Feedback in collective ideation

How does feedback affect the development of ideas within an idea management system?

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30 ECTS thesis submitted in partial fulfillment of a
Magister Scientiarum degree in Industrial Engineering

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Abstract

Innovative ideas are generated in many different arenas in modern organizations. One of the arenas is the web-enabled idea management systems. The idea management systems provide a venue for individuals or groups to share ideas to a large group of heterogeneous individuals within the organization. The aim is to draw upon the diverse source of knowledge from the group to develop the ideas further, improving their quality, and make them feasible as innovations. In this thesis we have developed a tentative theoretical framework to investigate how different dimensions of feedback affect development of ideas within an idea management system. The theoretical framework then serves as a basis for an empirical research performed on data from an internal idea management system in a multinational telecommunications company. The study shows association of many of the feedback dimensions with idea quality. Iterative feedback, confirmation, feedback valence, and feedback style, show signs of positive relation, while number of feedback per idea shows negative relation. Additional information had both elements of positive and negative relation to idea quality. Finally, managerial implications are derived based on the results from the empirical research and previous research associated with the theoretical framework.

Útdráttur

Hugmyndir til nýsköpunar eru búnar til á margvíslegan hátt í nútíma fyrirtækjum. Einn vettvangur sem hefur orðið meira áberandi á síðustu árum er notkun hugmyndastjórnunarkerfa. Hugmyndastjórnunarkerfi eru yfirleitt eingöngu aðgengileg starfsfólki fyrirtækja í gegnum innranet, en í sumum tilfellum eru kerfin opin utanaðkomandi aðilum. Hugmyndastjórnunarkerfi gerir starfsfólki kleyft að deila hugmyndum sínum með öðrum starfsmönnum innan fyrirtækisins. Tilgangurinn er að koma hugmyndum á framfæri innan fyrirtækisins og nýta fjölbreytilega þekkingu einstaklinga innan fyrirtækisins til að þróa hugmyndirnar áfram, bæta gæði þeirra og gera hugmyndirnar hæfar til nýsköpunar. Í þessu meistaraverkefni hefur verið þróuð hugmynd að skilgreiningarramma til að rannsaka hvernig mismunandi þættir athugasemda við hugmyndir innan hugmyndastjórnunarkerfis hafa áhrif á þróun hugmynda. Skilgreiningarramminn nýtist sem grunnur fyrir rannsókn á gögnum frá hugmyndastjórnunarkerfi alþjóðlegs fjarskiptafyrirtækis. Niðurstöður rannsóknarinnar sýna fram á tengsl milli margra þátta athugasemdanna og gæða hugmyndanna. Endurtekin samskipti, staðfesting hugmyndar, jákvæðni og framsetning skilaboða sýna jákvæð tengsl við gæði hugmynda. Fjöldi athugasemda við hverja hugmynd hefur neikvæð tengsl við gæði hugmynda. Og að lokum getur innihald athugasemdanna, fer eftir gerð innihalds, bæði haft jákvæð og neikvæð tengsl við gæði hugmynda. Með niðurstöður rannsóknarinnar og fyrri rannsókna á sama sviði að leiðarljósi eru lagðar fram tillögur að stjórnunaraðferðum fyrir athugasemdir við hugmyndir í hugmyndastjórnunarkerfum.

Dedication

To Hildur
For her love and support

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Abbreviations

ETD	Extract, Transform, and Load
FES	Feedback Environment Scale
IMS	The Telecommunications company's internal idea management system
R&D	Research and Development
RQ1	Research Question 1
RQ2	Research Question 2
SQL	Structured Query Language
VIF	Variance Inflation Factor

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Sigurður Hannesson
Kópavogur, June 2015

1 Introduction and background

The importance of ideation in organizations has grown rapidly as competition has become increasingly global and intense. Markets once divided by distance have merged as a result of the digital revolution, instigating global marketing for organizations as the norm. At the same time product life cycles have shortened, technology development and the increased number of organizations competing within the same market are driving new products and services into the markets in an unprecedented manner. As a result of these changes to the business environment, demand within organizations has increased for ideas that can become innovations in the form of new businesses, processes, products, and services (Björk & Magnusson, 2009; Porter, 2001; Aytac & Wu, 2013).

Ideation is the process of generating, developing and communicating novel ideas. Ideas are created by individuals or teams, and organizations are therefore dependent on their member's creative performance for providing ideas (Teresa M. Amabile, 1996). To foster that creative performance of employees, organizations have to embrace creativity within their organizational structures and strategies. Organizational climate, i.e. the extent to which creativity and innovation are supported in the organization, and work resources, e.g. funds, people, facilities, and information, is significant to perceived creativity and innovation in organizations (Farida Rasulzada, 2009). Ideation is of value to an organization only if the idea possesses certain quality in terms of novelty, feasibility, profitability and strategic alignment. The quality of an idea is a key determinant of whether it can be converted into a successful innovation (Archer & Ghasemzadeh, 1999).

