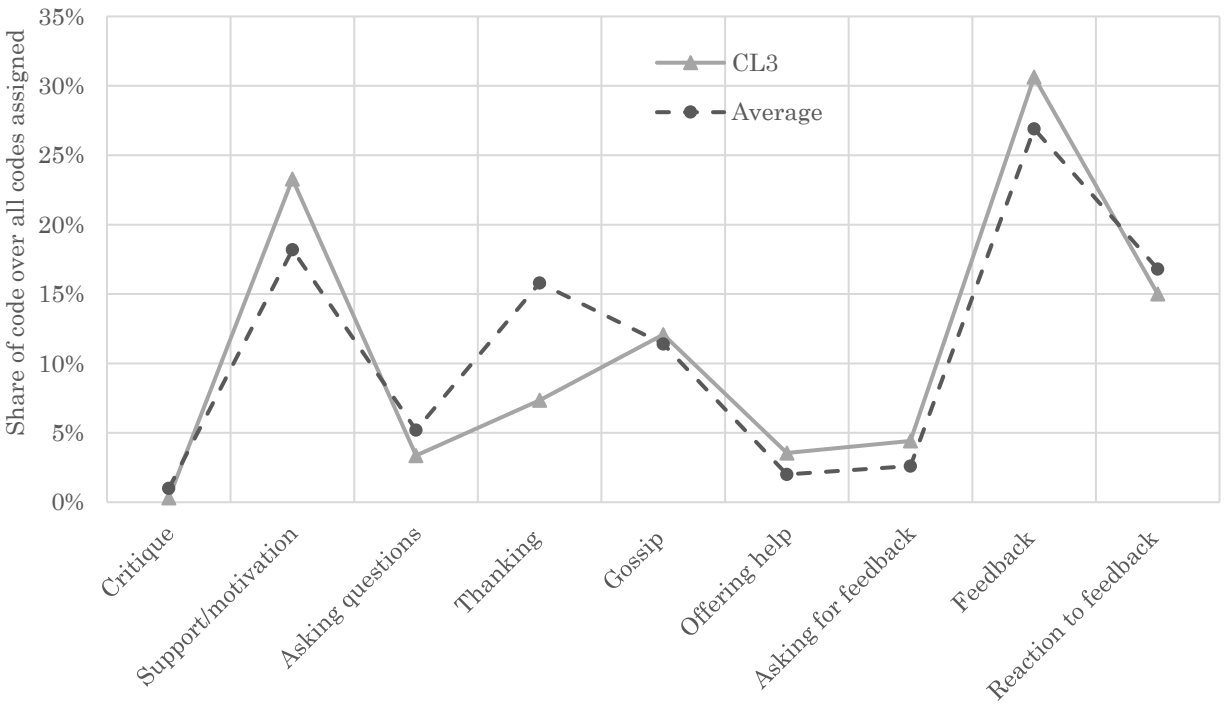


Figure 44. Communication pattern of cluster 3 (Stars)

6.4.3.2 Discussion

Stars are an interesting user group. They deliver high quality entries and thus substantially contribute to the overall innovative outcome of the challenge. *Stars* and their designs captured the interest by many other users. Beyond the high innovative potential, they also had a positive impact on the community culture (social potential). They seem to have a very collaborative attitude and were responsible for a large portion of the communication within the community.

From the intermediary platform's perspective, these users are highly valuable and can be considered a key resource to provide innovative solutions to seeking organizations on the one hand, and to establish a vivid and collaborative social network within the community on the other hand. By giving feedback to other users and thus helping them to improve the quality of their entries, they also contribute to an innovative output of the community overall.

A small group of diligent key users that account for a large portion of input to the content of a community was also found in other online communities, e.g., Wikipedia. In the context of innovation contests, scholars found that key users can be differentiated regarding their collaborative behavior (*collaborator* vs. *contributor* (Fuger et al., 2017), *idea generator* vs. *master* (Füller et al., 2014)). In our case, *Stars* combine these characteristics.

Users might be part of this cluster due to the following reasons:

- A user is interested in social exchange and feedback.
- A user has a collaborative attitude.
- A user can deliver high quality entries (high skill set in engineering/design).
- A user has a high level of self-efficacy.
- A user is experienced in co-creation.
- A user is rather intrinsically motivated.

6.4.3.3 Implications

Stars may have an enormous impact and influence on the challenge community though being only few. Thus, community management must have a strong interest in understanding these users and knowing about distinct user characteristics in order to find, attract them in the first place, and keep them associated with the community in the long term. *Stars* might also be eligible for special role assignments withing the community (e.g., assisting with community management, mentoring).

Interestingly, *Stars* seem to share characteristics with users that are well-known in other fields of research, e.g., *lead user* concept (domain-specific innovativeness, enjoying knowledge sharing or intrinsic motivation (Lüthje & Herstatt, 2004; Brem et al., 2018). Further analysis is required though to elaborate on this transfer which might lead to the emergence of a similar user type (*lead solver*) in the context of innovation challenge communities.

Distinct characteristics of a *lead solver* might be a high level of innovativeness and a strong collaborative attitude. However, the perceived collaborative attitude of

Stars in a rather competitive contest setting deserves a better understanding of this kind of user.

6.4.4 Cluster 4: Movers & Shakers

6.4.4.1 Results

Movers & Shakers (20; 3.7 %) are a very promising but small user group just as *Stars*. They too received many comments by other users (In-degree: 25) and were vivid communicators themselves (Out-degree: 24). Idea quality was high (2.92/5) and 3 out of 4 winners were in this group. A distinctive characteristic of this group was that most users submitted more than one entry. Looking at a representative network (Figure 45) and considering a high value of betweenness centrality tells us that *Movers & Shakers* were well-interconnected with other users.

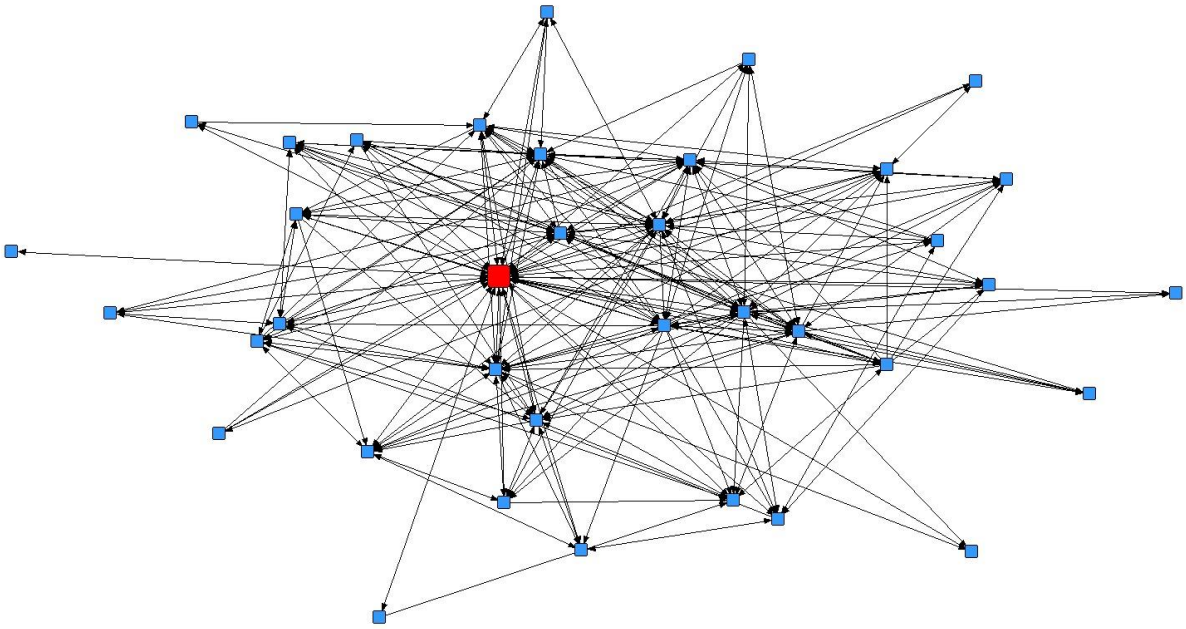


Figure 45. Egocentric network of average user in cluster 4 (Movers & Shakers) (ID300: IN 31; OUT 28; NO 2)

The communication pattern reveals that they were rather reactive like *Coys* (Figure 46). The codes *Thanking*, *Gossiping* and *Reaction to feedback* stood out.

Some comments illustrate the communication behavior of this user group:

Thanking:

ID273: "Hello XX, thank you for the support!"

ID441: "Thanks everybody for your feedback!"

ID469: "Well thank you! Coming from you especially, that's high praise! I'm so happy to be a part of this."

Gossiping:

ID505: "Yes it's been a while, but we will catch up for sure! :D: D :D"

ID300: "Thanks XX. Great to see you here...btw I could really use a craft for my dog!"

Reaction to feedback:

ID205: "Yeah, the torsion on the wing midsection from the tail group is my main concern structurally, but this is a common issue among twin boom designs. There are a few options I'm looking into -- reduce mass and Iyy in the fuselage and increase span loading by fattening the booms and placing batteries in those, or quite simply increasing the chord of the midsection for structural rigidity and accepting the drag hit. The former trades a bit of VTOL efficiency away, and the latter trades cruise efficiency. We will have to see which has less impact."

ID274: "I have updated the Frame sheet with the new wing specifications as well as the new cruising speed at 35m/s. At this speed, the L/D ratio is 17.29 giving a more efficient flight. Also updated the weight calculations to match with the calculated weights of the individual structure components"

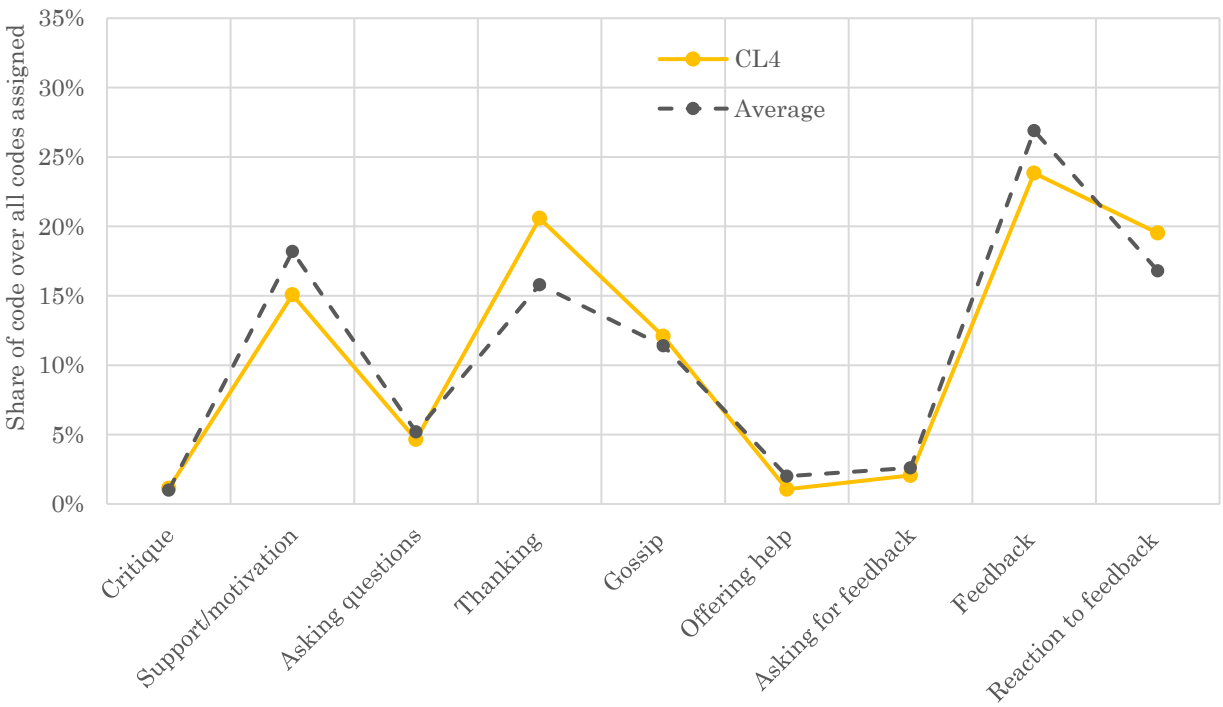


Figure 46. Communication pattern of cluster 4 (Movers & Shakers)

6.4.4.2 Discussion

Users of this cluster combine features of both *Coys* and *Stars*. Regarding innovativeness, *Movers & Shakers* are strongly associated with *Stars* (multiple designs and high quality of the designs). The communication behavior however is similar to *Coys* in the sense that they were rather passive and reactive. Still, the comparably large number of connections to other users in combination with the high innovative potential makes this this group a valuable resource and promising type of user too. The question remains why *Movers & Shakers* behave in the way they do.

A similar user type with substantial input and thus importance for a contest was found in other communities, too (*idea generator* (Füller et al., 2014), *contributor* (Fuger et al., 2017)). A better understanding of this user type is missing though.

To this point, we may assume that users are in this cluster for the following reasons:

- A user is not interested in social exchange (for courtesy reasons he responds to messages).
- A user follows a rather competitive strategy.
- A user can deliver high quality entries (high skill set in engineering/design).
- A user is new to the community (and needs to get used to the community culture).

6.4.4.3 Implications

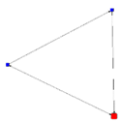
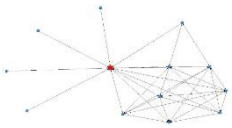
From an innovation perspective, *Movers & Shakers* play an important role in an innovation contest as they create a large amount high quality input. Together with *Stars* they form a small group of key users. They might also share some *lead solver* characteristics. Thus, a better understanding of this type of user is essential. In particular, it would be interesting to find out why they substantially differ from *Stars* regarding the communication behavior.

6.5 Discussion and implications

In line with results from research in other contexts, distinct user groups could be identified in the community under study by analyzing the individual communication and contribution behavior with both quantitative and qualitative analyses. The general network structure seems to be stable across different types of (innovation-related) online communities: A small group of highly engaged and interconnected users in the center of the network and a large proportion of rather passive users in peripherical areas.

Regarding specific role characteristics, I found similarities to other communities as well (see also Table 14): *Lurkers & Quiets* represent a well-established pattern for users that hardly communicate and, in many cases, do not participate in the challenge with an entry. The cooperative orientation and innovative potential thus are low. Still, the large number of users makes them an interesting group for further study to develop adequate activation strategies. *Coys* are like the latter regarding a rather passive attitude. However, most users in this group were able to submit a valid entry that received some comments by others.

Table 14. Overview of user types

	Cluster 1: Lurkers & Quiets	Cluster 2: Coys	Cluster 3: Stars	Cluster 4: Movers & Shakers
No. of users	442 (82.5 %)	68 (12.7 %)	6 (1.1 %)	20 (3.7 %)
In-degree	1.1	9.7	34.8	25.3
Out-degree	1.2	6.1	77.3	23.5
No. of entries	0.3	1.2	1.2	2.4
Idea Quality	2.46	2.82	3.04	2.92
Betweenness	32.7	1,103.6	15,282.4	6,282.3
Communication characteristics	Passive Supportive Asking questions feedback	Reactive Thanking Reaction to feedback	Active/collaborative Supportive Offer help Ask for feedback feedback	Reactive Thanking Reaction to feedback
Representative ego network				
Cooperative orientation	Low	Low	High	Medium
Innovativeness	Low	Medium	High	High

The key users of the community comprise *Stars* and *Movers & Shakers*. Users of both groups show a high potential for submitting high quality and innovative entries. They substantially contribute to the overall success of the challenge. Entries and users received a lot of attention by other users. Regarding their social potential or cooperative orientation, they differ in the sense that *Stars* are continually active communicators who reach out to other users, ask them for feedback and offer their help. *Movers & Shakers* too are very engaged in communication. However, they rather reacted on incoming messages, e.g., for courtesy reasons.

Referring to the lead solver framework, we may assume a correlation between innovativeness and cooperative orientation. Looking at an alternative graphical representation of the results of the clustering process supports this assertion: In Figure 47, I plotted all users of each cluster that were part of SNA (with variables IN and OUT) and had a valid entry with a voting result from the community voting (N=154). Each user is represented by a dot. The further right, the higher is the quality of a user entry and thus the innovativeness of a user; the further up, the higher is the number of outgoing relationships of a user (out-degree). The size of a dot indicates the number of incoming comments (in-degree). In combination, the latter two variables indicate cooperative orientation of a user. Shaded dots mark the 4 winners of the challenge.

Preliminary results derived by study 2 have various implications for community and contest management. It is important to consider social interaction, cooperation, and feedback mechanisms by means of communication functionalities even in a competitive contest setting as they serve social needs of users.

Key users such as *Stars* and *Movers & Shakers*, in particular, are highly engaged in communication and thus contribute to a vivid and cooperative community culture. These features may help to attract new innovative users to join the community. Regarding lead solver identification during a challenge, we may conclude that monitoring the flows of communication serves as a good proxy.

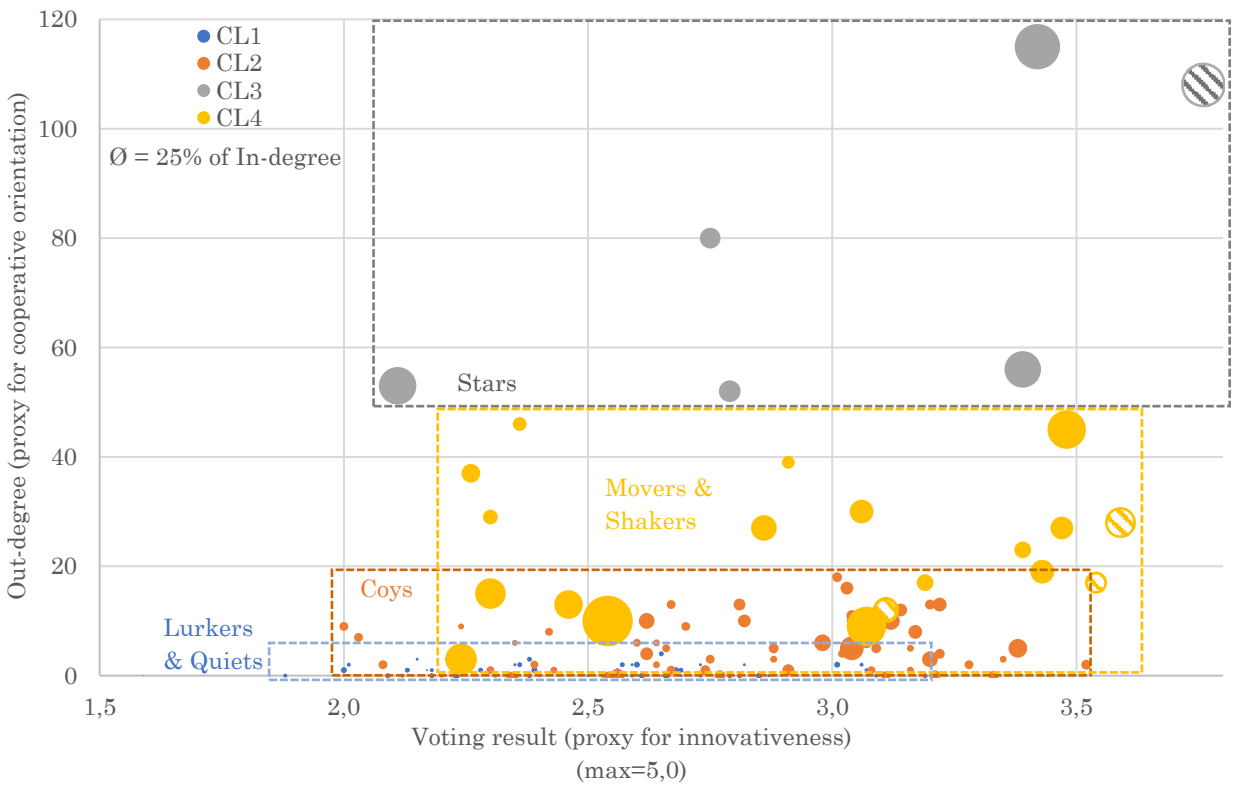


Figure 47. Applying the data (N=154) to the lead solver framework

Analyses to this point were suitable to identify distinct user groups and characterize these based on commenting and contribution behavior. For each user role, I determined the cooperative orientation and innovativeness and derived preliminary explanations for group affiliation.

Still, we do not know yet why users of different groups behave in the way they do. What defines their behavior (e.g., motivation, experience in co-creation)? We also do not know yet whether we should talk about user roles (related to a certain behavior that might change over time) or types (related to personality and are thus fixed). From Wikipedia (Arazy et al., 2016) and open source communities (e.g., Ducheneaut, 2005), we know that there are specific roles of users depending on experience and proficiency. If we talk about user roles, more research would be necessary to develop adequate strategies to facilitate users to switch roles and, hence, be more innovative, collaborative, or both. If we talk about types, we have to take a closer look at individual user characteristics that define a certain type.

Regarding the overall objective of the study, I found that with the methodology of study 2, it is possible to identify potential lead solvers by analyzing the

communication and submission behavior. I assume that lead solvers can be found in the two key user groups, *Stars* and *Movers & Shakers* as those two user groups stood out with exceptional quality and a strong cooperative orientation. To this point, however, we do not know what constitutes lead solverness beyond behavioral patterns. Hence, a qualitative approach is necessary to find out more about specific lead solver characteristics and explanations for the cooperative behavior and the high level of innovativeness.

Part IV: Understanding lead solvers

Chapter 7

Study 3: A user perspective

7.1 Introduction

Research to this point was not sufficient to fully understand users or certain types of users and, thus, derive implications for managing these. More specifically, I could not elaborate distinct characteristics of lead solvers beyond behavioral patterns yet.

On the one hand, previous studies revealed a great heterogeneity of users regarding background, motivation, and behavior. On the other hand, I identified distinct user types based on communication and contribution behavior via social network and cluster analysis in combination with content analysis.