Managing ideation is an extensive subject containing multiple methods different in nature but all of them are aimed at obtaining increased quality of the ideation process and output. At the very basis of managing ideation is resource allocation. Time and resources have to be devoted to the process to ensure participation of employees (Heising, 2012). Creating an environment which exposes individuals to a network of knowledge and information flows has been identified as highly important to learning and innovation. Novel ideas are often created on the boundaries of the knowledge of different individuals (Björk & Magnusson, 2009; Magnusson, 2015). Collaboration and competition are both arenas for submission of novel ideas, used to stimulate the creativity of individuals. Collective ideation is based on positive effects of interaction between individuals, working together towards a mutual goal and sharing of knowledge. Competition on the individual level however is based on taking advantage of the competitive nature of people, competing for prizes and awards. A combination of the two, co-opetition, has recently gained interest, showing that promoting community collaboration in a competitive context correlates positively with the quality of the ideas produced (Bergendahl & Magnusson, 2014). An idea management tool that is becoming more widespread in modern ideation is idea management systems. They are designed to create a common platform for different members of an organization to share their ideas in a collaborative or competitive setting, as well as allowing users to view and provide feedback on shared ideas from other members. Modern idea management systems are web-based and offer communication and interaction possibilities, offering substantially

higher efficiency and effectiveness than traditional idea management systems such as suggestion boxes (Björk, et al., 2014).

This brings us to the subject of this report, feedback in collective ideation. A major advantage of new idea management systems is the possibility to enhance the quality of ideas through the feedback it receives from other members of the organization. The role of feedback in this process is therefore a highly interesting subject of managing ideation in a collaborative environment. Feedback has been shown to be one of the most frequently used tools for motivation strategies and behavioral modification within organizations (Zhou, 1998). Previous research on feedback has shown the effect of three variables on creative performance: feedback valence, feedback style, and task autonomy. Results showed that individuals who received positive feedback in an informative style in highly autonomous tasks generated the most creative ideas (Zhou, 1998). Feedback has also been proven to affect creativity in a positive way. For example when presence of creative coworkers is high and the more supervisors give developmental feedback, the greater the creativity (Zhou, 2003). The role of the feedback provider is strengthened in a study conducted in competition settings, providing evidence that even random feedback is better than no feedback in relation to contest participation. Also showing that directed feedback raises the quality of bad submitted ideas, however having little or no effect on the best entries (Wooten & Ulrich, 2014).

Another study underpinning the tentative framework highlights the need for management involvement in the system to foster innovation within organizations and indicating the importance of receiving feedback in a timely manner (Fischer & Rohde, 2013). In the same sense that feedback can affect ideation positively feedback can also have a negative effect on ideation, untimely blocking the potential progression of an idea, e.g. negative feedback, and especially when provided in a controlling style, blocks creative behavior in individuals (Zhou, 1998). Therefore, it is of great interest to study the relationship between feedback and idea quality in idea management systems with the purpose of generating managerial implications that can increase optimization in the ideation process.

1.1 Contributions

The thesis aims to add new insights to existing knowledge about ideation in collaborative environment, focusing on idea management systems. More specifically, it aims to answer the following research questions:

RQ1: How do different dimensions of feedback affect the quality of an idea in an idea management system?

RQ2: What are the key challenges to managing feedback in idea management systems?

Answering these research questions will relate existing knowledge on feedback with modern idea management systems, and the resulting insights are establishing principles for improved management of these systems.

1.2 Structure of the thesis

In the next chapter, chapter 2, the frame of reference for the thesis is described. Main concepts, such as, idea, collective ideation, and feedback, are explained in the context of idea development within idea management systems. A tentative theoretical framework for feedback in collective ideation is also presented. The framework is designed to comprehend all the dimensions of the information exchange between idea providers and feedback providers in an idea management system. The framework is constructed with three fundamental dimensions, where each dimension contains several more specific factors. In chapter 3 the method and research settings for an empirical research is presented. An empirical research was conducted on data from an idea management system from a multinational telecommunications company. Logistic regression was used to analyze the dataset and the procedure of that analysis is described in the chapter. The dataset contained a great number of variables which are all described as well as other preparation of the data. In chapter 4 results from the analysis are presented. The procedure of arriving at a final set of variables that were used in the logistic regression model is described. Correlation and multicollinearity as well as other factors were taken into consideration when a set of variables was selected that represented the data successfully. The logistic regression model is finally presented and the significance of the selected variables is displayed. In Chapter 5 the analysis and discussion of the results are presented. The results from the analysis are used to answer the research questions previously presented in the thesis. The variables used in the analysis are related to different dimensions of the theoretical framework, firstly, in order of interpreting the results within the previously established environment for feedback in idea management systems, and secondly, in an effort to validate the tentative framework. Managerial implications for practice are then established based on the results from the analysis and suggestions for future research are presented. Finally, the conclusions of the thesis are presented in chapter 6.

2 Theory

In this chapter the aim is to describe the frame of reference for this study along with the terms that are imperative to the understanding of the subject. To study feedback in idea management system a tentative theoretical framework has been created. The framework is designed to comprehend several different dimensions of the information exchange between idea providers and feedback providers, and will be described in this chapter.