Subsequently, the next step was to follow a qualitative approach to get rich and in-depth insights into users' perspectives. I wanted to find out why user behave the way they do and whether certain characteristics or personal traits are stable among all or some user types, whereas others might be specific to one group. By comparing user types, I expect to find distinct elements that constitute lead solver status – attributable to a user who is very innovative and cooperative at the same time.

7.2 Method

I chose a qualitative method via semi-structured interviews to reach the overall goal of the study, namely the development of the lead solver concept. This approach

is suitable in a nascent scientific field where hardly any literature can be found (Eisenhardt & Graebner, 2007). Furthermore, it is a promising means towards understanding behaviors of people. By listening to "knowledgeable agents" (Gioia et al., 2013) one can gain deep and rich insights that can be used for inductive/abductive concept development as a first und crucial step towards (grounded) theory building in an unexplored field (Gehman et al., 2018; Glaser & Strauss, 1967).

In the context of this study, I relied on the Gioia methodology (2013) which can be described as a "systematic inductive approach to concept development" (Gioia et al., 2013, p. 16) with a strong focus on scientific rigor (see also Table 15). In contrast to *constructs* that can be tested with quantitative studies, *concepts* are "more general, less well-specified notion capturing qualities that describe or explain a phenomenon of theoretical interest" (Gioia et al., 2013, p. 16).

Table 15. Generic steps of Gioia methodology (adapted from Gioia et al., 2013)

Step	Key features
Research Design	• Formulate well-defined, but rather general research question (RQ) • Screening related literature
Data collection	• Multiple data sources, most important though is the **semi-structured interview** (directly addressing the people experiencing the phenomenon) • Strong focus on interview guideline: focus on RQ, anticipate relevant issues, constantly revise in the course of the interviews
Data analysis	• **1st order analysis**: Initial (open) coding by assigning codes to text passages • **2nd order analysis**: Categorizing codes more abstract by grouping them around different (theory-centric) topics relevant to answer the research question (axial coding) • Assemble terms, themes, and theoretical dimensions into a **data structure** (static)
Grounded theory articulation	• Formulate dynamic relationships among the 2nd order concepts • Transform static data structure into dynamic grounded theory model • Refine by comparing the model with literature

The primary goal of this study was the development of the lead solver concept. However, I chose to include other user types in the early analysis phases (1st order, 2nd order analysis) to identify differences and similarities between them and thus being able to clearly define distinct lead solver characteristics and behavioral

traits. Each cluster and user type will be described as detailed as possible and implications derived for community management. Finally, I will focus on lead solvers and build up a (grounded) theory model based on a thorough data analysis and the findings made in the previous stages of analysis.

7.3 Data collection

On the basis of the results from the mainly quantitative study 2, I decided to conduct semi-structured interviews with various users from the contest community. The interview guideline was developed based on suggestions by Flick (2014) and iteratively discussed and improved together with other researchers.

Relying on prior knowledge from literature as well as from previous findings from study 1 and 2, the interview guideline covered the following topics among others (see also Appendix B):

(1) Professional Background (Skill set, employment/job status)

(2) Co-creation experience

(3) Motivation

(4) Idea generation/submission behavior

(5) Communication/interaction

I randomly contacted 158 users among all clusters based on the pool of users established in study 2 (N=536). The sampling strategy aimed at a heterogeneous group of interviewees including users of each cluster. On this basis, I assumed it would be possible to identify distinguishing elements between user types. 38 users responded and agreed to participate in an interview (response rate: 25 %). Table 16 provides an overview of the sample.

At the beginning of an interview, I informed the interview partner about data protection measures and declared that I would anonymize all personal information in the course of the analysis. After a brief introduction to the aim and nature of the study, I asked questions about the personal backgrounds of the interviewees and along the phases of participation (before, during and after the challenge) to

facilitate the interview flow. During the interviews, I took notes to gather contextual aspects that might get lost over time.

The average age of a user was 34.7 years. The interviews lasted 61 minutes on average and were conducted by the author from July to November 2017 followed by transcription of the records from November 2017 to January 2018. 35 people were interviewed online via Skype, 3 interviewees preferred a questionnaire based on the interview guide. The interviews were recorded with the consent of the interviewees. Coding and analysis were conducted with ATLAS.ti.

Table 16. Overview of the sample

Age			**Education**			**Expertise**	
21-30	19 (51 %)		Engineering	21 (54 %)		Automotive	8 (21 %)
31-40	9 (23 %)		Design	16 (44 %)		Ind. Design	8 (21 %)
41-50	6 (15 %)		none	1 (3 %)		Aviation	6 (18 %)
51-60	3 (8 %)					IT	3 (8 %)
61-70	1 (3 %)		**Employment status**			Defense	1 (3 %)
			Employed	21 (56 %)		Education	1 (3 %)
Gender			Student	8 (21 %)		Production	1 (3 %)
male	38 (100 %)		Freelancer	5 (13 %)		Health care	1 (3 %)
			Founder/Entrepreneur	3 (8 %)			
Continent			Retired	1 (3 %)			
Europe	22 (59 %)						
N. America	7 (18 %)		**Job title**			**Cluster**	
Asia	5 (13 %)		(Industrial) Designer	15 (41 %)		CL1	18 (47 %)
S. America	3 (8 %)		Engineer	4 (10 %)		CL2	9 (24 %)
Australia/Oceania	1 (3 %)		PhD Student	3 (8 %)		CL3	4 (11 %)
			Consultant	2 (5 %)		CL4	7 (18 %)
Countries (top 3)			Project Manager	2 (5 %)			
Germany	7 (18 %)		Manager	2 (5 %)			
USA	6 (15 %)		Lecturer	1 (3 %)			
France	4 (10 %)		Entrepreneur	1 (3 %)			

7.4 Data Analysis

7.4.1 1st order analysis

Once the data set was prepared, I started analysis by screening the data set and marking interesting passages and statements. The next step was to openly code the marked text case-by-case with the informants' own words and to constantly

compare similar incidents between cases. By following this procedure, I could make myself familiar with the data set, identify interesting themes and get a first impression with respect to the research questions at hand.

Interestingly, the data reflected the great heterogeneity of interviewees based on different cluster affiliations. I thus was confident to gain rich insights and derive a broad spectrum of user characteristics. In particular, I discovered extensive coverage of themes such as prior experience in co-creation, motives for participation, feedback interactions and submission behavior. Reviewing literature led to the assumption that these aspects are very important to assess lead solverness.

7.4.2 2nd order analysis

In phase 2 of the analysis, the goal was to structure codes by creating categories and group them around (theory-led) themes that are relevant to answer the research question. The classification system was built up bottom-up and constantly revised against all cases and in accordance with findings from prior literature and the research framework (lead solver framework), respectively.

First, I developed a rather general data structure with a set of interconnected categories (see also Figure 48). Each category (e.g., color) implies at least one property (e.g., shade) and each property can be described by attributable dimensions (e.g., light). This framework was used to compare and analyze different clusters and user types, respectively. In a second phase, I rerun another round of in-depth analysis with special focus on lead solvers as a basis for theory development.

Below, I will introduce each category that emerged from the data. First, the emergent coding scheme will be presented including properties and dimensions. Each dimension will be explained with exemplary quotes from the interviews. Then, I will plot the code distribution for each category and against the 4 clusters derived in study 2.

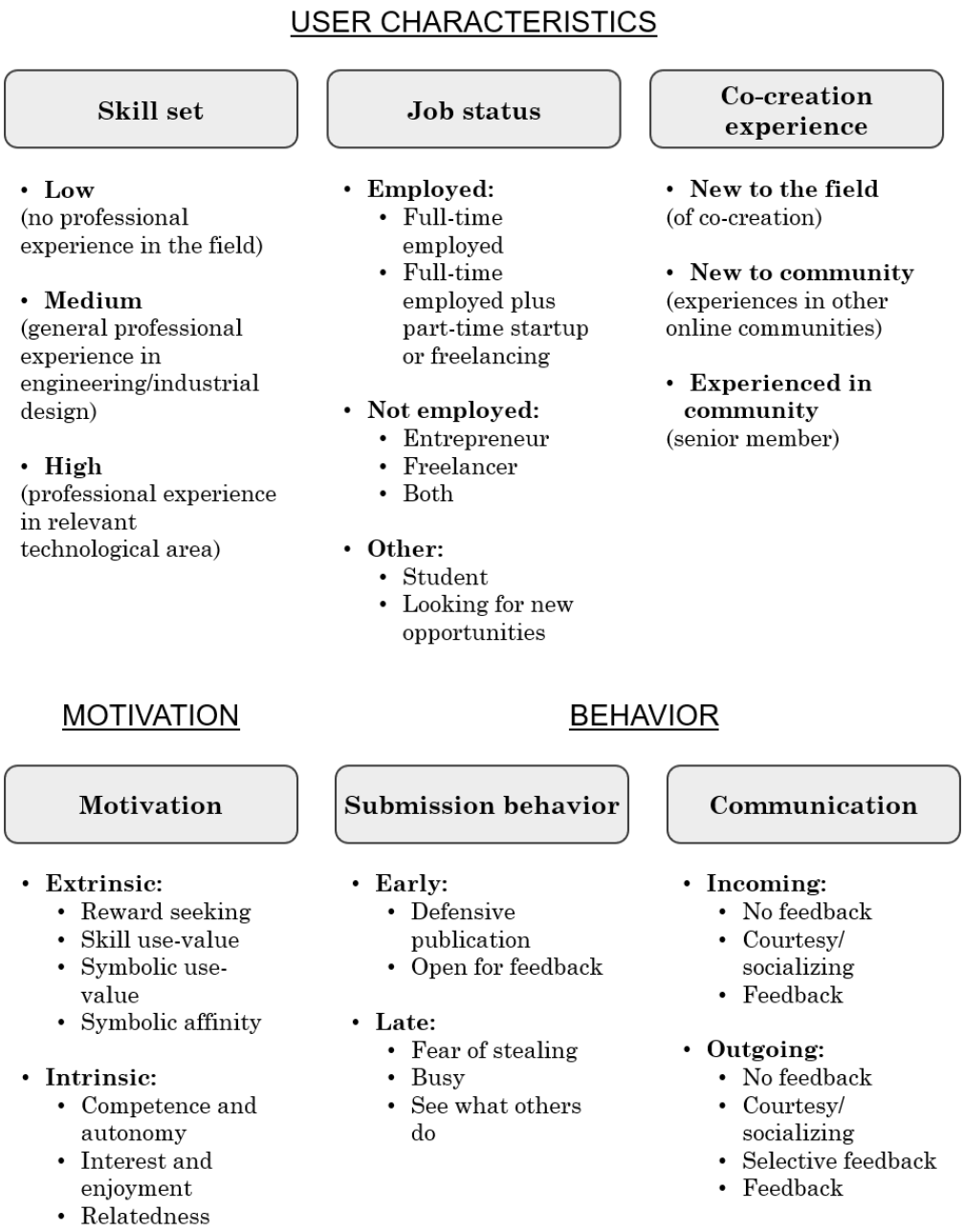


Figure 48. General data structure with categories, properties and dimensions

Cluster comparison was a crucial step to identify significant differences between clusters and thus being able to derive distinct lead solver characteristics. Therefore, it was appropriate to double-check the cluster affiliation of the interviewees. I reviewed the individual network measures against cluster average.

If a user profile fitted another cluster better, I reassigned cluster affiliation. In fact, I reassigned 5 users to a different cluster (see also Appendix C).

7.4.2.1 *Category: Skill set*

Coding scheme

Related literature tells us that technical expertise and experience in the relevant field is an important aspect to determine the innovativeness of a user. Having a closer look at the professional background of the interviewees thus should help me to check whether skill set should be included as a characteristic of lead solverness.

The task at hand was to come up with new concepts of drones. Required skills are thus basics in engineering and/or industrial design. In addition, specific knowledge in the realm of aeronautics and drone design are beneficial.

Initial coding of the data revealed a broad diversity in this realm ranging from students to very experienced engineers with a stark track record in the respective technological area. I reduced the number of codes by assigning each user a certain level of skills based on self-reported information on education and professional experience. I differentiated between professional experience and qualification in industrial design and engineering in general on the one hand, and topic-specific knowledge on the other hand.

The skill set was considered ***low***, if a user had 1) little experience in engineering and design, e.g., students and graduates without relevant professional experience, and 2) lacked significant knowledge and expertise in drone/aircraft design.

> *ID26: "The field was new for me. I have no experience here; I am not a specialist"*

> *ID46: "I didn't have much experience with planes, so this was new to me, but I was very interest in aviation […] since I was a child."*

A user was labeled with a **medium** skill level, if he or she had 1) professional experience and education in either engineering or design, e.g., from job positions and projects, but 2) did not have any drone-related points of contact yet.

> *ID2: "I am an aeronautical engineer […] working as a R&D engineer. We did the drone challenge when we were still students."*

ID8: "I'm an industrial designer. I worked in automotive […] and learned a lot about making things and right from the concept sketch to the actual details of the design. And also, I had my own consultancy. […] I was passing interest in aviation in whole but no detailed knowledge."

If a user had professional experience in both realms, namely 1) basic engineering/design and 2) domain-specific knowledge around drone technology, the skill level was set to **high**.

ID19: "I've done lots of partnerships with Airbus […] making some interiors for helicopters, some customizations, so I know the different restrictions about this."

ID3: "We build drones [in our startup] with a new technology for electric motors."

ID29: "I'm by education a doctor of aerospace and mechanical engineering. […] Then I started working in the aircraft industry as an aerospace designer and then later as a lean-designer in a couple of different roles since I started in 1999."

<u>*Code distribution*</u>

Table 17. Code distribution: Skill set

Cat.: **Skill set** Prop.: - Dim.:	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (N:38)
Low	4	3	-	-	7 (18%)
Medium	9	7	4	2	22 (58%)
High	2	1	2	4	9 (24%)

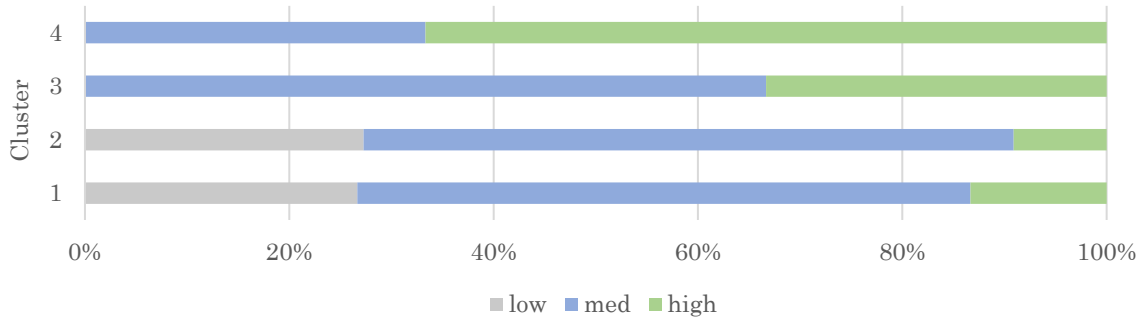


Figure 49. Cluster comparison: Skill set

7.4.2.2 Category: Motivation

Coding scheme

Motivation is a key aspect when it comes to innovativeness. We have learned from various other studies that intrinsically motivated people are more creative and self-determined. Intrinsic motivation is also related to high levels of need to achieve and self-efficacy. Furthermore, the driver for participation can also influence user behavior during a contest. A user that is interested in winning the price money is more prone to competitive behavior than a user who participates for the sake of learning or socializing. Motivation thus is expected to be an important lead solver characteristic.

Initial coding revealed a large number of motives. Interestingly, oftentimes more than one driver for participation was mentioned by the interviewees. By constantly comparing and revising codes and code assignments case-by-case among all interviewees and in-case in context with statements in related sections (e.g., background, means of compensation), it was possible to determine a major driver for each individual.

For further analysis, I aggregated the codes along the motivation framework of Asdourian and Lazarte (2018) who reviewed seminal literature in the field and derived this model for understanding users in the context of online communities. The model differentiates between extrinsic and intrinsic motivation as described in Ryan and Deci's (2000) self-determination theory (SDT). They define intrinsic motivation as "the doing of an activity for its inherent satisfactions rather than for some separable consequence" (Ryan & Deci, 2000, p. 56). In contrast, extrinsic motivation to do a task rather serves a "separatable outcome" such as a reward.

The codes were attributed to one of the following motivational constructs (Asdourian & Lazarte, 2018) :

Extrinsic motivation

- **Reward seeking:** winning a prize or earning a reward (e.g. prize money).

  ID19: "Well, 50,000 USD first price was a good driver."

  ID30: "The price money was an interesting argument for me."

- **Skill use-value**: learn new or improve skills for further material advantages (e.g., job or project).

  ID43: "I love to learn. And aviation is something I never touched before."

  ID2: "One of the objectives for us was also the experience itself. We knew, even if we did not win, we would still earn a lot of experience and that is very important for us."

- **Symbolic use-value**: sending strategic signals to receive positive reactions from other people (e.g., to enhance reputation and gain recognition, for career opportunities).

  ID2: "You get the opportunity, and this is the best think, this the most important thing of the challenge, that it gives you an opportunity to show yourself."

  ID7: "Very good for my cv and increasing the opportunities to be hired by either Airbus or other UAV companies."

- **Symbolic affinity**: compliance with the (socio-political) values and norms of a community or a firm (e.g., pro open-source).

  ID16: "This is the right thing to do. It has to be done. And that's why I participated"

  ID1: "I am pro open-source. So, if my idea is used and I don't get anything from that, I am really happy because for the implementation of my idea and its impact on the society is more important."

  ID9: "I guess it would be nice to be part of something that gets built, that helps people and improves humanity and that is what I thought I was doing here."

<u>Intrinsic motivation</u>

- **Competence and autonomy**: need to feel competent and in control to make decisions (e.g., self-efficacy and freedom to express).

  ID6: "It's a great place to test your level of creative thinking ability."

ID17: "What excited me was the technological challenge for oneself and the sense of achievement at the end when you made it."

ID25: "just to see if I could do it."

- **Interest and enjoyment**: a task is inherently stimulating and fun to do.

ID31: "I participated more because I really enjoyed the subject and in the process, I learned also stuff in a matter that was really interesting."

ID32: "We just did it for fun."

- **Relatedness**: need to feel connected to others and participate in a community of like-minded peers.

ID8: "I would say the community, because it's like during a challenge like that which takes you away from your work and let's you dream a bit and also getting to chat with a lot of individuals on the same level. Inspiration and just the way other guys think and getting all these other perspectives is amazing."

ID18: "I thought like: If I do this I make like two or three connections at best. People in aerospace, and that's ok. I feel like a winner with that."

<u>Code distribution</u>

Table 18. Code distribution: Motivation

Cat.: **Motivation**	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (N:38)
Prop: <u>Extrinsic</u> Dim.:					
Reward seeking	5	-	-	-	5 (13%)
Skill use-value	1	5	1	2	9 (23%)
Symbolic use-value	9	5	3	3	20 (52%)
Symbolic affinity*	-	-	-	-	-
Prop: <u>Intrinsic</u> Dim.:					
Competence and autonomy	-	-	2	1	3 (7%)
Interest and enjoyment	-	1	-	-	1 (2%)
Relatedness*	-	-	-	-	-
* While I found text passages that would relate to this motive, others were mentioned, too. Thus, I chose the stronger motive. This is the reason why exemplary text passages were presented above, but not considered for further analysis.					

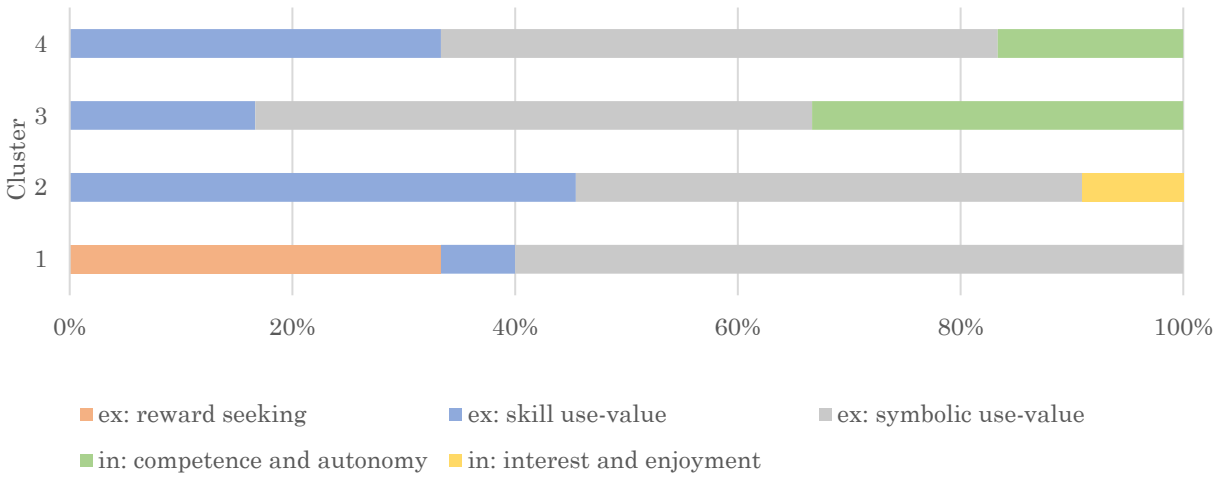


Figure 50. Cluster comparison: Motivation

7.4.2.3 Category: Submission behavior

Coding scheme

We know from lead user theory that, in general, lead users enjoy sharing knowledge and exchanging ideas. Related studies in the realm of contest communities also found that most of the users who come up with innovative ideas like to share them among their peers if the platform features allow to do so. The same phenomenon was observed in open-source software communities. Receiving feedback on an idea and thus being able to further improve it, is one reason why people share their ideas. Only few studies focused on the effect of openness in a contest setting and the results are ambiguous: While early disclosure of solutions can inspire other users and enable feedback interactions, it may also decrease the solution space as users are primed towards certain technological directions.

In the context of contests and crowdsourcing we can observe quite the opposite as well: users are seeking for IP protection against competitors. One strategy to obtain protection is to defensively publish an idea early and hence marking the field with a certain solution.

Hybrid contest communities usually facilitate cooperation and thus early submission, and feedback and exchange are enabled via messaging functionalities. For the lead solver concept, I argue that cooperative behavior, in this case via early submission, is characteristic to this type of users.

Subsequently, I coded relevant sections where interviewees talked about their submission behavior. Interestingly, both behavioral patterns, rather cooperative and competitive, could be observed. The codes assigned could basically be differentiated on the moment of submission: early (in the first 3 weeks) and late submissions (in the last week). Next, I focused on the reasons for a specific action.

I derived the following properties and dimensions:

<u>Early submission</u>

- **Defensive publication**: a user releases a draft or the final version of his or her concept very early in the course of the challenge to mark the field for a certain technological setup.

  ID2: "When we had the concept, we already uploaded the sketches on paper, just that nobody would take the idea or something like that…"

- **Feedback**: a user releases a draft or the final version of his or her concept very early in the course of the challenge to receive feedback from others, discuss ideas and concepts and make improvements based upon these.

  ID27: "Ehm, it's like a process and you don't want to submit it too late, because you want feedback that the other people are gonna give you, so I tried to submit it as early as possible…"

<u>Late submission</u>

- **Fear of stealing**: a user withholds a submission until the end so that other users cannot copy from him or her.

  ID12: "… if you upload your idea too early, you are potentially going to inspire your competitors with your ideas which you don't like as you dismiss your competitive advantage."

- **Busy**: a user was busy elaborating and finalizing the concept and thus could not upload the submission before the deadline.

  ID21: "We submitted [our concept] rather late, because we entered the challenge late and thus were very busy."

- **See what others do:** a user is looking at other entries to get inspiration before he works on his or her own concept.

  ID10: "I could look through the stuff all the other people uploaded, to see what is more interesting."

Code distribution

Table 19. Code distribution: Submission behavior

Cat.: **Submission behavior**	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (N:38)
Prop: Early Dim.:					
Defensive publication	2	-	3	2	7 (18%)
Feedback	6	9	2	1	18 (47%)
Prop: Late Dim.:					
Fear of stealing	1	1	-	-	2 (5%)
Busy	6	-	1	2	9 (23%)
See what others do	-	1	-	1	2 (5%)

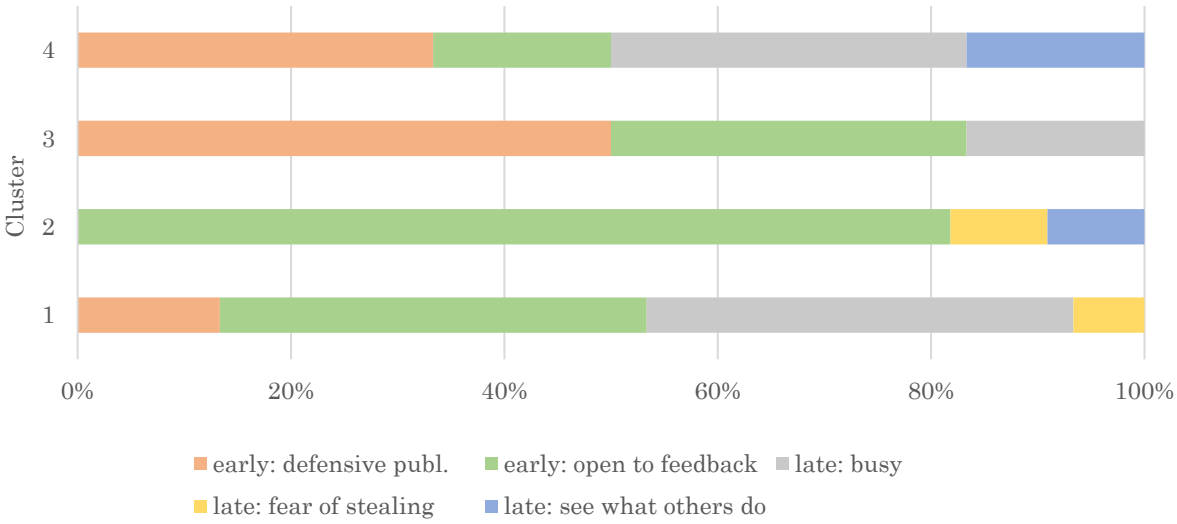


Figure 51. Cluster comparison: Submission behavior

7.4.2.4 Category: Employment/Job status

Coding scheme

The occupational situation of a participant cannot directly be associated with a distinct level of innovativeness. In our case, in particular, the sophisticated task of the challenge required some professional experience in the area of engineering and

industrial design. However, the job status of a user might serve as a proxy when it comes to aspects like autonomy, self-efficacy and need to achieve, or the effort a user invests. A full-time employee, in general, has no need to signal for a job or earn money. Quite contrary, a freelancer might participate in the challenge to showcase his abilities and strengthen reputation.

Thus, with this category I wanted to find out whether job status indirectly has an influence on lead solverness and on user behavior, in general. In fact, the interviews revealed various constellations of job situations. Only few people could be assigned with one specific occupation. Rather, I found most of the users to be engaged in different projects ranging from freelancing and part-time studies to startup activities.

I grouped the occupational status as following:

Employed:

- **full-time employed**: a user that has a regular income by a full-time job.
- **full-time employed plus part-time startup or freelancing**: a user that has a regular job, but on top is involved in start-up activities or is doing freelance work besides the regular job.

Not employed:

- **Entrepreneur**: a user who is (part of a team) running a business.
- **Freelancer**: self-employed industrial designers and engineering consultants.
- **Both**: a mix of the latter.

Other:

- **Student**: a user that is a full-time student and combines the participation with a student project or thesis.
- **Looking for new opportunities**: a user that is looking for a job or wants to move into a different professional field or industry.

Code distribution

Table 20. Code distribution: Employment/Job status

Cat.: **Employment/Job status**	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (N:38)
Prop: Employed Dim.:					
full-time employed	6	2	-	1	9 (23%)
full-time employed plus part-time startup or freelancing	-	-	3	-	3 (7%)
Prop: Not employed Dim.:					
Entrepreneur	3	1	-	-	4 (10%)
Freelancer	1	2	1	1	5 (13%)
Both	1	-	-	1	2 (5%)
Prop: Other Dim.:					
Student	3	5	1	3	12 (31%)
Looking for new opportunities	1	1	1	-	3 (7%)

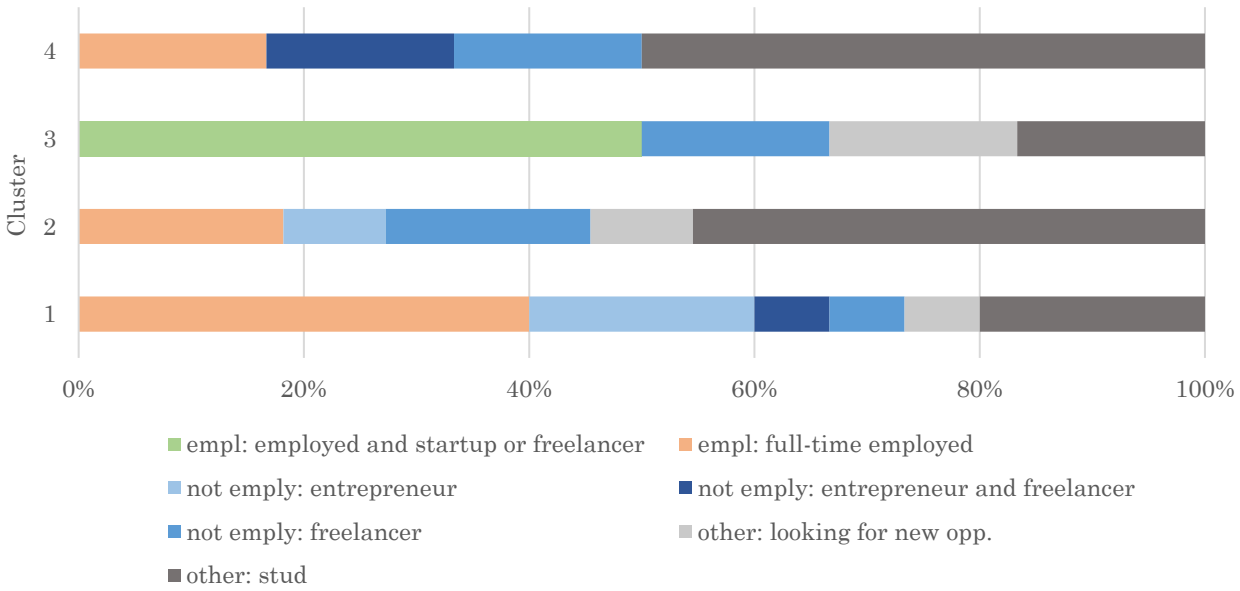


Figure 52. Cluster comparison: Employment/Job status

7.4.2.5 Category: Co-creation experience

Coding scheme

We have learned how users who initially join an online community, whether it is an open-source software project or a brand community, first need to accustom oneself to the values and practices of the respective community.

Likewise, I argue that users in a contest community will have different degrees of seniority, meaning experience in co-creation. The cooperative orientation of a user will strongly depend on this matter. If a user has experienced cooperation and interaction with other users before, e.g., via commenting and feedback, he or she is more likely to reciprocally behave in the same way.

Looking for additional characteristics of lead solvers, research from related fields indicates that this type of user is heavily engaged in social interaction with other users. By doing this, they accrue more social capital than other users. Hence, I expect lead solvers to be rather experienced co-creators, be it in the contest community under study or any other type of similar online community.

Indeed, many interviewees mentioned previous experiences in other contexts. I aggregated the codes found here into the following scheme:

<u>Co-creation experience</u>

- **New to the field**: a user that did not have any touch points with web-based co-creation yet.

  ID30: "It was my first experience with this co-creation."

- **New to community**: a user that had prior experiences in other co-creation communities.

  ID38: "No, I have been involved with opera project, with coding mostly, […] that kind of stuff. And I was interested in some android apps and some frameworks.

  So, I got kind of involved in the Github community and […] yeah, I came to know how to work in collaborative community."

- **Experienced in community**: a user that has been a member of the community at hand for a while and participated in at least one other challenge before.

  ID6: "I participated in various auto contests on the same online platform from time to time, depending on my free time."

Code distribution

Table 21. Code distribution: Co-creation experience

Cat.: **Co-creation experience** Prop.: - Dim.:	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (N:38)
New to the field	5	7	1	3	16 (42%)
New to community	6	1	2	1	10 (26%)
Experienced in community	4	3	3	2	12 (31)

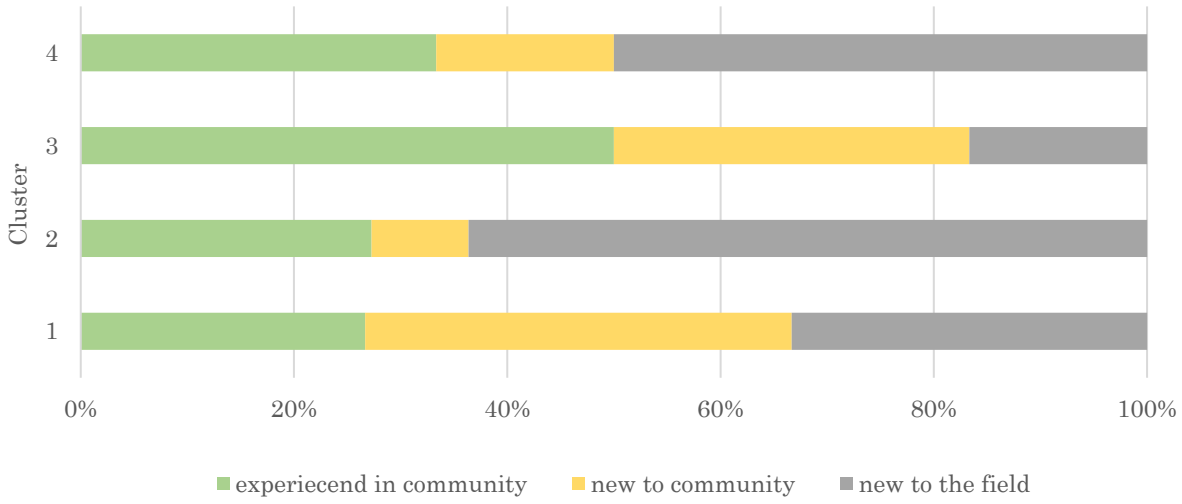


Figure 53. Cluster comparison: Co-creation experience

7.4.2.6 Category: Communication

Coding scheme

Besides knowledge sharing via early (and public) submission of an idea, cooperative user behavior is expressed by communication with other users. The forms vary depending on the platform's technical features, e.g., direct messaging, forum posts, comments. Beyond small talk, courtesy, and socializing, sending and receiving feedback represents the most important cooperative mechanism that fosters both, the mutual advancement of ideas and the accumulation of social capital. Related literature thus suggests communication to be a key category to study the cooperative orientation and subsequently the lead solverness of a user.

In this study, I was able to cover bidirectional communication flows via social network analysis. Accordingly, I gained insights into the communicational

patterns of the interviewees. The coding scheme basically distinguishes between receiving and sending messages. Both could be important. While received messages tell us something about a user's ability to catch attention, his or her social capital and boundary spanning potential, the outwards messaging behavior of a user indicates cooperative orientation.

Communication

Incoming:

- **No feedback:** a user did not receive any relevant messages from other users.

  ID7: "Feedback from others? No, I didn't expect it."

- **Courtesy/socializing:** a user received messages by other users for the purpose of socializing or by courtesy.

  ID3: "It was rather socializing, like: 'super, keep going!'"

- **Feedback:** a user received valuable feedback on how to improve his or her idea.

  ID23: "I did receive feedback, yes. It was helpful. It helped me improve the design."

Outgoing:

- **No feedback:** A user did not send messages.

  ID32: "Well, I looked through, but I didn't really get involved in that. […] I prefer to maybe not put too much feedback out there to anybody."

- **Courtesy/socializing:** If a user sent out messages, it was by courtesy, but without any substantial value regarding the improvement of an idea.

  ID14: "I posted comments for what I liked but not posted comments to maybe point out something which is not right, which can be improved or something like that.

- **Selective feedback:** a user did send messages with suggestions for improvement or feedback, however, only to selected users.

  ID7: "I gave feedback to some of them but didn't have much time."

- **Helping others:** a user did engage in feedback activities, in general.

  ID10: "Yes, I was working very much on the entries. I leave comments in terms of design. You know, the materials, the concept. Those are the things that I comment."

<u>*Code distribution*</u>

Table 22. Code distribution: Communication

Cat.: **Communication**	Cluster 1 (N:15)	Cluster 2 (N: 11)	Cluster 3 (N:6)	Cluster 4 (N:6)	Total (:38)
Prop: <u>Incoming</u> Dim.:					
No feedback	6	1	-	-	7 (18%)
Courtesy/socializing	3	3	3	2	11 (29%)
Feedback	6	7	3	4	20 (52)
Prop: <u>Outgoing</u> Dim.:					
No feedback	4	1	-	-	5 (13%)
Courtesy/socializing	7	8	1	-	16 (42%)
Selective feedback	3	1	2	3	9 (23%)
Feedback	1	1	3	3	8 (21%)

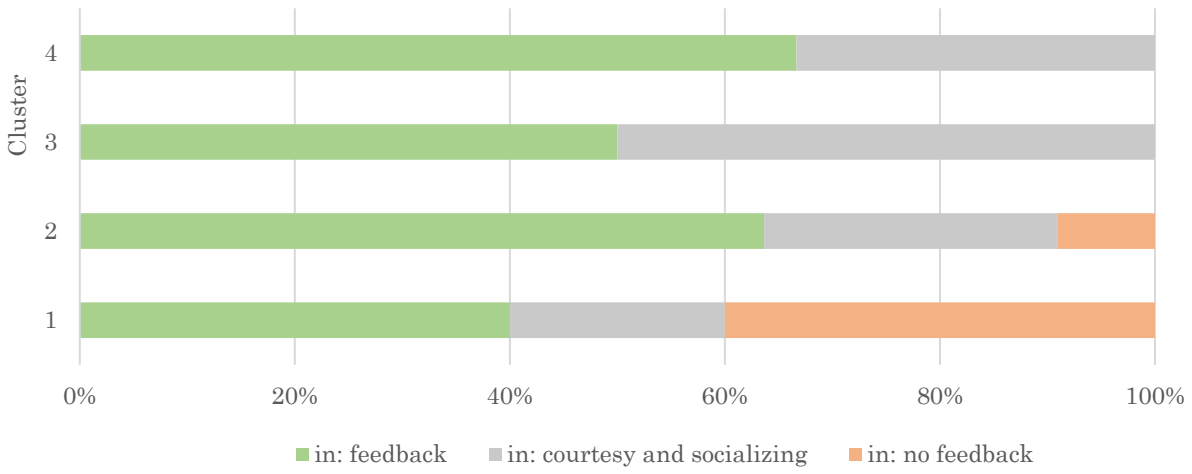


Figure 54. Cluster comparison: Communication (incoming)

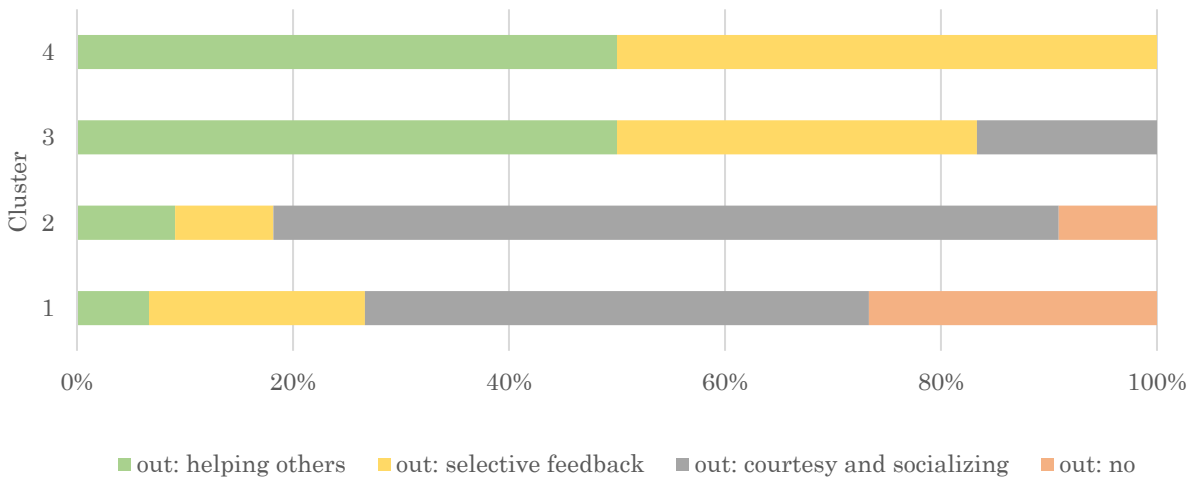


Figure 55. Cluster comparison: Communication (outgoing)

7.5 Preliminary findings: User typology

While the previous section focused on differences between clusters on the category level, the following analysis takes on a more comprehensive view aiming at distinct user profiles for each cluster. Based on results from study 2, the user typology will be enriched with detailed information from the interviews.

For each cluster, I first recall what is known so far and what not. I then provide distinct characteristics of each group followed by a more subtle description with illustrative quotes wherever suitable. Finally, management implications will be drawn individually.

7.5.1 Cluster 1: Lurkers & Quiets

From study 2, we know that the vast majority of users could be assigned to this user type. Users did hardly communicate or interact with other users. Only about a third did submit a (valid) entry after all, and the idea quality of those who participated with a valid submission, was rather low compared to other clusters. I thus concluded that the cooperative orientation as well as the level of innovativeness among these users was low.

But why is that? Why are *Lurkers & Quiets* so passive? Is there anything we can do about it in terms of community management or contest setting? The size of the

cluster provides us a large lever: Being able to mobilize users to move to another cluster would result in a much stronger contest community.

Analyzing the interviews of cluster 1 users led to results as follows:

7.5.1.1 Distinct characteristics

- **Skill set:** mixed, comparably low
- **Employment/Job status:** many full-time employees
- **Co-creation experience:** mostly new members of the community; Many new-to-the-field entrepreneurs
- **Motivation:** strong extrinsic motives, reward seeking in particular
- **Communication:** hardly outwards communication
- **Submission behavior:** new users late, experienced users early

7.5.1.2 Description

During initial coding different subgroups emerged. I thus subdivided the cluster into 3 subgroups.