2.1 Idea

As defined by the Oxford Dictionaries, an idea is "a plan, thought or suggestion, especially about what to do in a particular situation". Organizations require innovations in the form of new businesses, processes, products and services (Oxford University Press, 2015; Björk & Magnusson, 2009). All innovations originate from ideas that have been developed and implemented. In the context of idea management systems within organizations, an idea can therefore be described as: a plan, thought or suggestion on how to create new businesses, processes, products, or services. Ideas can be created and developed by anyone within the organization and even external participants if they have an association with the organization. The quality of an idea is determined by to what extent the idea is novel and useful to the organization. The greater the idea possesses these qualities the more likely it is that an innovation derived from the idea will become successful and beneficial for the organization (Jung, et al., 2010).

2.2 Collective ideation

Collective ideation is the social and collective endeavor of creating ideas for innovation. The more traditional way of viewing ideation is that ideas origin from individual creative brilliance. Organizations, however, have shifted their focus to an open and collective ideation by utilizing methods such as brainstorming, innovation competitions, and the use of idea management systems (Björk, et al., 2014). Network connectivity and knowledge sharing of diverse individuals within the organizations contribute to an improved ideation process. Innovations are often created on the boundaries of different knowledge areas, therefore by combining knowledge areas of different individuals increases the likelihood of identifying problems and solving them in a novel manner (Björk & Magnusson, 2009; Magnusson, 2015).

2.3 Feedback

The definition of feedback according to the Oxford Dictionaries, is that feedback is "information about reactions to a product, a person's performance of a task, etc. which is used as a basis for improvement" (Oxford University Press, 2015). In collective ideation, feedback can therefore be described as: the information output from a peer review of an idea. A participant in the ideation process reviews an idea and exchanges information, dependent on his knowledge and experience, with the idea provider and other participants. The feedback process allows the participants to expand the definition of the idea and its potential as an innovation. Feedback, therefore, contributes to the development of an idea, either improving the idea or possibly identifying its shortcoming, in either way moving the idea closer to the result of becoming or not becoming a candidate for innovation (Zhou, 2003).

2.4 Idea management systems

Idea management systems are generally web-enabled systems for organizations to collect ideas for innovations. The system can be open to participants from outside of the organization, as in the case of crowdsourcing, or more commonly internal for the members of the organization only. One of the obvious benefits to such a system is that everyone within an organization can participate regardless of their geographical location. Numerous different systems are available on the market such as BrightIdea, Innovation Central and CogniStreamer. Most of the systems available are built on the same principal function, to gather and evaluate ideas in a structured fashion. Idea management systems create an arena for sharing of ideas, development of ideas through feedback process, and ultimately feeding the ideas to management. The feedback or communication process generated following the submission of the idea can greatly influence how the idea is evaluated. Feedback from peers, supervisors or subordinates can contribute to the idea achieving its full potential, by e.g. adding additional information. If idea management systems are used actively for both idea submission and feedback through idea review, then it can demonstrate the benefits of collective ideation. If we however omit the participation of the feedback provider, the system relies mostly on the creative brilliance of the individual. Motivating the use of the idea management system for both idea providers and feedback providers is therefore an essential part of fruitfully using an idea management system (Björk, et al., 2014; Hutter, et al., 2011; InnovationManagement, 2013).

2.5 Theoretical framework for feedback in collective ideation

Feedback provided to an idea created in an idea management system contains several different dimensions of influence. Steelman, Levy and Snell (2004) created the Feedback Environment Scale (FES) which is a framework that describes performance feedback. The environment that FES describes shares most of the characteristics with feedback in collective ideation and can therefore serve as a starting point in creating a theoretical framework for feedback in collective ideation. According to Steelman there are two key sources of feedback providers, supervisors and co-workers. The feedback provided by these two sources have seven facets that define the meaning of the feedback to the audience. The facets are: source credibility, feedback quality, feedback delivery, favorable feedback, unfavorable feedback, source availability, and promotes feedback seeking. All of those facets or dimensions of feedback can be adapted to feedback in collective ideation. Additionally to the FES we would like to take into consideration all additional information that is related to the content of the idea, as well as a more detailed view of the source and the timing of the feedback. A complete revision and reorganization of the layout of the framework is therefore appropriate. A tentative theoretical framework for feedback in collective ideation is described in detail below.

Feedback provided to an idea in an idea management system has three fundamental dimensions:

- Feedback providers
- Feedback process
- Feedback content

The feedback content is the message itself or the information that is contained in the message. The feedback content can be interpreted differently depending on the feedback provider and the feedback process. These three dimensions are believed to be the fundamental dimensions for feedback in idea management systems, and each of the dimensions are composed of numerous different subfactors. All the dimensions and factors are described in detail below.

2.5.1 Feedback providers

Feedback providers contains all relevant information on the person providing the feedback and that information will establish the foundation for how the feedback is perceived by the audience, irrelevant of the content, e.g. intentions to improve for individuals who receive negative feedback from supervisors with low credibility are much lower and more unpredictable than for those receiving negative feedback from supervisors with high credibility (Bloom & Hautaluoma, 1987).