Subgroup: Competitive entrepreneurs

Obviously, the involvement of Airbus as a global industry player and the high amount of prize money attracted new kinds of users with **little to no previous experience in the field of co-creation**. Entrepreneurs of related technological fields with a clear business interest is one user type among these. They participated **to profit directly** (win the prize) **or indirectly** (future cooperation/contract with Airbus) from the challenge:

> *ID16: "If we win this, we can make a business out of it, we'll see our idea, our concept further expanded and being sold and released to the market."*
>
> *ID23: "For me the major driver was promotion for me and indirectly for the company. And also, I thought at one point in time that maybe I would be able to win it and in case I won any of the prices, that would be further promotion for the company and for the business."*

> *ID34: "You also try to get it touch with potential project partners that you wouldn't reach otherwise. Connecting with Airbus as a big industry player in particular is very appealing."*

Consequently, these users were rather **competitively oriented** and (wittingly or unwittingly) acting accordingly. They hardly communicated and, if they did, it was mostly a reaction to incoming feedback. Of course, as an entrepreneur they would not have much time to spend on the platform. Also, they submitted their designs either late (because they were busy) or early as an IP protection measure:

> *ID16: "I checked whatever it was in the platform. If someone was great and it was exactly the same idea I had in mind, I wouldn't apply for it. My idea had to be different."*

> *ID23: "When you publicize something, it's very difficult to protect, who would give me the points for something that I disclosed very early and later on everyone used and before me no one used it on design. So, who is going to be able to track this? It's impossible"*

A remaining question is why those entrepreneurs were not able to deliver more innovative ideas than other users. Unfortunately, there is not one precise answer. While some interviewees explained that they were operating in a related field (*ID23*, *ID16*), but not directly matched the technological scope of the challenge, others missed out the opportunity to receive feedback, because they were very busy:

> *ID21: "We started late and uploaded our idea right at the end and thus we missed the chance to receive feedback and change things."*

<u>*Subgroup: Low-skilled users*</u>

Another prominent group in cluster 1 comprises users with a rather **low skill level**, e.g., students. The interviewees participated to **improve their skills**, to **make money** or to **earn reputation** (e.g., with a record in their cv). They mostly **submitted their idea early** to be involved, to receive feedback and thus improve their ideas/skills:

> *ID27: "You don't want to submit it too late, because you want feedback that the other people are gonna give you, so I tried to submit it as early as possible."*

Unfortunately, only limited feedback was given to their ideas. Just like the competitive users, they hardly communicated with other users. The reason for not communicating is different though: they **did not feel entitled** to talk to the "people at the top":

> *ID15: "People like me, who are at the bottom competing with people who are at the very top […]. I didn't do much feedback, I was just like, most of the time was blown away by a lot of the other people's work […] No, I can't really criticize other people unless I'm better than them."*

> *ID38: "I'm not used to leaving comments. […] I could say yeah, nice design or something like that. But uh, I didn't, I don't think it had something specific to comment."*

Regarding the outcome, **limited professional experience** due to early career stages in combination with little to **no feedback** can explain a rather low degree of innovativeness.

<u>*Subgroup: Reward-seeking employees*</u>

The most obvious reason why a user would not interact with other users is that he or she is not interested. If a user considers the challenge purely a competition where helping others would diminish one's own chance of winning, there is no reason to behave cooperatively. This is even more true in a case where the major driver for participation is to win the prize (money).

In this subgroup, extrinsic motives were particularly pronounced. Some users explicitly mentioned the **prize (money)** to be important, others would see the challenge as an opportunity to strengthen their **reputation** by **exposing their capabilities** and **signal to Airbus** as a potential employer.

> *ID19: "Well, 50,000 USD first price was a good driver."*

> *ID12: "It's a good opportunity to showcase what you can. And it's a good signal to Airbus."*

The communication behavior supports a rather competitive attitude: Users in this group communicated very little (mostly reactive by courtesy) if at all.

> *ID13: "No, not really [did I give feedback]. I was being kind of selfish. It was fun working on it. I sort of treated the whole co-creation thing, just like a regular competition. So, for me the co-creating part did not exist."*

> *ID37: "I didn't get or give feedback because it was a competition"*

Regarding submission behavior, the situation is ambivalent: (New-to-the-community) users reported to submit late as they feared that other users might take advantage of their knowledge which would be publicly accessible then. In contrast, experienced community members submitted early despite their competitive orientation. Interestingly, it seems that users adapted to the community culture speculating for a bonus (e.g., *ID25: "They [Local Motors] prefer it this way [to release ear*ly]").

Despite medium-level skills on average, the quality of the entries released by users of this group was quite low. Reasons are not easy to determine: Users who submitted late, missed out the opportunity for feedback and thus the quality might be lower. Furthermore, aligning the goal for participation to the prize money (with only a tiny chance of winning) might not be sufficient to invest more-than-average time. Another explanation is a comparably low level of need to achieve of full-time employees without pressure to succeed.

7.5.1.3 Discussion

Interviewing representative users helped to shed some light on this cluster. Users are quiet for a reason. However, there are different reasons: someone can be quiet because he or she has nothing to say or if he or she does not want to say something. While community management can help users that are rather reserved with adequate community management measures, it will be hard to influence competitive users and provoke cooperative behavior. Still, clearly communicating what the goals of the community are and what kind of behavior is preferred will eliminate misunderstandings and avoid wrong expectations. What we still do not know exactly is the proportion of "true" lurkers meaning users who stop by, but

quickly move on. My data shows that about a third of the users in this cluster did not submit an entry. This gives us a good indication for the share of lurkers here.

Innovativeness: low

Cooperative orientation: mixed, on average rather low

7.5.1.4 Implications

- Clear communication of goals of a challenge (both sponsor and host) to avoid wrong expectations
- Display and communicate the code of conduct
- Stimulate communication and feedback
- Provide learning opportunities

7.5.2 Cluster 2: Coys

In study 2, we learned that *Coys* were quite reserved challenge participants. However, they were engaged in some interactions with other users, mostly by gratefully reacting on incoming feedback and support. The idea quality was medium. What could not be explained yet, was why they were rather shy. At least they were socially involved in the challenge community to some degree.

Analyzing the interviews of cluster 2 users led to results as follows:

7.5.2.1 Distinct characteristics

- **Skill set:** mixed, comparably low
- **Employment/Job status:** mostly students who also want to signal to Airbus
- **Co-creation experience:** mostly new-to-the-field users
- **Motivation:** engaged and enthusiastic learners
- **Communication:** reactive socializing and courtesy
- **Submission behavior:** early release of ideas for feedback

7.5.2.2 Description

Unlike cluster 1, cluster 2 revealed a distinct pattern that seems to be unique. We predominantly find users who were **new to the field** of co-creation. Not only were

they **new to the community** at hand, but they were also new to the field of web-based co-creation in general. This might explain a rather passive communication behavior. At first, they need to get accustomed to the (cooperative) environment and the community culture. Once they received feedback, they reciprocated likewise:

> *ID30: "Everyone that gave me feedback, I tried to give it back. In a certain way."*

Another explanation for the reserved and reactive behavior can be found in the motives that interviewees mentioned to be more important regarding their participation. In comparison to the other groups, many users joined the community and the challenge to **learn** and **improve their skills**, e.g., students or freelancers from another field:

> *ID35: "I love to learn. And aviation is something I never touched before. I played Flight Simulator game. I played drones. So why not take the challenge? I have nothing to lose."*

To go through a learning experience, users had to rely on feedback from the community which they could only receive if they **released their concepts early**. This is what almost all interviewees in this group reported:

> *ID18: "I first made some sketches with the blender software and just uploaded it, like raw, just some sketches and a little bit of descriptions and I thought: Well, people are gonna comment on this entry and give me some advice."*

> *ID14: "I uploaded an architecture how I wanted the drone to be, which was a bluff format rather than the X, everyone was leaning on the X or the H. And I tried to do a plus, but I didn't know if that would work. So, I posted it for the feedback. Then this guy said: "Yeah, it is possible." So, I went ahead with this idea."*

They received some answers to their questions and suggestions for improvements. Quite thankfully, the **learners reacted and commented back**. However, they

felt not eligible to give (constructive) feedback in reverse. Instead, they rather **socialized**:

> *ID18: "Well, I looked at many, many entries and I followed also many, many entries, but I didn't comment a lot. Because when I wanted to comment, it was to like to improve the design and everything but sometimes, you know, I didn't have anything to say, so I followed many designs."*

> *ID14: "No, I haven't done that yet. I haven't posted [feedback]. I posted comments for what I liked but not posted comments to maybe point out something which is not right, which can be improved or something like that. I didn't do that because I was not too much aware of drone design and aviation."*

Some (rather proficient) students also reported that they wanted to **enhance their reputation and signal to Airbus**, e.g.:

> *ID18: "Well, I can't miss that opportunity to show what I can do, to put my skills to use."*

Interestingly though, that did not keep them from releasing their work early too. Cooperative behavior and a competitive orientation are not necessarily opposing constructs as it seems.

7.5.2.3 Discussion

Coys mainly comprising students and engaged learners in general are an interesting user group which should be closely monitored and fostered wherever possible. Someone who is willing to learn shows a high level of engagement and self-determination. Also, if the learning experience is successful, a user is likely to return and become loyal. In addition, he or she will tell other people about it (positive word-of-mouth). And finally, a learner is happy when he learned something. Thus, he is not disappointed, if he does not win a prize. The compensation is the learning experience itself. The rather reserved interaction behavior of these users is very likely to be attributed to one of the following situations: a user is new to the community and/or a user has a low level of self-efficacy due to a lack in experience and skills.

Innovativeness: mixed, comparably low

Cooperative orientation: medium (unintentional)

7.5.2.4 Implications

- Provide opportunities to learn e.g., by encouraging feedback either by other contestants or experts from the seeking organizations or by providing topic-related tutorials
- Develop and prominently display community/challenge rules ("code of conduct")
- Mentorship for new users as guidance

7.5.3 Cluster 3: Stars

A very special and valuable type of user gathers in cluster 3. Study 2 revealed two distinct features of this group: Users are highly interconnected and strong collaborators on the one hand, and they are able to deliver high quality input to a challenge on the other hand. Both characteristics are crucial for a vivid and innovative contest community.

Obviously, community management must regard these users as a key resource and accordingly needs to find adequate ways to bind them. Furthermore, it is crucial to understand their behavior and attract more users of this type. While we know how those users positively shape the outcome of a challenge, we still do not know why they behave the way they do. Also, it would be interesting to know about distinct personal traits and/or situational factors that help us understanding these users.

Analyzing the interviews of cluster 3 users led to results as follows:

7.5.3.1 Distinct characteristics

- **Skill set:** medium to high (engineers from the field and very proficient industrial designers)
- **Employment/Job status:** mostly employed people who also have side projects/activities (startup, freelancing)

- **Co-creation experience:** experienced in community and new-to-community users
- **Motivation:** challenge oneself, enjoy the community, skill improvement, promoting entrepreneurial projects or display freelancing capabilities
- **Communication:** strong engagement in feedback activities
- **Submission behavior:** early (for feedback and defensive publication)

7.5.3.2 Description

Users in this cluster are **highly skilled** which to a certain extent explains the high-quality input. I basically found two groups of users here: **new-to-the-community** users, mostly **excellent engineers** with a strong background in the respective field on the one hand (this challenge was the first in a new technological field), and on the other hand **longstanding** and experienced **community members**, primarily **industrial designers** with a focus on automotive/transportation design, with outstanding skills in concept development and presentation (some of whom won previous challenges). An interview partner described the latter group as:

> *ID8: "All-timers, the ones that are comfortable talking to everybody and not scared to show their designs. They might not show everything, but they will show most of what they're doing. They're happy to give feedback and are quite open. They're just happy to be part of the team."*

What is interesting here, is the fact that most users are highly **self-determined** and driven by a strong **need to achieve** in the sense that they are engaged in freelancing or entrepreneurial activities, many even besides a regular fulltime job. So, they have their own projects and thus a high interest in public **recognition and reputation**, but also in **skill development**:

> *ID8: "We don't take ourselves too seriously, if we win, we win. […] it's more like developing yourself as a designer a lot of the time. What I like to do with my designs, the good thing about Local Motors is, that it helps my portfolio design, because I can always improve my skills and have a lot to show on my portfolio and it helps me get a job."*

ID3: "I am part of a drone startup and we took part here to get recognized and to promote our startup."

Besides, I also found a noticeable share of **intrinsically motivated** users here: they enjoy challenging themselves and being part of the community. This indicates a strong **self-efficacy**, and a strong **sense of community**:

ID6: "It's a great place to test your level of creative thinking ability, to get feedback on what you design, and eventually see how in an ideal world (no fear of stealing ideas, money in exchange for them) many minds together can contribute to a better final result and ultimately to a better world.

I also participate with the hope I may win, but this is not the main reason. The main gain is the comparison with others, the exchange of ideas and the evolution of a product as a result of this interaction. I think this kind of competition is very tempting for those not directly involved in the contest field (designing aircraft for example in our case). A designer like me would not have had the chance to get involved in this if it was not this contest, where you can have strange ideas without someone laughing at you, it's a platform for trying things as crazy as possible."

The most fascinating aspect about this user type was the presumably stark cooperative orientation which I derived in study 2. What I can say is that users in this cluster broadly agreed upon the **vital role of (mutual) feedback** to improve their designs:

ID8: "The more feedback I get, the better my design will end up usually."

ID2: "Yeah, we had some conversations with some users during the challenge, I think at least one or two that had some similar concepts and we just asked some questions."

Most users were strongly engaged in giving **feedback to other users** and the number and nature of the messages clearly supports this indication for cooperative behavior. Incoming feedback was **reciprocated**:

ID8: "Yeah, I gave feedback, yeah. Definitely. […] I tried to give feedback when something looked really good online. You feel like you're doing it

because you have like a debt to them to do that. You think: Well, they've spent time looking at mine, maybe I should look at his."

Interestingly, some users gave feedback to only certain users (**selective feedback**). Two reasons stood out here: limited time and strong ties to certain users:

ID3: "I commented a lot. At the beginning there were only few projects online, but at some point, there were to many. There were like 400 projects and I could not give feedback to all of them."

ID9: "I'm always open to feedback and just based on previous comments of the challenges, I corresponded with a couple dozen users over the years. It was probably 6 or 7 that I regularly correspond with, that we all see each other's projects and then make a point to comment."

What we can observe here is cooperation for the mutual benefit, not altruism. Even highly skilled users are reliant on feedback from other proficient peers or are looking for help in a certain area. Once they received feedback, they react likewise at least as an act of courtesy.

Besides feedback activities, the submission behavior is another sign of cooperative orientation of a user. I made two noticeable observations: First, experienced users know about the relevance of feedback for the quality of their concept and thus they must release their work early which they did. Second, new community members also uploaded their project documentation early, the reason for this was quite different though. They followed an IP protection strategy in the form of a **defensive publication** (if I release a certain technical configuration first, it is me who has to receive credit for it). It took some time until they learned about the cooperative community culture:

ID2: "In the beginning there were some concerns like: Maybe someone will look at your idea or take your idea. Or you don't exactly understand the terms and conditions of the organizers side: If you upload a similar idea, when it's okay or when it is not accepted. So, it was not so clear when you need to make your entry. But it went along, we understand that most of the entries have a lot of similarities and then you understand that stealing the concept is not

something that happened and even harder to prove when somebody does it, then the concern is a little bit like there were less concerns."

Interestingly, experienced users even released their ideas early despite knowing that other people might make use of their ideas which in fact happens now and then:

ID8: "It's not fully collaborative, that's always the problem with the challenge in a sense that not everyone wants to show everything, I'm quite open with my designs but a lot of the time I've seen my designs come back, you know, someone would steel something or if by intention, or not, of the risk is to show something too soon, someone may copy it. […] If I see someone just pop out of the blue. The weird thing is, when they don't collaborate, and they hand up a design the last day and it's brilliant and you go: With all the ideas from here how did he get there? I don't know, and you become very skeptical, you know. That's the worst thing."

7.5.3.3 Discussion

The interviews helped us to better understand the users of this cluster. Due to a high skill level and strong need to achieve they can deliver exceptional innovative input to a challenge. In addition, they utilize feedback mechanisms to enhance their entries even more. Regarding cooperative orientation, we learned that motives play a crucial role here: What users of this cluster have in common, is the fact that they are not primarily interested in the prize (money). Rather, they are interested in public recognition for one of their entrepreneurial projects or their capabilities as a freelancer.

Others wanted to further develop their skills or just enjoy being part of this vibrant community and jointly creating value (sense of community). As winning was not the primary objective, but the process of participation and the outcome of it (better skills, co-creation experience, enhanced reputation) was more important to them, there is no reason to be competitive. While experienced users of the community know about this fact (and thus they do not take themselves too seriously), new users first need to get accustomed to the cooperative community culture.

Innovativeness: High

Cooperative orientation: High

7.5.3.4 Implications

- Provide opportunities to learn and to receive recognition
- Provide feedback enabling features and incentives: Early release, messaging
- Foster feedback with proactive community management
- Bind users with special roles/responsibilities
- Analyze messaging behavior to identify users of this kind very early
- Advertise according to the motives

7.5.4 Cluster 4: Movers & Shakers

Like users of cluster 3, study 2 revealed that users of this cluster are quite communicative too, even if it seems like they were rather reactive. The skill level appears to be high which makes this cluster quite as promising as cluster 3.

Open questions relate to the reactive communication behavior. Why is it that users kindly respond, but not actively seek out for social interaction? How can we facilitate more proactive interaction including feedback? It is also worth studying potential differences between cluster 3 and 4 to further strengthen our understanding of distinct user types.

Analyzing the interviews of cluster 4 users led to results as follows:

7.5.4.1 Distinct characteristics

- **Skill set:** medium to high
- **Employment/Job status:** mostly students, some entrepreneurs/ freelancers
- **Co-creation experience:** more new-to-field users
- **Motivation:** exposure and reputation, signaling, some learning
- **Communication:** selective feedback, rather reactive and reluctant
- **Submission behavior:** defensive publication

7.5.4.2 Description

I found many similarities between users of cluster 3 and 4. Just like in cluster 3, users were highly skilled. Again, I could identify two subgroups**: new-to-the-field engineers** and **experienced community members** with a professional background in **industrial design**.

In the first group, I interviewed mainly excellent engineering students with a special background or focus on the technological realm of the challenge. They know about their skills and value for future employers. They thus wanted to take the opportunity to increase their **reputation**, **show off** what they can publicly and **signal to Airbus** or other companies in the field:

> *ID7: "I thought I had many chances of winning and also being able to shape the future of drones. I was really excited that Airbus was finally willing to get inside the drone-sector, the semi-drone sector, and I was willing to have my design at least, maybe not winning but posted and have a lot of reputation. Very good for my curriculum and to my colleagues and increasing the opportunities to be hired by either Airbus or other companies, other UAV companies."*

> *ID10: "It is the promotion, so if I can see my design on one of the promotion that would be perfect, but I didn't win. The setting itself, that is going on the feedback you can get, even if you didn't win, there is some feedback that makes you better."*

> *ID4: „I used the challenge to boost my profile in the field of UAV."*

The community-experienced designers in this group reported of different kinds of entrepreneurial activities in the area of industrial design they were engaged in e.g., freelancing:

> *ID5: "I divide my time between marketing for the company that I run and working on autonomous activities with regards to vehicles and conceptual design."*

For them, **improving** their **skills** in this (to them new) field was a major driver for participation. Once again, it was interesting to see that the prospect of a direct monetary compensation is not the reason why these users participated:

> *ID5: "I mean, if you did the mathematical equation of what one gets paid per hour to work as a designer and the hours that get put into the winning project, it's really not that significant of an amount in terms of the price money. And the unfortunate thing is that you end up giving it half away on behalf on the taxes anyway. So, it's not why we do it. The contest is more for recognition but for me it was more for the learning and you know it's sometimes hard to get motivated unless you're in a competition. So, what you get is a competitive aspect that pushes you harder than when you are working on your own. So, I think that's valuable."*

> *ID33: "I wanted to show what I can. And also, back then I had time to work on the project. I wanted to keep my skills updated."*

> *ID22: "I wasn't looking for a job at this time, not in the aerodynamics field. I just saw the opportunity to learn, that's all."*

Both groups obviously had a **strong need to achieve** and **high level of self-efficacy**. To this point, there is no big difference between cluster 3 and 4 except for the fact that the share of new-to-the-field users was higher. This might actually explain why these users were rather shy and reactive. They were new to the community and first needed to get comfortable.

The interaction behavior supports this assumption. While the old users were broadly engaged in feedback activities, new users sparsely invested their time for this. Even more, they carefully considered any engagement with a certain user based on the potential value of mutual feedback in exchange (**selective feedback**):

> *ID4: „I think experts in the field who are at the same level [of proficiency] can benefit from exchange and cooperation here. However, if those users interact with other users with lower skills [e.g. explaining things] there is hardly any benefit to them. I sparingly gave feedback, usually on entries where I knew it was worth it."*

> *ID33: "You could easily see who an expert in the field is and who is not. I followed some of those experts and tried to get feedback of those who are capable to give me constructive suggestions for my concept."*

It is also noteworthy that users of the same proficiency level (especially within cluster 3 and 4) helped each other. More precisely, engineers helped designers with aerodynamics and vice versa, designers supported engineers with suggestions for a powerful presentation:

> *ID5: "But they [engineers] helped me a lot, so it's an example of true collaboration […] being able to combine that with what they know and willing to share with me just on the fundamentals of getting something to fly, there's no way that I could have participated without their help […]."*

Submission behavior was similar to other new-to-the-field users beyond cluster affiliation. Users regard their contribution to be very valuable and thus they want to protect it. However, they also need to mark the field with their ideas and thus they also submitted sketches and drafts early (**defensive publication**) to claim ownership to a certain technological setup:

> *ID4: „I uploaded my ideas in the form of early sketches quite early. I thought: the idea belongs to the person who uploads it first. And then no one else may take it."*

> *ID33: „It was a dilemma: you don't want to reveal your idea too early so that other people won't take it. But at the same time, I realized quickly that you have to release your ideas early to claim ownership if someone comes up with the same idea."*

7.5.4.3 Discussion

We find many similarities between users of cluster 3 and 4. The rather reactive and reluctant communication behavior, which was reported by users of this cluster, can be attributed to the lack of co-creation experience in general and the cooperative community culture at work here. In addition, these users are well aware of their capabilities and the fact that other (less proficient) users can benefit more from mutual exchange. They thus quite carefully select whom they want to

interact with. While on paper these users appear to be cooperative, it is rather the necessity to protect their IP that drives them to release their work early.

Still, high skill sets in combination with a strong feedback engagement, even if rather selective or responsive, makes users of this cluster just as valuable to have in a contest community as users of cluster 3. With superior quality concepts which they release early, these users are able to attract and inspire other users.

Innovativeness: high

Cooperative orientation: medium

7.5.4.4 Implications

- Foster feedback with proactive community management
- Develop and prominently display community/challenge rules ("code of conduct")
- Provide mentoring/matching service with senior users
- Analyze messaging behavior to identify users of this kind very early

7.6 Preliminary conclusion

While the methodological approach of study 2 was appropriate to identify user types and describe their behavior broadly, it was not possible to understand why users behave the way they do. In contrast, interviewing representatives of each cluster – which in fact was done for the first time in this research field – helped the shed light on these open issues.

Lurkers & Quiets (cluster 1) were found to be quiet for a reason. While some users indeed participated to win the prize and thus acted in a rather competitive manner, others were reluctant because they did not feel entitled to engage in discussions due to their low skill level or because of their status as new members of the community. Despite a comparably low level of innovativeness, these users still deserve further attention by community management due to the sheer size of this group. More than 80 % of users could be found here. Activating only a small fraction of these would greatly benefit the overall quality of entries in a challenge.

Coys (cluster 2) are even more interesting from a community management perspective. We find here highly enthusiastic learners and students who want to signal their capabilities to potential future employers. These users should be closely monitored and supported in every possible way. There is a high chance to build up a strong relationship to those users if they perceive their participation to be a valuable learning experience. The quality of their entries could improve over time which then would make them valuable from an innovation seeker's perspective, too.

Stars (cluster 3) and *Movers & Shakers* (cluster 4) are key users of the challenge community. With a high skill level and in combination with a strong need to achieve they produce very innovative input. Beyond, these lead solvers are highly active collaborators who engage in commenting and feedback activities. I will focus on these two user groups in part 2 of the analysis. Another surprising fact is that most users are not primarily driven by the prospect of winning the prize (money). Either because they think that their chance is very low anyways or because they participate for other reasons. Challenging oneself, enjoying to jointly tackle a challenge, going through the experience, improving skills, or gaining visibility for own entrepreneurial projects are just some of those. Still, a (high) prize money seems to be important to attract people. It at least indicates relevance of a problem and the need of the seeking organization to solve it.

Beyond cluster affiliation, I found prior co-creation experience to be an important determinant for cooperative behavior, e.g., early submission and feedback activities. Users that were new-to-the-community or new-to-the-field of co-creation did not know about cooperative processes in the community and thus were rather passive in the beginning. I also found IP protection strategies at work. In the course of the challenge, they realized that knowledge exchange and openness is part of the community culture. It is very important thus to proactively communicate the values and norms of the community, especially to new members. A mentoring system would be another way how new users could be guided in the early phase of community affiliation.

Interestingly, the preliminary assessment of the criteria *cooperative behavior* and *innovativeness* of a user type (study 2) was mainly supported by the interview study (see also Table 23). Applying social network and cluster analysis in combination with text mining and analysis thus represents a suitable set of means to identify certain types of users in situ.

Table 23. Overview integrated user typology

	Cluster 1: Lurkers & Quiets	**Cluster 2: Coys**	**Cluster 3: Stars**	**Cluster 4: Movers & Shakers**
Skill set	mixed, comparably low	mixed, comparably low	medium to high (engineers from the field and very proficient industrial designers)	medium to high
Employment/ Job status	many full-time employees	mostly students who want to signal for a job	mostly employed people who also have side projects/activities (startup, freelancing)	mostly students, some entrepreneurs/ freelancers
Co-creation experience	mostly new members of the community; Many new-to-the-field entrepreneurs	mostly new-to-the-field users	experienced in community and new-to-community users	more new-to-field users
Motivation	strong extrinsic motives, reward seeking in particular	engaged and enthusiastic learners	challenge oneself, enjoy the community, skill improvement, promoting entrepreneurial projects or display freelancing capabilities	exposure and reputation, signaling, some learning
Communication	hardly outwards communication	reactive socializing and courtesy	strong engagement in feedback activities	selective feedback, rather reactive and reluctant
Submission behavior	new users late, experienced users early	early release of ideas for feedback	early (for feedback and defensive publication)	defensive publication
Cooperative orientation	Low	Low	High	Medium
Innovativeness	Low	Medium	High	High

7.7 Findings: (Grounded) lead solver theory building

Comparing lead solvers with users from other groups enabled us to gain a good understanding of lead solverness in the form of descriptive notions.

To postulate a (grounded) lead solver theory, however, the concepts and categories described above have to be integrated into a dynamic model and related to theoretical themes and dimensions. Furthermore, relationships between the latter elements must be elaborated in order to fully grasp the concept and be able to derive research hypotheses.

I thus rerun the data analysis procedure with a special focus on the interviews with users of cluster 3 (*Stars*) and 4 (*Movers & Shakers*) and with reference to the theoretical concepts in the form of the lead user framework.

Once again, the phenomenon of lead solverness is that even in a competitive setting, users behave in a cooperative manner. In addition, lead solvers can deliver highly innovative input. This user type is thus a very valuable resource in a contest community. The goal of the lead solver concept is to understand those users and their behavior.

7.7.1 Data structure

Coming from rather descriptive categories in the initial coding and analysis phase, I now took into account theoretical themes and interrelated them with in vivo codes derived from quotations of lead solvers.

These themes were then subsumed towards more abstract dimensions (see Figure 56 for final data structure). *Innovativeness level* basically describes why lead solvers are as innovative as they are. *Cooperative orientation* adds the individual collaborative predisposition which then leads to certain cooperative behavioral patterns (*cooperative behavior).*

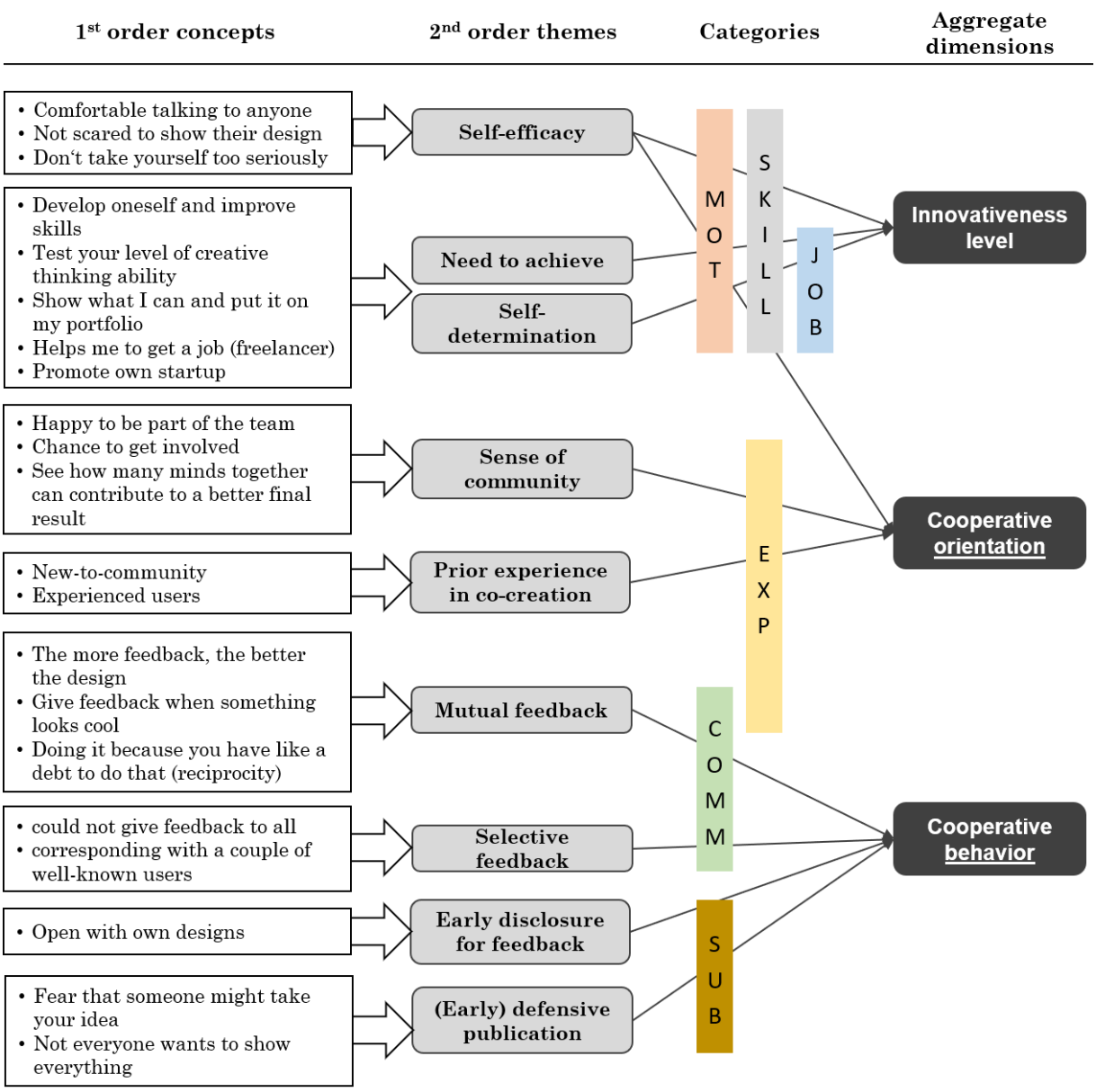


Figure 56. Data structure of lead solver concept

7.7.2 Lead solver model

While the data structure gives us a good but static representation of the lead solver phenomenon, the goal of the *lead solver model* is to set the themes and dimensions in motion and describe the dynamic relationships between them (Figure 57).

Cooperative orientation and *innovativeness* refer to the initial situation before the contest. The cooperative orientation of lead solvers to a large extent can be attributed to prior *co-creation experience*. Lead solvers know that cooperative behavior in particular via mutual feedback can help them to improve their skills and thus the quality of their entries. Furthermore, over time they have developed

a strong *sense of community* and perceive themselves to be part of a team. New members of the community are not aware of this cooperative culture in the beginning and thus rather reactively and selectively share knowledge and interact with other users.

With a high level of *self-efficacy* cultivated by various professional experiences and a strong educational background, lead solvers are open to talk to anyone and exchange ideas as they regard social interaction as a chance to learn and an opportunity to help others grow.

Indirectly, motivational aspects influence the cooperative orientation of lead solvers, too. Lead solvers are aware of the fact that the chance of winning is low, the winner selection process rather random and that the time invested will not be directly remunerated. They thus regard the contest and implicitly the process of co-creation as an opportunity. An opportunity to (jointly) tackle a challenging real-life problem, the chance to interact with an interesting organization and like-minded peers and, for themselves, the possibility to advance their skills, to show what they can, to gain reputation, and to push forward their own projects, e.g., freelancing service, own startup.

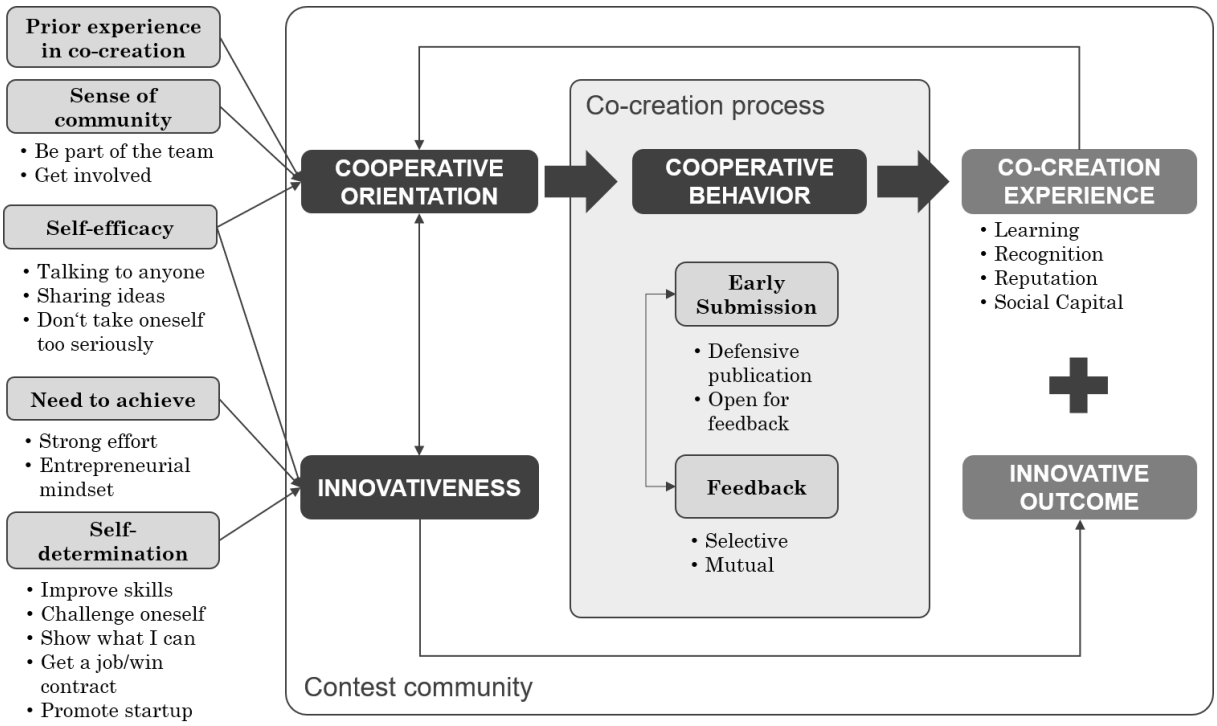


Figure 57. Lead solver model

Lead solvers are capable of delivering exceptional quality in terms of innovative solutions to a contest. In fact, all winners could be found in either cluster 3 or 4. The reasons are manifold: First, they are highly skilled either with technical expertise in the technological realm of the contest and/or with related process knowledge, e.g., in concept development. Second, they know about the power of feedback to improve their designs and thus heavily interact with other users. Third, they are very *self-determined* with a *strong need to achieve*. Lead solvers like to challenge themselves and thus make a strong effort to reach their individual goals. What they have in common is an entrepreneurial mindset. Lead solvers offer freelancing services and/or run their own startup in a related field, sometimes even besides a regular job.

The cooperative orientation results in *cooperative behavior* during the co-creation process. Experienced lead solvers are very open to *feedback* as they know about the mutual benefits derived from it. They thus have no problem to *release their work (early)* as this is the basis for feedback. They perceive themselves to be part of a team and are open to share knowledge and answer questions and thus support other users to improve their own ideas. Still, lead users' time is limited. With their popularity comes a lot of attention by other users. At some point, they have to limit their interactions with other users by carefully selecting whom they talk to. If lead solvers themselves need help or want to get inspired by other lead solvers, this is what they are looking for. Long-term members might also prefer to talk to fellow peers they have known for some time. In fact, many lead solvers reported to regularly engage with certain users. The least that they can do, however, is to react by courtesy and comment on other users' entries in return.

A special case can be observed with rather unexperienced users who are more reluctant and reactive in the beginning. They also release their work early, however, the reason is more to defensively publish an idea or a certain technical setup and thus to mark the field. In the course of the contest, they realize that the community culture is more cooperative. A major difference between lead solvers and other users is that by going through the co-creation process they gain additional benefits. By releasing their work early, they receive feedback and thus learn and improve their skills. Also, they get public recognition and can enhance

their reputation. In fact, many interviewees among the lead solvers reported that they were addressed by firms from related industries during and after the contest. One lead solver got a job offer by the contest host, another one from the sponsoring firm.

Finally, they build up social capital by networking within the community. Even if lead solvers do not win a prize, they still take away something. To summarize, lead solvers like to compete with themselves and to cooperate with others for the mutual benefit.

7.8 Conclusion

A detailed analysis of textual data derived from the interviews with users in cluster 3 and 4 made it possible to build a data structure and a (grounded theory) model with a special focus on lead solvers.

The lead solver model helps us to understand this type of user. For the first time, distinct user characteristics and behavioral traits could be identified and explained on the basis of individual insights from the users themselves. A major finding is that (experienced) lead solvers besides a high level of innovativeness have in common that they (know how to) fully utilize the process of co-creation for the mutual benefit. By cooperating with other users, they improve their own innovativeness over time via feedback. At the same time, they support and inspire others and thus raise the level of quality in the community overall.

Part V: Integration of findings

Chapter 8

Discussion of findings

8.1 Summary of findings

The goal of this research was to further explore hybrid contest communities as a promising and popular means for innovation seeking and problem solving outside a firm's domain. I was particularly interested in users and distinct user roles that were found to be present in different types of online communities. While social network analysis and netnography enabled us to identify different types of users (based on the publicly traceable behavior), the latter methods did not allow us to understand them. Only a qualitative approach would reveal those insights.

In this setup, a very interesting and usually very small user group could regularly be observed by scholars, which I call *lead solvers*. Lead solvers are users who are very innovative and at the same time very cooperative in terms of their behavior in a contest. As these users have a strong influence on both the innovative outcome and the culture of a contest community, I wanted to find out who those users are, why they behave the way they do, what they have in common and how one could find them (see also Table 24).

Table 24. Main research questions

Research Questions	
RQ1:	*How to identify lead solvers in a contest community?*
RQ2:	*Why do lead solvers behave cooperatively?*
RQ3:	*What are distinct characteristics and behavioral traits of lead solvers?*

I started off with (pre-)study 1 to make myself familiar with the community under study and to check whether differences in behavioral patterns could be observed and thus this context would be suitable to research the phenomenon at hand. The survey revealed that challenge participants are very heterogenous with major differences in motivation, skill set, and behavior during the challenge. Interestingly, a large number of users acted cooperatively (early submission, commenting and feedback) despite the competitive setting of the contest. The context hence was found useful for further research on user roles and lead solverness, in particular.

The main objective of study 2 was to identify different user roles based on the individual communication and submission patterns during the challenge. I used a mix of both quantitative (social network and cluster analysis) and qualitative methods (content analysis) and found 4 distinct user roles (for details, see Table 26). In line with prior research, I identified a rather small group of highly interconnected and active users in the center of the network and a large periphery with passive users. The role characteristics were quite similar to other research contexts as well, e.g., *Lurkers & Quiets* (cluster 1) as a large group of passive and undedicated users. In cluster 2 (*Coys*), I found users who are rather reluctant, too. However, they at least managed to submit valid entries and received some attention by other users.

Finally, there are the key users of the challenge, split into *Stars* (cluster 3) and *Movers & Shakers* (cluster 4). Both groups were able to submit highly innovative concepts. In fact, all the winners could be found here. They differ regarding their cooperative behavior which is also related to co-creation experience. *Stars* are more open towards cooperation with more outwards communication. Still, I regard users of both clusters to be lead solvers in the context of the research framework.

Interestingly, study 2 revealed a correlation between innovativeness and cooperative orientation in line with the lead user framework and in line with Bullinger et al. (2010). A general trend could be described as follows: the more cooperative a user was (in terms of messages sent to other users), the higher was the quality of the entry. Regarding *RQ1*, study 2 revealed that the methodological

approach is suitable to identify lead solvers even in an early phase of a contest by analyzing the communication behavior.

In study 3, I applied a qualitative approach via semi-structured interviews with representatives of each cluster to understand why lead solvers (in comparison to other users) behave the way they do. This was the first research study to take on a user's perspective in the realm of contest communities. Grounded theory analysis was run along the Gioia methodology (2013).

Table 25 illustrates an integrated user typology with results from all studies.

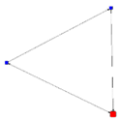
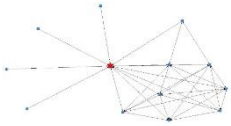
With regard to *RQ2*, I found that lead solvers are cooperatively oriented and act upon mostly because of prior *co-creation experience*, a strong *sense of community* and a high level of *self-efficacy*. In addition, they know about the power of *mutual feedback* which also helps them to improve their own designs. To receive feedback, they first need to release their work early which is another sign of cooperation.

Complementary aspects (with regard to *RQ3)* include *motivation* (lead solvers are not primarily driven by the prize money, but rather by a personal use-value), *self-determination* (lead solvers are constantly challenging themselves and want to show what they can) and a *strong need to achieve* due to own projects that they want to push forward by means of participation (e.g., publicity and recognition for own startup or freelancing capabilities).

As the research field at hand is still in a nascent state, a secondary objective of this study was to formulate research propositions that in future research could be converted into testable hypotheses to validate the lead solver model in other contexts.

The model was built abductively on the basis of interview data and the lead solver framework (via preliminary research propositions) in mind. The final step of a grounded theory articulation is to compare findings with literature and refine the model/theory. This embedding in literature is crucial for generalizing statements of this theory. The initial set of research propositions thus now has to be tested against the results of study 3.

Table 25. Overall user typology

	Cluster 1: Lurkers & Quiets	**Cluster 2: Coys**	**Cluster 3: Stars**	**Cluster 4: Movers & Shakers**
No. of users	442 (82.5 %)	68 (12.7 %)	6 (1.1 %)	20 (3.7 %)
In-degree	1.1	9.7	34.8	25.3
Out-degree	1.2	6.1	77.3	23.5
No. of entries	0.3	1.2	1.2	2.4
Idea Quality	2.46	2.82	3.04	2.92
Betweenness	32.7	1,103.6	15,282.4	6,282.3
Communication characteristics	Passive Supportive Asking questions Give feedback	Reactive Thanking Reaction to feedback	Cooperative Supportive Offer help Ask for feedback Give feedback	Reactive Thanking Reaction to feedback
Representative ego network				
Skill set	mixed, comparably low	mixed, comparably low	medium to high (engineers from the field and proficient ind. designers)	medium to high
Employment/ Job status	many full-time employees	mostly students who want to signal for a job	employed people who also have side projects/activities (startup, freelancing)	mostly students, some entrepreneurs/ freelancers
Co-creation experience	mostly new members of the community; Many new-to-the-field entrepreneurs	mostly new-to-the-field users	experienced in community and new-to-community users	more new-to-field users
Motivation	strong extrinsic motives, reward seeking in particular	engaged and enthusiastic learners	challenge oneself, enjoy the community, skill improvement, promoting entrepreneurial projects or display freelancing capabilities	exposure and reputation, signaling, some learning
Communication	hardly outwards communication	reactive socializing and courtesy	strong engagement in feedback activities	selective feedback, rather reactive and reluctant
Submission behavior	new users late, experienced users early	early release of ideas for feedback	early (for feedback and defensive publication)	defensive publication
Cooperative orientation	Low	Low	High	Medium
Innovativeness	Low	Medium	High	High

In the following, each research proposition will be critically discussed and checked upon validity. In case of disagreement, a proposition will be reformulated.