The feedback provider credibility is established by seven factors:

- Hierarchical position
- Network position
- Skill level
- Previous interaction
- Activity level
- Diversity
- Distance
- Informal leaders – hidden factor

Hierarchical position

Research has shown that message received from supervisor or someone in a higher hierarchical position is perceived differently by the message receiver than a message from a peer. When a knowledge worker receives an interruption, which is a situation that demands the attention of the receiver, the worker experiences both time and evaluation pressure. The degree of the evaluation pressure depends on the hierarchical position of the message provider. Messages from a supervisor causes therefore a higher degree of evaluative pressure and attention conflict than a message from a peer. Interestingly the interruptive message from a supervisor can cause the receiver to adopt a heuristic strategy in processing the primary task of the message due to time pressure, potentially compromising quality. Whereas quality is rather compromised in primary task from a peer due to lack of attention or processing capabilities (Ashish Gupta & Sharda, 2013). In collective ideation the original ideahas already been submitted when a feedback message from a supervisor can be received so the influence on the quality of the original idea is expected to be minimal. However, it may affect the potential added value of the other feedbacks provided to the idea.

Network position

Human interaction and externally acquired information has proven in previous research to be highly influential in the development of individual knowledge. The extent to how connected an individual is within a network relates to how much knowledge and information he has at his disposal when creating ideas, correlating positively with the quality of the ideas created (Björk & Magnusson, 2009). In the case of collective ideation we therefore believe

that network position will relate to the quality of the feedback provided, where a stronger network position increases the chances of the feedback affecting the development of the idea positively.

Skill level

Sharing expertise and knowledge in free-flowing, creative ways that foster new approaches to problems have been shown to be important for innovation and learning in organizations (Björk & Magnusson, 2009). Individuals are prone to seek advice from experts rather than non-experts because of their knowledge and ability to provide accurate information, and researchers argue that information stemming from experts weigh more heavily in the receivers consideration (Purnawirawan, et al., 2014). This leads us to the potential negative effect of expert feedback in ideation. Studies have shown that productivity in brainstorming can be inhibited by fear of evaluation, allowing few to dominate the discussion, underpinning one of brainstorming's best practice guidelines: „Criticism is ruled out. Adverse judgment of ideas must be withheld until later" (Isaksen & Gaulin, 2005). The feedback of an expert has a greater potential in dominating and limiting the feedback conversation. However in online communication the skill level of the participants is not as obvious to determine and it could therefore be less significant than in offline communication (Purnawirawan, et al., 2014).

Previous interaction

Trust has been recognized as an important factor in knowledge sharing. Trust is based on a set of beliefs that individuals form a relationship where they behave in a dependent manner with respect to each other and do not take advantage of any situation on the cost of one another. Trust is formed through repeated interactions, normally a time-consuming process involving initial trust formation until a firm loyalty is established (Hsu, et al., 2007). The degree of acceptance of feedback provided to the idea may therefore depend on the level of previous interactions between participants.

Activity level

The activity level of the person providing feedback can potentially affect how his message is perceived. Those who are active within the system may have acquired credibility or expertise in their roles as participants in the ideation process, as an idea creator, feedback provider, or both. Feedback from sources that have credibility and expertise is more likely to influence the behavior of the recipient than feedback from sources that are not perceived competent (Steelman, et al., 2004). Active individuals within community-based systems that voluntarily serve a co-operative network position are proven to provide quality feedback. Those individuals participate in conversations with the aim of collaborating in the community, sharing knowledge and experience (Hutter, et al., 2011). Within the realms of an idea management system it is possible that active individuals are perceived either competent or not, but their level of activity will most likely mean that the community will possess information about the competency of these individuals.

Diversity – Gender, age, ethnicity and education

Diversity can be described by ascribed and achieved characteristics. Ascribed characteristics are related to demographic diversity such as gender, age, ethnic background, and nationality, while achieved characteristics are educational background, functional background, and work

experience. Diversity can affect how members of an organization communicate and interact, as well as how they apply and combine existing knowledge. As the diversity of the employees and the knowledge base of the company grows, the possibilities for new combinations of internal knowledge through interaction and learning increase. A study of 1648 Danish firms showed that diversity in general is positively related to innovation within companies, also revealing that gender diversity had one of the strongest relations to companies' innovative performance. Ethnicity was also positively related to innovation while age had a neutral or negative relation, supporting previous research showing that age diversity causes disagreements leading to lower innovative performance (Ostergaard, et al., 2011).

Distance – Geographical and organizational

The effectiveness of collaboration may depend on the ability of members with different background to collaborate. Behavior in online communities can be significantly different from one culture to another. In order to be successful in creating a multinational knowledge-based online community, a well designed online community should take into account differences in employee's values, perceptions, preferred style of communication, and cognitive and learning style (Gallagher & Savage, 2013). Geographical distance has an influence on group functioning and proximity has shown to increase attention, social impact and familiarity between group members. Face-to-face interaction between members is the most direct and easy route to a deeper understanding of the tasks and creates an opportunity to observe and learn from one another. Distance can lead to inattention between co-workers and lower effort in group functioning. The effects of dysfunction due to distance are noticeable when the distance between members is such that they stop meeting spontaneously at the coffee machine, copier, etc., and increases with greater distance (Kiesler & Cummings, 2002). Greater geographical distance is therefore likely to affect ideation negatively but increased organizational distance has however shown to have its positive effects. Individuals in different locations within the organizations are assumed to hold different knowledge sets and values. If the organizational distance is greater, the chance of creating radical ideas is higher, because new knowledge is created through a combination of existing ideas and information. However if the organizational distance is smaller, ideation is more likely to result in incremental ideas based on in-depth analysis. If the difference between knowledge sets of individuals in collaboration is too great, the result of ideation in general is believed to be negative as there is a lack of mutual interest and understanding (Bergendahl & Magnusson, 2015).