Dimension: Innovativeness

- *P1.1 Lead solvers are rather intrinsically motivated.*

  Result: Refine

  Explanation: Intrinsic motivation plays an important role and seems to be inherently present with most lead solvers. Otherwise, they would not engage in a social online community with a subject that matters to them. However, we have to keep in mind that many lead solvers are freelancers and entrepreneurs (some even besides a regular job). Thus, there is always prospect of use-value (either through learning or public recognition/reputation) involved. Theses motives however are not detrimental for cooperation.

  Refined proposition:

  P1.1n Lead solvers are primarily driven by the prospect of an individual use-value.

- *P1.2 Lead solvers show a high level of autonomy and self-determination.*

  Result: Support

  Explanation: Lead solvers are highly qualified users who are usually engaged in different entrepreneurial or freelancing activities, sometimes even besides a regular job. Thus, they have a strong internal locus of control and like to constantly challenge themselves by exploring new fields and trying out new things whenever they see an opportunity.

- *P1.3 Lead solvers are familiar with the respective domain in terms of technical expertise or experience.*

  Result: Refine

  Explanation: I found two sorts of lead solvers: subject matter experts and process experts. The first group was attracted by the challenge as it covered their field of interest and expertise (in this case drones); the second group stood

out due to extensive process-related knowledge (e.g., concept development and design), so they could easily adapt to the technological area at hand. Interestingly, both groups can complement each other which was reported. It is worth considering expertise and experience in a broader sense regarding lead solverness.

Refined proposition:

P1.3n Lead solvers are familiar with the respective domain in terms of technical expertise and/or have extensive innovation process-related experience from related fields.

- *P1.4 Lead solvers enjoy sharing knowledge and exchanging ideas.*

Result: Refine

Explanation: While some lead solvers indeed enjoy sharing knowledge and exchanging ideas (strong sense of community), others cooperate more for the sake of reciprocity. Lead users generally are aware of the fact that their designs can always be improved by means of feedback. A user can only receive feedback and subsequently improve a submission, however, if another person can actually review the design, thus he or she has to reveal it.

Furthermore, other users will only support me in expectation of my feedback for their ideas in return. Cooperative behavior here can be described as mutual (tit for tat) rather than altruistic.

I also found that some lead solvers carefully select whom they interact with (can the other person help me improve my design?). They do not necessarily exchange ideas with anyone. At least, they react on requests made or answer questions asked by other (less proficient) users.

Defensive publication (=early disclosure) was also reported. Here too revealing served a purpose. Still, I could observe that the latter behavioral trait fades away with increasing community affiliation. Selective feedback on the other hand increases with an unmanageable number of requests.

Refined proposition:

P1.4n Lead solvers share knowledge and exchange ideas because they know that cooperative behavior will be beneficial to the quality of their own design.

- *P1.5 Lead solvers make strong effort compared to regular users.*

  Result: Support

  Explanation: To a large extent, lead solvers are driven by the prospect of skill or symbolic use-value through the process of participation which they want to employ in personal professional activities, e.g., freelancing services or entrepreneurial projects. They are thus more engaged than other users.

- *P1.6 Lead solvers show a high level of self-efficacy.*

  Result: Support

  Explanation: Self-efficacy is closely related to self-determination (see also *P1.2*) in the sense that both concepts regard humans as agents of their own actions. While self-determination and autonomy in particular mean that I perceive myself to be in charge of my actions and behavior, self-efficacy is what drives me to reach a certain goal. In the same way, lead solvers feel capable to successfully participate in a challenge due to a high level of expertise and/or professional experience. Furthermore, they feel confident and competent and act upon, e.g., by giving feedback to other users or sharing knowledge.

- *P1.7 Lead solvers have a strong need to achieve.*

  Result: Support

  Explanation: Lead solvers have a strong need to achieve either to push their own projects, to advance their skills or to find new clients for their consulting and design services. It is noteworthy that it is not necessarily the need to win the challenge (see also *P1.5*).

Dimension: Cooperative orientation

- *P2.1 Lead solvers accumulate more social capital than regular users.*

  Result: Support

Explanation: Far more than average users, lead solvers engage heavily in social interactions with other users, e.g., by proactively giving feedback, exchanging ideas or answering questions. With a high betweenness centrality, they hold important bridging positions that interconnect many other users and thus they serve a vital function in the contest community. The large number of interconnections to other users is also an indication for a high level of social capital those users are able to accrue.

- *P2.2 Lead solvers are heavily engaged in commenting activities.*

  Result: Support

  Explanation: Lead solvers are strong communicators. They talk to many different users and generally in a very positive and supportive manner.

- *P2.3 Lead solvers proactively give feedback to other users.*

  Result: Refine

  Explanation: Depending on prior co-creation experience, lead users engage more or less in feedback activities. While unexperienced users are rather reluctant with feedback in the beginning, long-term members know about the value of mutual feedback and thus proactively comment on other users' ideas to receive reactions on their concepts in return. Even in a competitive setting, they behave cooperatively.

  Refined proposition:

  P2.3n Depending on the level co-creation experience, lead solvers engage more or less in feedback activities.

- *P2.4 Lead solvers possess boundary spanner characteristics.*

  Result: Support

  Explanation: From a social network perspective, lead solvers are critical nodes within the challenge community. With a large number of connections and a high betweenness centrality, they can be regarded as bridges between users. They are thus in a position of power to span boundaries between users and user groups within the community. Some lead solvers even reported activities in

other co-creation communities. Hence, they are potential boundary spanner across communities, too.

- *P2.5 For lead solvers, winning is not the major driver for participation.*

  Result: Support

  Explanation: Winning the challenge plays only a minor role, if at all. For most lead solvers, the process of participation itself and a use-value derived from it, is far more important. They know that the chance of winning is rather small. In fact, too small to justify hours and days of work. However, the time invested is not lost, if you can learn something or gain visibility to expose your capabilities.

The refined lead solver framework is presented in Table 26:

Table 26. Summary of research results

Dimension: Innovativeness		
~~P1.1~~ *P1.1n*	*~~Lead solvers are rather intrinsically motivated.~~* *Lead solvers are primarily driven by the prospect of an individual use-value.*	**R**
P1.2	*Lead solvers show a high level of autonomy and self-determination.*	✓
~~P1.3~~ *P1.3n*	*~~Lead solvers are familiar with the respective domain in terms of technical expertise or experience.~~* *Lead solvers are familiar with the respective domain in terms of technical expertise and/or have extensive innovation process-related experience from related fields.*	**R**
~~P1.4~~ *P1.4n*	*~~Lead solvers enjoy sharing knowledge and exchanging ideas.~~* *Lead solvers share knowledge and exchange ideas because they know that cooperative behavior will be beneficial to the quality of their own design.*	**R**
P1.5	*Lead solvers make strong effort compared to regular users.*	✓
P1.6	*Lead solvers show a high level of self-efficacy.*	✓
P1.7	*Lead solvers have a strong need to achieve.*	✓
Dimension: Cooperative orientation		
P2.1	*Lead solvers accumulate more social capital than regular users.*	✓
P2.2	*Lead solvers are heavily engaged in commenting activities.*	✓
~~P2.3~~ *P2.3n*	*~~Lead solvers proactively give feedback to other users.~~* *Depending on the level co-creation experience, lead solvers engage more or less in feedback activities.*	**R**
P2.4	*Lead solvers possess boundary spanner characteristics.*	✓
P2.5	*For lead solvers, winning is not the major driver for participation*	✓

To sum up, contest communities are a promising means for firms to engage with a community of external actors and co-create value for the mutual benefit. The contest configuration spurs innovation with a specific problem and within a short period of time. The contest is embedded in a community of like-minded peers who enjoy collaborating with the seeking and host organizations.

Little was known about those solvers so far. While research to this point was able to cover behavioral patterns of users and to identify user groups in a community, there was a clear lack of understanding those users. This is critical though to design and manage a community properly.

The emergence of lead solvers is of particular interest here as those users are innovative and cooperative at the same time. They thus contribute massively to the long-term success of an innovation community.

My research led to the development of the *lead solver model* which helps us to understand those users. A refined *lead solver framework* delivers research propositions that set a promising basis for further research in other contexts.

The key take-aways are as follows:

- Lead solvers are a small group of highly active communicators; thus, they can be easily identified by means of social network analysis.
- They cooperate with other users because they have a strong sense of community and are experienced in co-creation practices. They thus know about the power of mutual feedback which they fully utilize to improve their own skills and concepts.
- Lead solvers are more innovative than other users because they have a proficient skill set to solve the problem at hand, a high level of self-efficacy and a strong need to achieve (personal use-value through participation such as learning, public recognition, or reputation).
- They embrace a contest as an opportunity to challenge themselves, to push forward their own projects (e.g., startup or freelancing services), but also to jointly tackle an innovation problem.
- Lead solvers like to compete with themselves and at the same time enjoy cooperating with others for the mutual benefit.

8.2 Scope of generalization and limitations

Of course, this research has limitations that shall be addressed. I want to focus on two major aspects: generalizability and scientific rigor.

First, a shortcoming is the focus one context only (single case with one contest in one community) and with it a limited generalizability. However, I intentionally chose a single case setting which I researched with multiple (both quantitative and qualitative) methods and thus from different angles. This approach improves the validity of results overall (Jick, 1979) and is suitable in a scientific field that is rather nascent as is gives the researcher the opportunity to gain rich and in-depth insights and thus supports theory building (Eisenhardt & Graebner, 2007). In addition, I used a theoretical framework that was rooted in related fields and attached my results to previous studies wherever suitable. In study 2, for example, I made use of a methodological approach that was found to be useful in other research contexts (e.g., similar user roles were found in other contest communities). There is thus a high chance that the lead solver model to a certain extent is transferable to other contexts beyond the specific setting, scope, and technological focus of the community under study.

Finally, I elaborated research propositions from related fields of literature and refined them in accordance with the lead solver model. Follow-up studies can thus easily test the model.

Regarding scientific rigor, I relied on an established methodology (with both quantitative and qualitative methods) wherever possible (study 2) to replicate results from related studies. In the qualitative study 3, I chose the Gioia methodology (Gioia et al., 2013) as it provides a systematic approach to inductive concept development on the basis of qualitative data with a strong focus on scientific rigor without stifling a creative interpretation by the researcher. In addition, I made extensive use of quotations from the interviews which strengthens the internal validity of the (grounded theory) model. The interview data itself on which the model is based is prone to different biases from both sides, the interviewer (e.g., confirmation bias) and the interviewee (e.g., social desirability). I addressed those issues by working with an interview guide that was reviewed by

other researchers. Furthermore, I could reduce potential biases on the interviewees' side by talking to different users of the same cluster and by gathering data from all clusters for constant comparison.

Another more general shortcoming that I want to touch upon is diversity. While I was able to interview users from all over the world with different backgrounds, there was no female interviewee in my sample. In fact, only 2 out of 425 participants of the challenge were women (as far as I could tell) and unfortunately, these 2 did not follow my invitation.

With these assertions in mind, I think that my results are at least partially testable, replicable and to a certain extent transferable to other contexts. I thus hope to inspire other researchers with new stimuli.

Chapter 9

Conclusions

9.1 Implications for theory

The results of my research contribute to literature in many ways. Regarding the concept of **innovation-contest communities**, the case under study adds another context to the body of literature beyond consumer-oriented and rather low-tech and one-time approaches studied so far (e.g. jewelry (Füller et al., 2014), LED lights (Hutter et al., 2011)).

What is new is that the community has already existed before the challenge, that we have an intermediary as a contest host between seeker and solvers, and that the task was in a high-tech field (industrial drones) which required a certain skill set for participation. In addition, solvers are not customers, but technology-driven experts in the field who like to spend their time with like-minded peers in technology-related online communities.

Having that in mind, my research revealed that the concept of innovation-contest communities is applicable in such an environment as well to generate innovative input for a seeking organization. While consumer-oriented contexts might also serve marketing and brand reputation purposes, more technologically driven initiatives have a stronger focus on innovation as solvers are no customers, in general. Implicitly though, the latter configuration can support employer branding and recruitment. The focus thus is different.

Still, the mechanisms are alike and so are some of my results indicating a certain degree of generalizability beyond contexts. I found similar network structures, user roles/types and behavioral patterns. What was missing so far, was a better understanding of the participants which would explain differences between groups and thus enable a differentiated user-specific community management.

I found that the most innovative input stems from cooperative lead solvers. They are like user roles/types found in other studies regarding their communication behavior. These users act cooperatively on the basis of prior co-creation experience in this or another community. Related to the experience is a sense of community that was built up over time. They regard themselves to be part of a team with the other users. This aspect is hard to achieve in a newly built community which makes a code of conduct and a thorough community management even more important. Rather protective strategies and reactive behavior of new (lead) solvers in the community (defensive publication, selective feedback) support this assumption.

Beyond co-creation experience, a high level of self-efficacy is another personal trait that helps us to understand why lead solvers are rather open-minded and collaborative. They know about their capabilities and thus are not afraid of sharing knowledge. In addition, lead solvers release their ideas early for mutual benefit. They themselves want to receive feedback and improve their ideas accordingly.

Finally, motivation, self-determination and need to achieve seem to be unique with lead solvers. While a prize might be necessary to attract people, it is not sufficient to motivate lead solvers to participate. For them, additional benefits need to be in reach, e.g., an opportunity to learn, to collaborate with others, to show their capabilities or to gain reputation which is closely related to individual projects they pursue. The prospect of a personal use-value via participation is a major driver explaining why lead solvers make a strong effort resulting in very innovative outcomes.

Besides lead solvers, I also found interesting behavioral patterns and explanations for other user types as well, e.g., rather passive users are quiet for a reason (competitive orientation, perceived lack of skills, new to community).

My results also support the concept of communitition (Hutter et al., 2011) which argues that very innovative users compete (by submitting many and very innovative ideas) and collaborate at the same time. However, the reasons for a certain behavioral pattern and thus structural position in the network are different (see above).

The U-shaped relation between innovativeness and cooperative orientation that Bullinger et al. (2010) found in an experimental setting could not be supported with my results. The researchers argue that innovative users in an innovation-contest community setting are either very competitive or very cooperative. In contrast, my observations reveal that with a higher cooperative orientation comes a higher level of innovativeness. The reasons can be derived from the lead solver model. Lead solvers harness the powerful mechanism of feedback and have a strong need to achieve which besides other user characteristics results in very innovative output. A difference between Bullinger's setting and the case under study is that the community already existed before the contest. This could mean that over time a cooperative community culture can evolve that turn an initial competitive mindset into collaborative behavior. This explanation is supported by my insights into new community members. Even some lead solvers acted rather competitively in the beginning until they got accustomed to the cooperative culture of the community.

The concept of (proactive and reactive) boundary spanning that Bullinger et al. (2010) as well as Dahlander & Frederiksen (2012) found to be crucial for an innovation community, can only partly be supported. I too found that lead solvers hold an important structural position within the community. They thus may be called internal boundary spanners. I did not find evidence though for lead users to span boundaries beyond the community at hand.

Füller et al. (2014) called for further exploration of what constitutes a user role in a contest-community for the purpose of differentiation. Here, I found several aspects that should be taken into consideration (see also Table 24). Communication and submission behavior are two central indicators to differentiate between users and to identify lead solvers, for example. In addition, prior co-creation experience

(e.g., via membership status), the individual employment situation and, related to it, the motivation for participation are distinguishing characteristics.

To what extent these elements are transferable to a more consumer-oriented context is open though. While the first aspects can be tracked likewise beyond contexts, the employment situation (freelancing designers and engineers) seems to be rather case-specific. Still, even in a low-tech and consumer-oriented idea contest, one might find entrepreneurs who are interested in gaining visibility through the open innovation format.

The results of this study also contribute to **contest literature** in general. Regarding motivation, I found that some extrinsic motivational factors (skill or symbolic use value) not necessarily have a detrimental effect on cooperative behavior. Neither does a strong incentive regime in terms of high prize money for only few winning ideas. Given the right features to extract alternative (personal) use-values, users will act in a cooperative manner despite the competitive setting.

While the competitive setting (with prizes and deadlines) might be important to rise attention, set a framework and trigger participation, it is not relevant during the contest where users rather perceive themselves to be part of a team. Users compete with themselves (can I do it?) rather than with each other.

I can also provide evidence supporting the positive effects of entry visibility in a contest (e.g. Wooten & Ulrich, 2013). Many users entered the challenge to learn and get inspiration by other users. Without entry visibility, they would not have had the chance to do that. In addition, entry visibility can also prevent parallel invention in the sense that early disclosure of an idea (like a defensive publication) marks the field for a certain technological setup. A potential increase in diversity regarding the solution space (in a non-visible setting) thus stands against many similar ideas being developed in parallel.

In addition, my study makes another striking case for the power of feedback. In accordance with Wooten & Ulrich (2017), feedback mechanisms (both among peers and with the host/seeking organization) are crucial challenge features to foster collaboration and enable learning experiences and personal growth opportunities.

It strengthens the community culture, sparks interaction between users and thus increases the innovative challenge output overall.

Publicly visible feedback interactions between users can also help us to identify lead solvers as this is one of their signature features. This aspect was not covered by literature yet.

Finally, using a similar terminology requires a word on the difference between the long-standing **lead user concept** and the idea of the lead solver. The major difference is that a lead user himself heavily uses a certain product and thus is an expert in the related field. He is thus a valuable source of innovation for a firm in the sense that he provides innovative ideas facing certain needs early (as a potential customer) himself, solving it and providing the solution to other users of the product or, in the best case, to the firm. (Lüthje & Herstatt, 2004)

On the contrary, lead solvers provide solutions to a seeking company in an industrial context meaning that they will not be a customer of the product or even a user, in general. They are experts in the field, too. However, they are not facing a problem themselves personally, but bring in broad experience and expertise from several professional occasions which they are willing to contribute to solve a bigger problem. The lead solver in general is not a potential customer, but rather a potential employee and at least contractor.

Running an innovation-contest community thus can be a powerful means for recruiting. Employers can assess many important aspects in the realm of innovation and product development, such as the innovativeness, team play, work style, feedback mentality etc. Just as an idea contest in the consumer segment might be a useful means to identify lead users (Brem & Bilgram, 2015), an idea contest in an industrial B2B-context can help to find and address interesting employees or freelancers.

To sum up, I present the new concept of lead solvers that have not been studied in-depth so far. While this kind of solver (very innovative and at the same time cooperative) has been identified in other settings by means of social network analysis before, I contribute to extant literature by adding a users' perspective with insights from the individuals themselves.

9.2 Managerial implications

With an in-depth study on a real contest community, my findings may also be of help for practitioners in the realm of (open) innovation.

For **innovation managers** that consider opening up the innovation funnel to ideas from the outside, the concept of contest communities represents a promising means. The competitive contest setting serves as a framework to initially gather a community and jointly work on a specific problem or topic.

Collaborative features such as feedback and commenting set the basis for community building. The latter are crucial to attract lead solvers. They are not only valuable in terms of innovativeness but might also be interested in working for or cooperate with the organization hosting the community.

Besides sourcing for innovative ideas, sourcing for creative people can thus be a secondary goal for an organization. In the case study at hand, the seeking organization received up to 500 innovative concepts to choose from within a short period of time. The best ideas came from very proficient experts, some even working for other firms in related fields. Besides, several participants were recruited after the initiative by either the seeking organization or the hosting intermediary.

However, building up a community from scratch is not easy. It requires a strategic alignment with the corporate innovation process, sufficient resources for community management, a serious interest in co-creation, and time. Collaborating with an existing community and an intermediary host thus can be a good starting point with a comparably low risk and manageable (financial) invest.

One should keep in mind though that even with an intermediary at place the community wants to interact with the seeking organization, e.g., via feedback. Users will notice if a seeker is serious about co-creation and truly interested in their contributions. They want respect for their effort and be treated on eye level.

Also, we have learned that money cannot buy innovation. Innovative lead solvers are not primarily motivated by the prospect of money. They want to engage with

an organization, be part of a greater whole and enjoy collaborative value creation with like-minded peers.

Regarding **community management** (both by a hosting firm or an intermediary), my research provides recommendations on many levels.

First, collaborative (community) features should be implemented on a contest platform wherever possible. They enable cooperation and communication between users, while at the same time providing community management the possibility to track interactions with automated text mining and analysis which can help to identify different types of users. An adequate methodology was presented in this study. A cooperative contest community culture is also a crucial premise to attract lead solvers.

Next, studying user types and lead solvers in particular revealed that prizes and money are nice to have, but are not decisive factors. To many users, it is more interesting to derive an individual use-value, e.g., a fascinating learning experience, a nice time with like-minded peers, a chance to push forward own projects, a chance to publicly show one's capabilities or signal for a job. These needs have to be addressed with a compelling platform, thorough community management and a diverse incentive regime (e.g., non-cash prizes such as an internship or a project budget).

Interestingly, improving skills and learning was a very important driver among all user groups. Providing topic-specific tutorials and online courses thus should be considered. While users with a low skill set might not be among the most innovative users at first, they could be a valuable community member in the future.

I also learned that users who join a cooperative contest community for the first time, need assistance in terms of getting accustomed to the norms and values of a community, especially when this community competes for a prize within a contest. They rather act competitively as collaborating with foreigners seems counterintuitive at first sight. Prominently displaying the code of conduct and providing mentorship in the beginning are just two approaches that can address these issues.

To sum up, competitive as well as cooperative elements in a co-creation setting such as a contest community are crucial to attract lead solvers. In combination with a broad set of value propositions where users individually can attach themselves to, a vivid and cooperative community culture, and a strong commitment by a seeking organization, there is a high chance to create a synergetic and mutually beneficial collaboration resulting in new and innovative ideas.

9.3 Research outlook

Research on contest communities and its users still is in a nascent state with a lack of a general theoretical understanding. Hence, the goal of my study was to develop a model with a specific focus on lead solvers testable via hypotheses.

For this reason, I studied a contest community setting in-depth and with mixed methods which led to a better understanding of user types in general and the development of the lead solver model in particular. This model is grounded in the data and thus internal validity per se high. Transferability to other contexts, however, is limited. I addressed this methodological weakness by applying multiple methods and by reflecting on extant literature in related fields and on different phases of my research (e.g., research framework, research propositions, discussion of results) and thus reached a certain level of generalizability.

Per definition, the next step thus is to test the lead solver model in other research contexts on the basis of the refined research propositions. Among such contexts could be consumer-oriented and low-tech contest communities or new communities that were set up during an initial contest. The field of social innovation would also be an interesting research setting.

Elaborating on user types in general, I captured a multi-perspective but static view of users in one setting. It would be interesting to find out whether and, if so, how users evolve over time and change roles within an innovation-contest community. Can users be mobilized by community management? Can, for example, a *Coy* become a *Star* (lead solver) and, if so, how does it work? Will innovativeness increase first (by participation and learning) and the collaborative orientation will

follow leading to cooperative behavior? Or is it the other way around (the positive co-creation experience leads to more mutual feedback and this improves innovativeness)? They might also evolve in parallel. Can anyone become a lead solver?

Noteworthy is also the role of co-creation experience of users here, which deserves further attention. I found that this aspect represents an important determinant for lead solverness. How can cooperative behavior and trust be triggered if a user is new to the field? This would avert protective strategies by users and unlock the full potential of co-creation from the beginning.

It would also be interesting to study user behavior in vivo in the sense of tracking communication live during a contest and thus being able to identify certain user roles as early as possible. Users could then be individually addressed with adequate measures by community management.

So, answering those questions is not only interesting from a research perspective, but also vital to practitioners who want to make use of the powerful process of collaborative value creation. I thus hope that my work stimulates further research in this promising field.

Part VI: Appendices

Appendix A

Survey questionnaire (study 1)

- **Q1: What is your gender?**
- **Q2: In what country do you currently reside?**
- **Q3: What is your age?**
- **Q4: What is the highest level of education you have completed?**
    - Less than high school degree
    - High school or equivalent
    - Vocational-technical school
    - Some college but no degree
    - Bachelor's degree
    - Master's degree
    - Doctoral degree
    - Professional degree (MD, JD, etc.)
    - Other
- **Q5: Which of the following categories best describes your employment status?**
    - Employed, working 40 or more hours per week
    - Employed, working 1-39 hours per week
    - Not employed, looking for work
    - Not employed, not looking for work
    - Retired
    - Disabled, not able to work
    - Self-employed
    - Vocational Training
    - Student
    - Other
- **Q6: What is your current yearly gross income?**

- **Q7: Regarding your participation on the Local Motors platform, do you consider yourself a… (check all that apply)**
    - Designer
    - Educator
    - Engineer
    - Entrepreneur
    - Fabricator
    - Hobbyist
    - Inventor
    - Maker
    - Researcher
    - Scientist
    - Student
    - Technician
    - Tinkerer
    - All Other Responses
- **Q8: Have you ever participated in cocreation activities on the Local Motors platform before the Drone Challenge and if so, what did you do?**
    - Submit own entry
    - Comment on others´ entries
    - Discuss in the forums
- **Q9: I participate in co-creation activities to…**
    - enhance my reputation in the
    - community
    - find recognition for my work
    - compete with others
    - solve problems
    - make money
    - improve my skills and learn
    - signal for the job market
    - have fun
- **Q10: Regarding your entry, did you work on your own or with the help of others?**
    - On my own
    - On my own, but with support of other users
    - Team entry

- **Q11: How many hours did you spend on your entry in total?**
  - 1 - 5
  - 6 - 15
  - 16 - 25
  - More than 25 hours
  - Other (please specify)
- **Q12: Regarding your expenditure of time for your entry, to which percentage did you spend it for?**
  - clarification of the task
  - the conceptual design (determine functions and search for solution principles)
  - the embodiment design (develop preliminary layouts and form designs and optimize and complete form designs)
  - the detail design (finalize details, check all documents)
- **Q13: Did you comment on others' entries?**
  - Yes, to give feedback
  - Yes, with suggestions for improvement
  - Yes, for exchange of ideas and inspiration for my own entry
  - No
- **Q14: In your opinion, what are the primary drivers for a company like Airbus to get users like you involved?**
  - Gather new ideas
  - Outsource R&D
  - Improve brand awareness
  - Marketing
  - Search for employees
  - Learn about Crowd
  - Sourcing
- **Q15: How do you rate the transparency of the terms and conditions regarding the intellectual property of your entry?**
  - Very low
  - Low
  - Neither high or low
  - High
  - Very high
- **Q16: Are you likely to continue participating in further co-creation activities on the LM platform?**
  - Yes
  - If not, why?

- **Q17: When did you initially submit your entry?**
  - Early (week 1 - 2) (Apr 12 - Apr 25)
  - Middle (week 3 - 4) (Apr 26 - May 8)
  - Late (week 5 - 6) (May 9 - May 21)
  - Very late (day of submission closing - May 22)
- **Q18: I want my work to be mostly recognized and appreciated by…**
  - the community.
  - Local Motors.
  - Airbus.
- **Q19: What do you prefer as compensation in case you win the challenge?**
  - Cash prize
  - Material prize
  - Job offer
  - Other:
- **Q20: For the community prize, what is most important to you when voting on other entries?**
  - Innovativeness of the concept
  - Design of the concept
  - Functionality of the concept
  - Concept must meet the
  - requirements
  - Cooperativeness of the user
  - Reputation of the user
  - Activity level of the user

Appendix B

Interview guideline (study 3)

- **Introduction:** My research on user roles
- **Personal Background**

  First, I want to get to you know you better. Please tell me a bit more of yourself… e.g.

  - Where do you live?
  - How old are you?
  - What‘s the highest level of education?
  - What is your profession/job?
  - What do you consider yourself? (e.g., engineer, designer, tinkerer)
  - How would your friends describe you as a person? (e.g., open, creative, reserved, outgoing)
  - How would you describe your engineering and design skills? Where did you learn it?
  - How about aviation/drones? (e.g., hobby, job, …)
- **General co-creation experience**
  - When and how did you get in touch with co-creation for the first time? (online communities/challenges/crowdsourcing)?
  - Have you been engaging in other user communities before the drone challenge? If yes, where and what did you do?
  - Why do you engage in those communities?
- **Co-creation experience in the community**
  - Have you been co-creating with Local Motors before? If yes, explain how? (e.g., other challenges, own projects)
  - Did you know other users from the platform before the ACDC? If yes, do you exchange ideas or talk to each other?

- How did you get to know about the ACDC? What attracted you? (e.g., drones, cool community, involvement of Airbus, interesting problem to solve, high prize)
- Why did you decide to participate in the ACDC? Please explain… (e.g., solve problems, learn about industrial design, exchange with peers, win the prize, show Airbus what you can, earn money, bring own idea to life, job signaling, recognition for work)

- **Idea generation**

  Can you explain the process of your participation? What happened after you decided to participate?

  - How did you create your entry? (e.g., Inspiration, Creation, Improvement, Feedback, Upload/Submission)
  - On your own? Did you need or look for help from others?
  - Where did you find inspiration for your entry?
  - Did you ask others for feedback (online/offline)?
  - When did you submit your idea (initially)?
  - Did you continuously work on it (early upload, feedback) or submit it before submission closing?

- **Communication/socializing**

  - Did you regularly visit the platform? What for?
  - After receiving an e-mail or because you wanted to look what was going on?
  - Did you actively comment on other entries or on the forum? Please explain…
  - If not, why? If yes, for what reason? What were the comments about? (e.g., socializing, feedback, looking for help)
  - Did you react to comments on your entry? Please explain…
  - If not, why? If yes, how? (e.g., direct reply, communicate on facebook or other media?)

- **Cooperation/competition**

  What was the atmosphere like in the community during the challenge?

  - Did you feel a sense of collaboration/cooperation/trust? Please explain… (People rather working together than competing for the prize)
  - For you personally, what kind of atmosphere do you prefer? (the best shall win or did you enjoy the experience with other users during the challenge?

- **Post-challenge**
  - What happened to your idea after the challenge? (Nothing, post it in other forums, commercial/license it to other parties?)
  - Are you still active on the LM platform? If yes, what are you doing?
  - If no, can you explain why?
  - Did you make friends during the challenge? Are you still in contact with users you were engaged with? If yes, on the LM platform or somewhere else?
- **Challenge experience**
  - After all, was the ACDC a good experience? Where your expectations met? Did you feel adequately compensated? (experience, fun, learning, money)
  - What did you like most about the challenge? What not at all?
  - Did you experience a special moment (positive/negative) with other users that you still remember?
  - What would you change? What was missing? e.g., prize, evaluation, how-to-videos (CAD), communication, requirements etc.
  - What are your thoughts on co-creating with companies like Local Motors or Airbus? Would you like to see more challenges like this one?

Appendix C

Overview coding scheme (study 3)

ID	CL	EDU	SKILL SET	COCREA EXP	JOB STAT	MOT	INTERACT IN	INTERACT OUT	SUBM	Comment
12	1	ENG	med	new to community	other: stud	ex: symbolic use-value	in: feedback	out: courtesy and socializing	late: fear of stealing	
13	1	DSGN	med	new to community	empl: full-time employed	ex: symbolic use-value	in: feedback	out: no	late: busy	
15	1	DSGN	low	new to community	other: stud	ex: skill use-value	in: no feedback	out: courtesy and socializing	early: open to feedback	
16	1	ENG	med	new to the field	not empl: entrepreneur	ex: reward seeking	in: feedback	out: selective feedback	early: defensive publ.	
21	1	ENG	med	new to the field	not empl: entrepreneur	ex: symbolic use-value	in: no feedback	out: no	late: busy	
23	1	DSGN	high	new to the field	not empl: entrepreneur	ex: symbolic use-value	in: feedback	out: selective feedback	early: defensive publ.	
24	1	DSGN	med	new to community	empl: full-time employed	ex: reward seeking	in: no feedback	out: selective feedback	late: busy	
25	1	ENG	med	experienced in community	empl: full-time employed	ex: reward seeking	in: no feedback	out: courtesy and socializing	early: open to feedback	
26	1	ENG	low	new to the field	other: looking for new opp.	ex: symbolic use-value	in: no feedback	out: courtesy and socializing	early: open to feedback	
27	1	DSGN	med	experienced in community	not empl: freelancer	ex: symbolic use-value	in: feedback	out: helping others	early: open to feedback	
31	1	ENG	low	experienced in community	empl: full-time employed	ex: reward seeking	in: courtesy and socializing	out: courtesy and socializing	late: busy	
34	1	DSGN	med	new to community	not empl: entrepreneur and freelancer	ex: symbolic use-value	in: courtesy and socializing	out: courtesy and socializing	late: busy	
37	1	DSGN	med	experienced in community	empl: full-time employed	ex: symbolic use-value	in: no feedback	out: no	early: open to feedback	
38	1	ENG	low	new to community	other: stud	ex: symbolic use-value	in: feedback	out: no	late: busy	
19	1	ENG	high	new to the field	empl: full-time employed	ex: reward seeking	in: courtesy and socializing	out: courtesy and socializing	early: open to feedback	
18	2	ENG	med	new to the field	other: stud	ex: symbolic use-value	in: feedback	out: courtesy and socializing	early: open to feedback	
17	2	ENG	med	new to community	other: stud	ex: symbolic use-value	in: feedback	out: selective feedback	early: open to feedback	
1	2	ENG	med	new to the field	other: stud	ex: symbolic use-value	in: courtesy and socializing	out: no	late: fear of stealing	from CL 4 to 2 because OUT10 and VOT low plus stud
14	2	DSGN	low	new to the field	other: stud	ex: skill use-value	in: feedback	out: courtesy and socializing	early: open to feedback	
20	2	ENG	low	new to the field	other: looking for new opp.	in: interest and enjoyment	in: courtesy and socializing	out: helping others	early: open to feedback	

ID	CL	EDU	SKILL SET	COCREA EXP	JOB STAT	MOT	INTERACT IN	INTERACT OUT	SUBM	Comment
36	2	DSGN	med	experienced in community	not empl: freelancer	ex: symbolic use-value	in: feedback	out: courtesy and socializing	early: open to feedback	
30	2	DSGN	low	new to the field	other: stud	ex: skill use-value	in: feedback	out: courtesy and socializing	early: open to feedback	
2	3	ENG	med	new to the field	other: stud	in: competence and autonomy	in: feedback	out: selective feedback	early: defensive publ.	
3	3	ENG	high	new to community	empl: employed and startup or freelancer	ex: symbolic use-value	in: feedback	out: helping others	early: defensive publ.	
6	3	DSGN	med	experienced in community	empl: employed and startup or freelancer	in: competence and autonomy	in: courtesy and socializing	out: courtesy and socializing	late: busy	From CL 4 to 3 because OUT 39 and VOT 2,9
8	3	DSGN	med	experienced in community	empl: employed and startup or freelancer	ex: skill use-value	in: courtesy and socializing	out: helping others	early: open to feedback	
9	3	DSGN	med	experienced in community	not empl: freelancer	ex: symbolic use-value	in: courtesy and socializing	out: selective feedback	early: defensive publ.	From CL 4 to 3: no. of contributions and comments
11	3	ENG	high	new to community	other: looking for new opp.	ex: symbolic use-value	in: feedback	out: helping others	early: open to feedback	
4	4	ENG	high	new to the field	other: stud	ex: symbolic use-value	in: courtesy and socializing	out: selective feedback	early: defensive publ.	
5	4	DSGN	med	experienced in community	not empl: entrepreneur and freelancer	ex: skill use-value	in: feedback	out: helping others	early: open to feedback	
7	4	ENG	high	new to the field	other: stud	ex: symbolic use-value	in: courtesy and socializing	out: selective feedback	late: busy	
10	4	DSGN	med	new to community	other: stud	in: competence and autonomy	in: feedback	out: helping others	late: see what others do	
22	4	DSGN	high	experienced in community	empl: full-time employed	ex: skill use-value	in: feedback	out: helping others	late: busy	from CL2 to 4: VOT and OUT
33	4	ENG	high	new to the field	not empl: freelancer	ex: symbolic use-value	in: feedback	out: selective feedback	early: defensive publ.	from CL2 to 4: VOT and OUT

References

Adamczyk, S., Bullinger, A. C., & Möslein, K. M. (2012). Innovation contests: A review, classification and outlook. *Creativity and Innovation Management*, *21*(4), 335–360.

Albert, R., & Barabási, A.-L. (2002). Statistical mechanics of complex networks. *Reviews of Modern Physics*, *74*(1), 47–97. https://doi.org/10.1103/RevModPhys.74.47

Allen, R. C. (1983). Collective invention. *Journal of Economic Behavior & Organization*, *4*(1), 1–24. http://www.sciencedirect.com/science/article/pii/0167268183900239

Amabile, T. M. (1996). *Creativity in context*. Westview press.

Amabile, T. M. (2018). *Creativity in context: Updates to The social psychology of creativity*. London, New York. https://doi.org/10.4324/9780429501234

Amabile, T. M., Conti, R., Coon, H., & Lazenby, J. & Herron, M. (1996). Assessing the Work Environment for Creativity. *Academy of Management Journal*, *39*(5), 1154–1184. https://doi.org/10.5465/256995

Arazy, O., Daxenberger, J., Lifshitz-Assaf, H., Nov, O., & Gurevych, I. (2016). Turbulent stability of emergent roles: The dualistic nature of self-organizing knowledge coproduction. *Information Systems Research*, *27*(4), 792–812.

Ardichvili, A., Page, V., & Wentling, T. (2003). Motivation and barriers to participation in virtual knowledge-sharing communities of practice. *Journal of Knowledge Management*, *7*(1), 64–77. https://doi.org/10.1108/13673270310463626

Asdourian, B., & Lazarte, J. (2018). Making for humanity. *Nordisk Tidsskrift for Informationsvidenskab Og Kulturformidling*, *7*(2), 32–45. https://doi.org/10.7146/ntik.v7i2.111298

Baldwin, C. Y., & Clark, K. B. (2003). *The Architecture of Cooperation: Does Code Architecture Mitigate Free Riding in the Open Source Development Model? HBS Working Paper: 03-209*. https://www.hbs.edu/faculty/Pages/item.aspx?num=15639

Bayus, B. L. (2013). Crowdsourcing new product ideas over time: An analysis of the Dell IdeaStorm community. *Management Science*, *59*(1), 226–244.

Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. Yale University Press.

Bockstedt, J., Druehl, C., & Mishra, A. (2016). Heterogeneous Submission Behavior and its Implications for Success in Innovation Contests with Public Submissions. *Production and Operations Management*, *25*(7), 1157–1176. https://doi.org/10.1111/poms.12552

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). Ucinet for Windows: Software for social network analysis. *Analytic Technologies*, *6*.

Boudreau, K. J., Lacetera, N., & Lakhani, K. R. (2011). Incentives and problem uncertainty in innovation contests: An empirical analysis. *Management Science*, *57*(5), 843–863.

Boudreau, K. J., & Lakhani, K. R. (2011). The Confederacy of Heterogeneous Software Organizations and Heterogeneous Developers: Field Experimental Evidence on Sorting and Worker Effort. *NBER Chapters*, 483–502.

Boudreau, K. J., & Lakhani, K. R. (2013). Using the crowd as an innovation partner. *Harvard Business Review*, *91*(4), 60–69.

Boudreau, K. J., & Lakhani, K. R. (2015). "Open" disclosure of innovations, incentives and follow-on reuse: Theory on processes of cumulative innovation and a field experiment in computational biology. *Research Policy*, *44*(1), 4–19. https://doi.org/10.1016/j.respol.2014.08.001

Brandtzæg, P. B. (2010). Towards a unified Media-User Typology (MUT): A meta-analysis and review of the research literature on media-user typologies.

Computers in Human Behavior, *26*(5), 940–956. https://doi.org/10.1016/j.chb.2010.02.008

Brandtzæg, P. B. (2012). Social networking sites: Their users and social implications—A longitudinal study. *Journal of Computer-Mediated Communication*, *17*(4), 467–488.

Brem, A., & Bilgram, V. (2015). The search for innovative partners in co-creation: Identifying lead users in social media through netnography and crowdsourcing. *Journal of Engineering and Technology Management*, *37*, 40–51. https://doi.org/10.1016/j.jengtecman.2015.08.004

Brem, A., Bilgram, V., & Gutstein, A. (2018). Involving Lead Users in Innovation: A Structured Summary of Research on the Lead User Method. *International Journal of Innovation and Technology Management*, *15*(03), 1850022. https://doi.org/10.1142/S0219877018500220

Bullinger, A. C., Neyer, A.-K., Rass, M., & Moeslein, K. M. (2010). Community-based innovation contests: Where competition meets cooperation. *Creativity and Innovation Management*, *19*(3), 290–303. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8691.2010.00565.x/full

Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior*, *22*, 345–423. http://www.sciencedirect.com/science/article/pii/S0191308500220091

Calinski, T., & Harabasz, J. (1974). A dendrite method for cluster analysis. *Communications in Statistics - Theory and Methods*, *3*(1), 1–27. https://doi.org/10.1080/03610927408827101

Chesbrough, H. (2006). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open innovation: Researching a new paradigm*. Oxford University Press on Demand.

Chiang, C.-F., & Jang, S. (2008). An expectancy theory model for hotel employee motivation. *International Journal of Hospitality Management*, *27*(2), 313–322. https://doi.org/10.1016/j.ijhm.2007.07.017

Cohen, J. (1960). A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*, *20*(1), 37–46. https://doi.org/10.1177/001316446002000104

Cooper, R. (1987). New products: What separates winners from losers? *Journal of Product Innovation Management*, *4*(3), 169–184. https://doi.org/10.1016/0737-6782(87)90002-6

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention*. Harper Collins. https://psycnet.apa.org/record/1996-97915-000

Dahlander, L., & Frederiksen, L. (2012). The core and cosmopolitans: A relational view of innovation in user communities. *Organization Science*, *23*(4), 988–1007.

Deutsch, M. (1949). A Theory of Co-operation and Competition. *Human Relations*, *2*(2), 129–152. https://doi.org/10.1177/001872674900200204

Drucker, P. (1954). *The practice of management* (1st ed.). Harper & Row. http://worldcatlibraries.org/wcpa/oclc/230717

Ducheneaut, N. (2005). Socialization in an Open Source Software Community: A Socio-Technical Analysis. *Computer Supported Cooperative Work (CSCW)*, *14*(4), 323–368. https://doi.org/10.1007/s10606-005-9000-1

Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations: The ideas competition as a method to nurture a virtual community for innovations. *R&D Management*, *39*(4), 342–356. https://doi.org/10.1111/j.1467-9310.2009.00564.x

Eisenberg, I. (2011). Lead-User Research for Breakthrough Innovation. *Research-Technology Management*, *54*(1), 50–58. https://doi.org/10.1080/08956308.2011.11657673

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, *50*(1), 25–32. http://amj.aom.org/content/50/1/25.short

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: Exploring the phenomenon. *R&D Management*, *39*(4), 311–316. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9310.2009.00570.x/full

Faraj, S., Jarvenpaa, S. L., & Majchrzak, A. (2011). Knowledge Collaboration in Online Communities. *Organization Science*, *22*(5), 1224–1239. https://doi.org/10.1287/orsc.1100.0614

Fiori, K. L., Smith, J., & Antonucci, T. C. (2007). Social network types among older adults: A multidimensional approach. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *62*(6), P322-P330. http://psychsocgerontology.oxfordjournals.org/content/62/6/P322.short

Flick, U. (2014). *An introduction to qualitative research* (5. ed.). Sage.

Flick, U. (2015). *Introducing research methodology: A beginner's guide to doing a research project* (2. ed.). Sage.

Foege, J. N., Lauritzen, G. D., Tietze, F., & Salge, T. O. (2019). Reconceptualizing the paradox of openness: How solvers navigate sharing-protecting tensions in crowdsourcing. *Research Policy*, *48*(6), 1323–1339. https://doi.org/10.1016/j.respol.2019.01.013

Fowler, F. J. (2014). *Survey research methods* (5th ed.). *Applied social research methods series: Vol. 1*. Sage Publication.