Informal leaders – Hidden factor

An informal leader is an individual within an organization that is able to influence the decisions of others and have a very strong effect on group goals and group performance. The informal leader receives its authority and power not from hierarchical position, but from peers based on his experience and reputation (Pescosolido, 2001). This influence is likely noticed within idea management systems, but the definition of the role is somewhat captured by other dimensions, such as, network position, activity level and skill level. Therefore, it is not viewed as a separate dimension in this theoretical framework although it is important to acknowledge the role of the informal leader.

2.5.2 Feedback Process

The conversation between an idea creator and different feedback providers may develop in different ways depending on feedback source availability and support for feedback seeking within an organization. The dynamics of this conversation affects the development of the idea as the feedback will generate different reactions depending on the different factors that can be used to describe the process of the conversation. Those factors are:

- Compressed vs. Stretched - in time
- Repeated or Iterative
- Number of Feedback per Idea

Compressed vs. Stretched – in time

Studies within behavioral management have shown that feedback is more effective when provided in a timely and objective manner. The feedback becomes less stimulating for the receiver as time passes. In a computer-mediated idea generation environment, providing feedback timely is one of the main motivational factors for the participants (Jung, et al., 2010). Providing feedback with timely responses is important so that the flow of cognition and action does not break (Zhang, 2008). This can directly be related to collective ideation as timely responses could therefore lead to a focus of attention of participants to a specific subject.

Repeated or Iterative

Repeated or iterative responses by either a feedback provider or idea creator demonstrates that the individual is interested and advert to the subject. Repeated interactions between participants allow for discovery of knowledge that may be hard to achieve with a single interaction, allowing value-creation through repeated interaction. (Mell, et al., 2015).

Number of Feedback per Idea

The total number of feedback per idea provided not only demonstrates how well an idea matches the interests and knowledge area of other users but is also a measure of the effectiveness of a collaboration. The amount of communication, as well as the quality, are an effective measure in assessing effectiveness of a collaboration (Karakaya & Demirkan, 2015). If we look at feedbacks as a distribution of potential payoff, it becomes apparent that by increasing the sample size, or the number of feedback per idea, increases the likelihood of obtaining a greater payoff, in our case more valuable feedback. However, the expected increase in value decreases gradually with growing sample size (Leiponen & Helfat, 2010). This suggests that number of feedback per idea may affect idea quality positively until a potential saturation in information has been reached.

2.5.3 Feedback Content

The content of the feedback is central to how the feedback will affect the development of the idea. Feedback content will contribute to the definition of the idea if provided as additional information, but can also affect the motivational state of the participant involved in the ideation process dependent on other factors, e.g. feedback valence, feedback style, etc., satisfying or dissatisfying achievement and affiliation needs of participants (Özer,

2013). In this tentative theoretical framework feedback content contains the following factors:

- Additional Information
- Confirmation vs. Objection
- Feedback Valence – Positive vs. Negative
- Feedback Style – Informative vs. Controlling
- Feedback Formulation/Complexity

Additional Information

Additional information provided can either strengthen or diminish the validity of the idea. The information can affect the quality of the idea in terms of, for example, novelty, feasibility, profitability and strategic alignment, and can therefore be a deciding factor of whether the idea is chosen to become a development project or not (Archer & Ghasemzadeh, 1999). Added information can contribute to different areas of the idea definition, for instance with regard to the problem or the solution. The problem definition represents a need in the market and the solution definition a potential means to satisfy that need. Information that improves the definition of these areas will be of value to the development of the idea (Magnusson, 2015).

Confirmation vs. Objection

The content of feedback can suggest a confirmation or an objection to the validity of an idea. A rejection or an approval can affect the motivational state of the participants and the following activity for that idea. An objection is most likely affiliated with negative results and confirmation with positive results, but an interesting aspect is to evaluate whether objection delivered in an informative or positive way could yield better results, which would be expected for individual performance but perhaps not as meaningful on an idea basis.

Feedback Valence - Positive vs. Negative

Feedback valence describes whether feedback on individual‘s performance is constructed in a positive or negative manner. Positive feedback has in previous research been related to higher creative performance, while negative feedback is associated with lower creative performance. Motivation is one of the key drivers of creativity. Motivation can be defined as either intrinsic or extrinsic in nature, where positive feedback acts as a stimulus for intrinsic motivation. An individual driven by intrinsic motivation is motivated by an interest in the task itself, preferring complexity and novelty in the task, while an individual motivated by extrinsic motivation is in general motivated to complete a task in order to attain an external reward. Intrinsically motived individuals are believed to be more likely to exhibit high creativity (Zhou, 1998).

Feedback Style – Informative vs. Controlling

The feedback style, whether a feedback is provided in an informative or controlling manner, is just like feedback valence associated with an individual‘s motivation. Informative feedback gives the recipient a sense of autonomy and is most likely interpreted as constructive, informative, understanding and supportive. The message will therefore stimulate intrinsic motivation and help the recipient to maintain a high performance or encourage him to improve his performance. Controlling feedback however gives a sense of reduced autonomy and is likely to be interpreted as inhibiting and restraining, and is

therefore believed to affect performance in a negative way (Zhou, 1998). Informative feedback, either positive or negative, is therefore believed to produce better result than controlling feedback.

Feedback Formulation/Complexity

Feedback can be formulated in multiple different ways, e.g. as text, picture, video or hyperlink, and can vary in complexity. The effectiveness of complex messages is related to a person‘s need for cognition, or the tendency of an individual to engage in cognitive activities. A person with high need for cognition is more likely to be influenced by the quality of substantive message argument, while a person with low need for cognition is more likely to be influenced by messages that provide a fast understanding of the content (See, et al., 2009). These motivational difference for people with different needs for cognition may affect how messages different in formulation and complexity are evaluated.

Figure 1: Tentative theoretical framework for feedback in collective ideation.

3 Method and research settings

This empirical research is a study within the subject of ideation and was carried out by using a theoretical framework for feedback in collective ideation. The framework will be used as a basis for a statistical analysis on data acquired from a multinational telecommunications company (in this thesis referred to as TeleCom company). In this chapter I will describe the method and research settings for the analysis of the data.

3.1 Research Settings

This study and the accompanying report was generated under joint supervision of KTH Royal Institute of Technology and the University of Iceland. The headquarters of the TeleCom company and KTH are both located in Stockholm, Sweden, and they have developed a close research based relationship, serving a mutual benefit for both parties. Therefore, with interest from myself, the department of integrated product development at KTH, and the TeleCom company, it was decided to use data from the internal idea management system of the TeleCom company to study feedback in collective ideation.

3.2 Research delimitations

This research could potentially have benefitted from a comparison of the TeleCom company's data with data from other organizations, but due to the fact that usage of comparable idea management systems is currently not very widespread, access to other sources of data is not easily available. Consequently, due to data availability, project scope, and time constraints, the TeleCom company's data was used as the single source of data for this empirical research.

3.3 The TeleCom company's idea management system

The TeleCom company is a Swedish multinational organization working within communications technology and services, operating in over 100 countries worldwide. In 2008 an internal idea management system (in this thesis referred to as IMS) was launched within the company. IMS was designed to create a common web-based platform where ideas from all the different subsidiaries can be shared, developed and selected for development projects. The IMS system consists of several hundred different IMS boxes. IMS boxes can be created at any time and are normally created for specific functions or problems. When an idea is submitted to the system it is submitted to a specific IMS box. Based on the content of the idea it can be moved to a different box if it matches better the description of another box. Feedback or comments on the ideas are then provided within the IMS box containing the idea. Each IMS box is managed by one or more innovation managers, who are responsible for managing the box, as well as promoting the box and the ideas created within the box to the organization. The role of the innovation manager is a voluntary position and is not necessarily dependent on hierarchical position or other function of that individual within the organization.One measure of idea quality within the system is the ability of innovation managers to claim an idea. Ideas are claimed for interest, action, or implementation, which signals that further resources can be assigned for actions related to

the development of the idea. This representation of idea quality is the dependent variable in our study. Since the launch of the system in 2008 a global adaptation of the system within the organization has been successful, it is currently the system of choice after replacing multiple local tools. In mid-2013 the system contained approximately 450 IMS boxes, 35.000 ideas and 70.000 comments (Björk, et al., 2014; Paynter, n.d.).

3.4 IMS box selection

The IMS box that was selected for the empirical study is a general research and development (R&D) IMS box from the TeleCom company's subsidiary in Hungary. The TeleCom company has a long history of operating in Hungary dating back to 1911 when the TeleCom company acquired two telephone plants, one in Budapest and one in Vienna. Now the company has an approximately 1.700 person staff in Hungary, thereof 1.200 working within their R&D unit, making it one of four most important R&D sites of the TeleCom company (The TeleCom company, 2015). The unit in Hungary has implemented the IMS idea management system very successfully and is acclaimed as one of the company's most effective sites in usage of the system. Therefore it was of great interest to select an IMS box from the site in Hungary. The general R&D IMS box was selected as it is a box of favorable size, containing 238 ideas and 1022 feedbacks. The lifetime of this IMS box is fixed as the box was closed in 2014 due to management decisions to replace it with a number of boxes that are more specific and less general with regards to subjects (Beretta, 2015). The first activity within this specific box was an idea created in April 2009 and the last activity registered was a feedback in December 2014.