Franke, N., Keinz, P., & Klausberger, K. (2013). "Does This Sound Like a Fair Deal?": Antecedents and Consequences of Fairness Expectations in the Individual's Decision to Participate in Firm Innovation. *Organization Science*, *24*(5), 1495–1516. https://doi.org/10.1287/orsc.1120.0794

Franke, N., & Piller, F. (2004). Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market. *Journal of Product Innovation Management*, *21*(6), 401–415. https://doi.org/10.1111/j.0737-6782.2004.00094.x

Franke, N., Poetz, M. K., & Schreier, M. (2014). Integrating Problem Solvers from Analogous Markets in New Product Ideation. *Management Science*, *60*(4), 1063–1081. https://doi.org/10.1287/mnsc.2013.1805

Franke, N., & Shah, S. (2003). How communities support innovative activities: An exploration of assistance and sharing among end-users. *Research Policy*, *32*(1), 157–178. http://www.sciencedirect.com/science/article/pii/S0048733302000069

Fuger, S., Schimpf, R., Füller, J., & Hutter, K. (2017). Network Structure and User Roles of a Crowdsourcing Community-The Context of Social Innovations for a Development Project. Advance online publication. https://doi.org/10.1080/02681102.2017.1353947

Füller, J. (2010). Refining virtual co-creation from a consumer perspective. *California Management Review*, *52*(2), 98–122.

Füller, J., & Hienerth, C. (2004). Engaging the creative consumer. *European Business Forum*(19), 54–57.

Füller, J., Hutter, K., & Faullant, R. (2011). Why co-creation experience matters? Creative experience and its impact on the quantity and quality of creative contributions. *R&D Management*, *41*(3), 259–273. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9310.2011.00640.x/full

Füller, J., Hutter, K., Hautz, J., & Matzler, K. (2014). User roles and contributions in innovation-contest communities. *Journal of Management Information Systems*, *31*(1), 273–308.

Füller, J., Jawecki, G., & Mühlbacher, H. (2007). Innovation creation by online basketball communities. *Journal of Business Research*, *60*(1), 60–71. http://www.sciencedirect.com/science/article/pii/S0148296306001408

Füller, J., Matzler, K., & Hoppe, M. (2008). Brand community members as a source of innovation. *Journal of Product Innovation Management*, *25*(6), 608–619. http://onlinelibrary.wiley.com/doi/10.1111/j.1540-5885.2008.00325.x/full

Galvagno, M., & Dalli, D. (2014). Theory of value co-creation: A systematic literature review. *Managing Service Quality*, *24*(6), 643–683. https://doi.org/10.1108/MSQ-09-2013-0187

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *Journal of Product Innovation Management*, *19*(2), 110–132. https://doi.org/10.1111/1540-5885.1920110

Gebauer, J., Füller, J., & Pezzei, R. (2013). The dark and the bright side of co-creation: Triggers of member behavior in online innovation communities. *Journal of Business Research*, *66*(9), 1516–1527. https://doi.org/10.1016/j.jbusres.2012.09.013

Gehman, J., Glaser, V. L., Eisenhardt, K. M., Gioia, D., Langley, A., & Corley, K. G. (2018). Finding Theory–Method Fit: A Comparison of Three Qualitative Approaches to Theory Building. *Journal of Management Inquiry*, *27*(3), 284–300. https://doi.org/10.1177/1056492617706029

Ghobadi, S., & D'Ambra, J. (2011). Coopetitive knowledge sharing: An analytical review of literature. *Electronic Journal of Knowledge Management*, *9*(4), 307–317. http://www.ejkm.com/issue/download.html?idArticle=302

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research. *Organizational Research Methods*, *16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Glaser, B. G., & Strauss, A. (1967). The discovery of grounded theory. *Alpine, New York*.

Gleave, E., Welser, H. T., Lento, T. M., & Smith, M. A. (Eds.) (2009). *A conceptual and operational definition of'social role'in online community*. IEEE.

Granovetter, M. S. (1977). The Strength of Weak Ties. In *Social Networks* (pp. 347–367). Elsevier. https://doi.org/10.1016/B978-0-12-442450-0.50025-0

Harhoff, D., & Lakhani, K. R. (2016). *Revolutionizing innovation: Users, communities, and open innovation*. MIT Press.

Häuberer, J., & Jeřábek, H. (2011). *Social capital theory: Towards a methodological foundation*. Zugl.: Prague, Charles Univ., Diss., 2010 (1.ed.). *VS Research*. Verl. für Sozialwiss. https://doi.org/10.1007/978-3-531-92646-9

Hautz, J., Hutter, K., Fuller, J., Matzler, K., & Rieger, M. (2010). How to Establish an Online Innovation Community? The Role of Users and Their Innovative Content. In R. H. Sprague (Ed.), *43rd Hawaii International Conference on System Sciences (HICSS), 2010 ; Honolulu, Hawaii, 5 - 8 Jan. 2010* (pp. 1–11). IEEE. https://doi.org/10.1109/HICSS.2010.221

Hertel, G., Niedner, S., & Herrmann, S. (2003). Motivation of software developers in Open Source projects: An Internet-based survey of contributors to the Linux kernel. *Research Policy*, *32*(7), 1159–1177. http://www.sciencedirect.com/science/article/pii/S0048733303000477

Hinds, D., & Lee, R. M. (2008). Social network structure as a critical success condition for virtual communities. In *Proceedings of the 41st Annual Hawaii International Conference on System Sciences*. IEEE.

Hippel, E. von (1986). Lead users: A source of novel product concepts. *Management Science*, *32*(7), 791–805.

Hippel, E. von. (2006). *Democratizing Innovation*. MIT Press.

Hippel, E. von, & Krogh, G. von (2003). Open source software and the "private-collective" innovation model: Issues for organization science. *Organization Science*, *14*(2), 209–223.

Howe, J. (2009). *Crowdsourcing: How the power of the crowd is driving the future of business*. Random House Business.

Hutter, K., Hautz, J., Füller, J., Mueller, J., & Matzler, K. (2011). Communitition: The tension between competition and collaboration in community-based design contests. *Creativity and Innovation Management*, *20*(1), 3–21. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8691.2011.00589.x/full

Jeppesen, L. B., & Frederiksen, L. (2006). Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments. *Organization Science*, *17*(1), 45–63.

Jeppesen, L. B., & Lakhani, K. R. (2010). Marginality and problem-solving effectiveness in broadcast search. *Organization Science*, *21*(5), 1016–1033.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, *24*(4), 602–611. http://www.jstor.org/stable/2392366

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Interaction Book Company. https://psycnet.apa.org/record/1989-98552-000

Johnson, D. W., & Johnson, R. T. (2005). New developments in social interdependence theory. *Genetic, Social, and General Psychology Monographs*, *131*(4), 285–358.

Kerr, N. L. (1992). Efficacy as a causal and moderating variable in social dilemmas. In W. B. G. Liebrand, D. M. Messick, & H. A. M. Wilke (Ed.), *International series in experimental social psychology. Social dilemmas: Theoretical issues and research findings* (pp. 59–80). Pergamon Press.

Ketchen Jr, D. J., & Shook, C. L. (1996). The application of cluster analysis in strategic management research: An analysis and critique. *Strategic Management Journal*, 441–458. http://www.jstor.org/stable/2486927

Kim, A. J. (2000). *Community building on the web: Secret strategies for successful online communities*. Addison-Wesley Longman Publishing Co., Inc. http://dl.acm.org/citation.cfm?id=518514

Kmhkmh. (2020). *Illustration for n=3, repeated application of the Pythagorean theorem yields the formula: Own work, CC BY 4.0*. https://commons.wikimedia.org/w/index.php?curid=67617304

Koberg, C. S., Detienne, D. R., & Heppard, K. A. (2003). An empirical test of environmental, organizational, and process factors affecting incremental and radical innovation. *The Journal of High Technology Management Research*, *14*(1), 21–45. https://doi.org/10.1016/S1047-8310(03)00003-8

Koch, G., Hutter, K., Decarli, P., Hilgers, D., & Füller, J. (2013). Identifying participants' roles in open government platforms and its impact on community growth. In *46th Hawaii International Conference on System Sciences (HICSS), 2013*. IEEE.

Kozinets, R. V. (1999). E-tribalized marketing? The strategic implications of virtual communities of consumption. *European Management Journal*, *17*(3), 252–264. http://www.sciencedirect.com/science/article/pii/S0263237399000043

Krogh, G. von, & Hippel, E. von (2006). The promise of research on open source software. *Management Science*, *52*(7), 975–983.

Krogh, G. von, Spaeth, S., & Lakhani, K. R. (2003). Community, joining, and specialization in open source software innovation: A case study. *Research Policy*, *32*(7), 1217–1241. http://www.sciencedirect.com/science/article/pii/S0048733303000507

Lakhani, K., Garvin, D., & Lonstein, E. (2010). TopCoder (A): Developing Software through Crowdsourcing. *Harvard Business School General Management Unit Case*, *610-032*.

Lakhani, K., & Wolf, R. G. (2003). Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects. *SSRN Electronic Journal*. Advance online publication. https://doi.org/10.2139/ssrn.443040

Lauritzen, G. D. (2017). The Role of Innovation Intermediaries in Firm-Innovation Community Collaboration: Navigating the Membership Paradox. *Journal of Product Innovation Management*, *34*(3), 289–314. https://doi.org/10.1111/jpim.12363

Leclercq, T., Hammedi, W., & Poncin, I. (2016). Ten years of value cocreation: An integrative review. *Recherche Et Applications En Marketing (English Edition)*, *31*(3), 26–60. https://doi.org/10.1177/2051570716650172

Lerner, J., & Schankerman, M. (Eds.). (2010). *The comingled code: Open source and economic development*. The MIT Press.

Lerner, J., & Tirole, J. (2002). Some simple economics of open source. *The Journal of Industrial Economics*, *50*(2), 197–234. http://onlinelibrary.wiley.com/doi/10.1111/1467-6451.00174/full

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & Hippel, E. von (2002). Performance Assessment of the Lead User Idea-Generation Process for New Product Development. *Management Science*, *48*(8), 1042–1059. https://doi.org/10.1287/mnsc.48.8.1042.171

Lin, N., Cook, K. S., & Burt, R. S. (2001). *Social capital: Theory and research*. Transaction Publishers.

Lüthje, C. (2004). Characteristics of innovating users in a consumer goods field. *Technovation*, *24*(9), 683–695. https://doi.org/10.1016/S0166-4972(02)00150-5

Lüthje, C., & Herstatt, C. (2004). The Lead User method: An outline of empirical findings and issues for future research. *R&D Management*, *34*, 5.

Lüthje, C., Herstatt, C., & Hippel, E. von (2005). User-innovators and “local” information: The case of mountain biking. *Research Policy*, *34*(6), 951–965. https://doi.org/10.1016/j.respol.2005.05.005

Matsui, T., Okada, A., & Mizuguchi, R. (1981). Expectancy theory prediction of the goal theory postulate, "The harder the goals, the higher the performance.". *The Journal of Applied Psychology*, *66*(1), 54–58. https://doi.org/10.1037/0021-9010.66.1.54

McCalister, D. V., Katz, D., & Kahn, R. L. (1967). The Social Psychology of Organizations. *Social Forces*, *46*(1), 118. https://doi.org/10.2307/2575337

McWilliam, G. (2000). Building stronger brands through online communities. *Sloan Management Review*, *41*(3), 43.

Moritz, M., Redlich, T., Grames, P. P., & Wulfsberg, J. P. (2016). Value creation in open-source hardware communities: Case study of Open Source Ecology. In *2016 Portland International Conference* (pp. 2368–2375). https://doi.org/10.1109/PICMET.2016.7806517

Moritz, M., Redlich, T., & Wulfsberg, J. P. (2018). Best Practices and Pitfalls in Open Source Hardware. In Á. Rocha & T. Guarda (Eds.), *Advances in Intelligent Systems and Computing Ser: v.721. Proceedings of the International Conference on Information Technology and Systems (ICITS 2018)* (Vol. 721, pp. 200–210). Springer. https://doi.org/10.1007/978-3-319-73450-7_20

Muniz, A. M., & O'guinn, T. C. (2001). Brand community. *Journal of Consumer Research*, *27*(4), 412–432.

Nonnecke, B., & Preece, J. (2001). Why lurkers lurk. *AMCIS 2001 Proceedings*, 294. http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1733&context=amcis2001

Nonnecke, B., Preece, J., Andrews, D., & Voutour, R. (2004). Online Lurkers Tell Why. *AMCIS 2004 Proceedings*. https://aisel.aisnet.org/amcis2004/321

Nuvolari, A. (2004). Collective invention during the British Industrial Revolution: The case of the Cornish pumping engine. *Cambridge Journal of Economics*, *28*(3), 347–363. http://cje.oxfordjournals.org/content/28/3/347.short

Obstfeld, D. (2005). Social Networks, the Tertius Iungens Orientation, and Involvement in Innovation. *Administrative Science Quarterly*, *50*(1), 100–130. https://doi.org/10.2189/ASQU.2005.50.1.100 (Administrative Science Quarterly, 50(1), 100-130).

OECD. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition.* Organisation for Economic Co-operation and Development; Statistical Office of the European Communities, Luxembourg. The Measurement of Scientific and Technological Activities.

O'Mahony, S., & Lakhani, K. R. (2011). Organizations in the shadow of communities. In *Communities and organizations* (pp. 3–36). Emerald Group Publishing Limited.

Osterloh, M., & Rota, S. (2007). Open source software development—Just another case of collective invention? *Research Policy*, *36*(2), 157–171. http://www.sciencedirect.com/science/article/pii/S0048733306001983

Panciera, K., Halfaker, A., & Terveen, L. (2009). Wikipedians are born, not made. In S. Teasley (Ed.), *Proceedings of the ACM 2009 international conference on Supporting group work* (p. 51). ACM. https://doi.org/10.1145/1531674.1531682

Panzarasa, P., Opsahl, T., & Carley, K. M. (2009). Patterns and dynamics of users' behavior and interaction: Network analysis of an online community. *Journal of the American Society for Information Science and Technology*, *60*(5), 911–932. http://onlinelibrary.wiley.com/doi/10.1002/asi.21015/full

Perry-Smith, J. E., & Shalley, C. E. (2003). The social side of creativity: A static and dynamic social network perspective. *Academy of Management Review*, *28*(1), 89–106. http://amr.aom.org/content/28/1/89.short

Pfeil, U., Svangstu, K., Ang, C. S., & Zaphiris, P. (2011). Social roles in an online support community for older people. *Intl. Journal of Human–Computer Interaction*, *27*(4), 323–347.

Piller, F. T., Ihl, C., & Vossen, A. (2010). A typology of customer co-creation in the innovation process.

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: A novel method to integrate users in new product development. *R&D Management*, *36*(3), 307–318.

Poetz, M. K., & Schreier, M. (2012). The value of crowdsourcing: Can users really compete with professionals in generating new product ideas? *Journal of Product Innovation Management*, *29*(2), 245–256.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creating unique value with customers. *Strategy & Leadership*, *32*(3), 4–9.

Preece, J., Nonnecke, B., & Andrews, D. (2004). The top five reasons for lurking: improving community experiences for everyone. *Computers in Human Behavior*, *20*(2), 201–223. https://doi.org/10.1016/j.chb.2003.10.015

Preece, J., & Shneiderman, B. (2009). The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation. *AIS Transactions on Human-Computer Interaction*, *1*(1), 13–32. https://aisel.aisnet.org/thci/vol1/iss1/5

Prell, C. (2015). *Social network analysis: History, theory & methodology* (Reprinted). Sage.

Punj, G., & Stewart, D. W. (1983). Cluster Analysis in Marketing Research: Review and Suggestions for Application. *Journal of Marketing Research*, *20*(2), 134. https://doi.org/10.2307/3151680

Redlich, T. (2011). *VDI-Buch. Wertschöpfung in der Bottom-up-Ökonomie* (T. Redlich, & J. P. Wulfsberg, Eds.). Springer. https://doi.org/10.1007/978-3-642-19880-9

Rifkin, J. (2015). *The Zero Marginal Cost Society: The internet of things, the collaborative commons, and the eclipse of capitialism*. Palgrave Macmillan.

Roser, T., DeFillippi, R., & Samson, A. (2013). Managing your co-creation mix: Co-creation ventures in distinctive contexts. *European Business Review*. Advance online publication. https://doi.org/10.1108/09555341311287727

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68. http://psycnet.apa.org/journals/amp/55/1/68/

Sarstedt, M., & Mooi, E. (2014). *A Concise Guide to Market Research: The Process, Data, and Methods Using IBM SPSS Statistics* (2. ed. 2014). *Springer*

Texts in Business and Economics. Springer Berlin Heidelberg; Imprint: Springer.

Sawhney, M., Verona, G., & Prandelli, E. (2005). Collaborating to create: The Internet as a platform for customer engagement in product innovation. *Journal of Interactive Marketing*, *19*(4), 4–17. http://www.sciencedirect.com/science/article/pii/S1094996805700785

Schöttle, A., Haghsheno, S., & Gehbauer, F. (2014). *Defining cooperation and collaboration in the context of lean construction. Proc. 22nd Ann. Conf. of the Int'l Group for Lean Construction.* http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1078.6457&rep=rep1&type=pdf

Schreier, M., Oberhauser, S., & Prügl, R. (2007). Lead users and the adoption and diffusion of new products: Insights from two extreme sports communities. *Marketing Letters*, *18*(1-2), 15–30. https://doi.org/10.1007/s11002-006-9009-3

Schreier, M., & Prügl, R. (2008). Extending Lead-User Theory: Antecedents and Consequences of Consumers' Lead Userness *Journal of Product Innovation Management*, *25*(331-346). https://doi.org/10.1111/j.1540-5885.2008.00305.x

Sun, N., Rau, P. P.-L., & Ma, L. (2014). Understanding lurkers in online communities: A literature review. *Computers in Human Behavior*, *38*, 110–117. https://doi.org/10.1016/j.chb.2014.05.022

Tedjamulia, S., Dean, D. L., Olsen, D. R., & Albrecht, C. C. (2005). Motivating Content Contributions to Online Communities: Toward a More Comprehensive Theory. In R. H. Sprague (Ed.), *Proceedings of the 38th Annual Hawaii International Conference on System Sciences: Abstracts and CD-ROM of full papers: 3-6 January, 2004, Big Island, Hawaii* (193b-193b). IEEE Computer Society Press. https://doi.org/10.1109/HICSS.2005.444

Terwiesch, C., & Ulrich, K. T. (2009). *Innovation Tournaments: Creating and Selecting Exceptional Opportunities*. Harvard Business Press.

Terwiesch, C., & Xu, Y. (2008). Innovation contests, open innovation, and multiagent problem solving. *Management Science*, *54*(9), 1529–1543.

Turner, R. H. (1978). The Role and the Person. *American Journal of Sociology*, *84*(1), 1–23. https://doi.org/10.1086/226738

Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On value and value co-creation: A service systems and service logic perspective. *European Management Journal*, *26*(3), 145–152. https://doi.org/10.1016/j.emj.2008.04.003

Ward Jr, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, *58*(301), 236–244.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge university press.

Webb, A. (1991). Coordination: A problem in public sector management. *Policy & Politics*, *19*(4), 229–242. https://doi.org/10.1332/030557391782454188

Weber, S. (2004). *The Success of Open Source*. Harvard University Press.

Welser, H. T., Coseley, D., Kossinets, G., Lin, A., Dokshin, F., Gay, G., & Smith, M. (2011). Finding social roles in Wikipedia. In *Proceedings of the 2011 iConference*. ACM.

West, J., & Lakhani, K. R. (2008). Getting Clear About Communities in Open Innovation. *Industry and Innovation*, *15*(2), 223–231. https://doi.org/10.1080/13662710802033734

Wooten, J. O., & Ulrich, K. T. (2013). The Impact of Visibility in Innovation Tournaments: Evidence from Field Experiments. *SSRN Electronic Journal*. Advance online publication. https://doi.org/10.2139/ssrn.2214952

Wooten, J. O., & Ulrich, K. T. (2017). Idea generation and the role of feedback: Evidence from field experiments with innovation tournaments. *Production and Operations Management*, *26*(1), 80–99.

Wulfsberg, J. P., Redlich, T., & Bruhns, F.-L. (2011). Open production: Scientific foundation for co-creative product realization. *Production Engineering*, *5*(2), 127–139. https://doi.org/10.1007/s11740-010-0286-6

Yang, Y., Chen, P.-Y., & Pavlou, P. (2009). Open innovation: An empirical study of online contests. In *ICIS 2009 Proceedings* (Vol. 13).

List of own publications

Publications listed here partly covered (preliminary) results that are also part of this dissertation.

<u>Study 1:</u>

Moritz M., Redlich T., Wulfsberg J. (2018a) Kollaboration und Wettbewerb bei Ideenwettbewerben – eine Userperspektive. In: Redlich T., Moritz M., Wulfsberg J. (eds) *Interdisziplinäre Perspektiven zur Zukunft der Wertschöpfung*. Springer Gabler, Wiesbaden. https://doi.org/10.1007/978-3-658-20265-1_24

Moritz M., Redlich T. (2019) How to Co-create Value with Users: A Case Study on Local Motors' Contest Community. In: Redlich T., Moritz M., Wulfsberg J. (eds) *Co-Creation*. Management for Professionals. Springer, Cham. https://doi.org/10.1007/978-3-319-97788-1_2

<u>Study 2:</u>

Moritz M., Redlich T., & Wulfsberg J. (2018b). Who Are Your Design Heroes? Exploring User Roles in a Co-creation Community. In: Rocha Á., Adeli H., Reis L.P., Costanzo S. (eds) *Trends and Advances in Information Systems and Technologies*. WorldCIST'18 2018. Advances in Intelligent Systems and Computing, vol 745. Springer, Cham. https://doi.org/10.1007/978-3-319-77703-0_40