3.5 Interviews

Three semi-structured interviews were conducted to gain deeper understanding of the research settings. First an interview two employees of the TeleCom company at the company's headquarters in Stockholm. Both of those employees work at maintaining and developing IMS, the idea managements system used and developed by the TeleCom company. They shared their experience and knowledge on the system and gave me a hands-on introduction on how the system is used. The second interviewee was a PhD. Student in innovation management at Aarhus University, who performed a research on ideation in web-enabled ideation systems. Part of her research involved interviewing innovation managers from the TeleCom company in Hungary allowing her to give me good insight into the management of the Hungarian IMS boxes, as well as supporting the selection of the R&D general IMS box for the statistical analysis. The third interview was with a manager within the TeleCom company who has direct supervision of the development of the IMS. He gave me helpful feedback on my work as well as further insight into the TeleCom companies IMS and its potential future development.

3.6 Variables

The data acquired from the TeleCom company is used for statistical analysis with respect to the research questions. The variables contained in the data will be used in a logistic regression model as independent variables or dependent variables. The independent variables can all be categorized by the different dimensions of the theoretical framework, which is explained in the description of each variable, while the dependent variable represents the quality of the idea. None of the variables relate to the fundamental dimension

Feedback Providers as the data did not contain any human resource information due to the TeleCom company's policy. A significant difference in the nature of the variables is how they are created. The data used in the analysis consists firstly of all the data recorded by the idea management system, which in this report be will called system variables, and secondly by data generated by the author of this report when interpreting the content of the feedbacks provided, which will be called interpreted variables. A large number of variables was initially created with the objective of being able to filter them down to a suitably sized subset based on different filtering techniques, described in section 3.9. A description of all the relevant variables is provided in the sections below, categorized by how they were created. Whether their role in the logistic regression model will be as independent or dependent variables will be stated in their text description. The lack of control variables is discussed and a table with all the variables is provided for quick reference.

3.6.1 System variables

All variables created by the system when an idea or a feedback is generated, or other activity within the system is recorded. Also all variables derived directly from those variables through calculations, e.g. count of number of feedback per idea, length of text, etc.

Time from Idea Max – Independent variable

The time elapsed from when an idea was created in the system until the last feedback regarding that specific idea was recorded. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Time from Idea Average – Independent variable

The average time elapsed for all feedbacks provided to one specific idea, the time interval being from when the idea was created until the feedback was provided to that specific idea. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Time from Idea STDEV – Independent variable

The standard deviation for the time elapsed for all feedbacks provided to one specific idea. The time interval being from when the idea was created until the feedback was provided to that specific idea. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Time from last Activity Max – Independent variable

The maximum time elapsed between any single activity to the next for a specific idea, from idea creation to the last feedback provided. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Time from last Activity Average – Independent variable

The average time elapsed between all activities for a specific idea, from idea creation to the last feedback provided. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Time from last Activity STDEV – Independent variable

The standard deviation for the time elapsed between activities for a specific idea, from idea creation to the last feedback provided. This variable is measured in seconds and relates to *Compressed vs. Stretched* dimension of the theoretical framework.

Number of Feedback per Idea – Independent variable

The total number of feedback provided for a specific idea. This variable relates to the *Number of Feedback per Idea* dimension of the theoretical framework.

Unique Contributors – Independent variable

The total number of unique contributors for a specific idea, counting the idea provider and all feedback providers. This variable relates to the *Repeated/Iterative* dimension of the theoretical framework.

Iterations – Independent variable

Counts the number of instances the same individual provides feedback to an idea. The resulting number for each idea is the maximum number of feedback provided by one individual for that specific idea. This variable relates to the *Repeated/Iterative* dimension of the theoretical framework.

Idea Creator Comments – Independent variable

Counts the number of instances the idea creator provides feedback to his own idea. This variable relates to the *Repeated/Iterative* dimension of the theoretical framework.

Text Length Sum – Independent variable

The total text length of the feedbacks provided to a specific idea. This variable relates to the *Formulation/Complexity* dimension of the theoretical framework.

Text Length Average – Independent variable

The average text length of a feedback provided to a specific idea. This variable relates to the *Formulation/Complexity* dimension of the theoretical framework.

Total Rating Up – Independent variable

The system provides the option of rating the idea up or down without leaving any textual feedback. This variable counts the total number of instances when a specific idea has been rated up. This variable relates to the *Confirmation vs. Objection* dimension of the theoretical framework.

Total Rating Down – Independent variable

The system provides the option of rating the idea up or down without leaving any textual feedback. This variable counts the total number of instances when a specific idea has been rated down. This variable relates to the *Confirmation vs. Objection* dimension of the theoretical framework.

Claimed – Dependent variable

This variable is the dependent variable in our study and indicates whether an idea has been claimed for interest, action, or implementation. The value of the variable is binary, one representing claimed, and null representing not claimed. This variable represents idea quality in our study.

Claimed Anytime – Dependent variable

This variable indicates whether an idea has been claimed for interest, action, or implementation at any point in the lifetime of the IMS box. Ideas claimed in this variable but not in the variable Claimed, have therefore been unclaimed at some point in time. This variable could potentially be of interest in the analysis as a replacement to the dependent variable Claimed. The value of the variable is binary, one representing claimed, and null representing not claimed.

3.6.2 Interpreted variables

Interpreted variables are all variables that are interpreted by the author of this thesis from the content of the feedbacks and ideas in the idea management system. Also all variables created by Semantria which is a text and sentiment analysis software. Semantria is able to determine whether text is positive, negative, or neutral, and can therefore act as a potential replacement for manual interpretation in this and/or future research if the results are comparable to manual interpretation. The Semantria software also generates a language strength value which can serve as a potential measure of complexity of feedback.

Additional Information on Solution – Independent variable

Counts the number of feedback for a specific idea that provide any additional information regarding how to solve the problem defined in the idea. This variable relates to the *Additional Information* dimension of the theoretical framework.

Additional Information on Problem – Independent variable

Counts the number of feedback for a specific idea that provides any additional information that adds to the definition of the problem defined in the idea, e.g. addition of a related problem, correction of a misconception in idea content related to problem, etc. This variable relates to the *Additional Information* dimension of the theoretical framework.

Additional Information on Market – Independent variable

Counts the number of feedback for a specific idea containing any information related to the idea‘s market environment. Market information can be any kind of user information, information on competing or similar products/services, information on registered patents for similar products/services, etc. This variable relates to the *Additional Information* dimension of the theoretical framework.

Additional Information on Technology – Independent variable

Counts the number of feedback for a specific idea containing any technical information related to the content of the idea. This variable relates to the *Additional Information* dimension of the theoretical framework.

Confirmation – Independent variable

Counts the number of feedback confirming in any way the validity of the idea. This variable relates to the *Confirmation vs. Objection* dimension of the theoretical framework.

Objection – Independent variable

Counts the number of feedback objecting in any way to the validity of the idea. This variable relates to the *Confirmation vs. Objection* dimension of the theoretical framework.

Positive – Independent variable

Counts the number of feedback that are positive towards the content of the idea. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

Negative – Independent variable

Counts the number of feedback that are negative towards the content of the idea. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

Neutral – Independent variable

Counts the number of feedback that are neutral towards the content of the idea. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

Idea Exists – Independent variable

Counts the number of feedback where the feedback provider claims that there is an existing product/service in the market that serves the same function as that specific idea. This variable relates to the *Additional Information* dimension of the theoretical framework.

Idea Exists in IMS – Independent variable

Counts the number of feedback where the feedback provider claims that there is another idea within IMS that serves the same function as that specific idea. This variable relates to the *Additional Information* dimension of the theoretical framework.

Idea Partly Exists – Independent variable

Counts the number of feedback where the feedback provider claims that there is an existing product/service in the market that partially, but not entirely, serves the same function as that specific idea. This variable relates to the *Additional Information* dimension of the theoretical framework.

Idea Evaluation – Independent variable

Counts the number of instances when a feedback states that the idea has been sent to an individual or a group for evaluation. It also includes instances when an idea is advised to be sent to a specific person for evaluation. This variable relates to the *Additional Information* dimension of the theoretical framework.

Innovation Manager Status Request – Independent variable

Counts the number of instances when an innovation manager asks about the status of the idea, usually the innovation manager asks whether he can close the idea or if the idea should

remain open. This variable relates to the *Feedback Style* dimension of the theoretical framework.

Idea Closed – Independent variable

Counts the number of instances where a feedback provided states that this specific idea has been closed. This variable relates to the *Additional Information* dimension of the theoretical framework.

Idea Moved – Independent variable

Counts the number of instances where a feedback provided states that this specific idea has been moved to a different IMS box within the TeleCom company. This variable relates to the *Additional Information* dimension of the theoretical framework.

Idea Implemented – Independent variable

Counts the number of instances where a feedback provided states that this specific idea has been implemented within the TeleCom company. This variable relates to the *Additional Information* dimension of the theoretical framework.

Language Strength Sum – Independent variable

The sum of all the values that each feedback is given in language strength for a specific idea, calculated by Semantria which is a text and sentiment analysis software. This variable relates to the *Formulation/Complexity* dimension of the theoretical framework.

Language Strength Average – Independent variable

The average of all the values that each feedback is given in language strength for a specific idea, calculated by Semantria. This variable relates to the *Formulation/Complexity* dimension of the theoretical framework.

Semantria Positive – Independent variable

Counts the number of feedback that are positive towards the content of the idea, where positivity is determined by Semantria. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

Semantria Negative – Independent variable

Counts the number of feedback that are positive towards the content of the idea, where negativity is determined by Semantria. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

Semantria Neutral – Independent variable

Counts the number of feedback that are positive towards the content of the idea, where neutrality is determined by Semantria. This variable relates to the *Feedback Valence* dimension of the theoretical framework.

3.6.3 Lack of control variable

Ideally we would be able to control for the quality of the idea originally submitted to the idea management system, so that the empirical research would solely explain the development of idea quality based on the feedback provided. Without the control variable it is hard to separate the effect of the original idea from the original idea with additional quality stemming from the feedback provided. However as that data is not accessible, the empirical research ignores the quality of the original idea while the effect will be taken into account in the analysis and discussions of the results.

3.6.4 Quick reference table

In this section all variables are presented in a table for quick reference. The table shows which dimension in the theoretical framework the variables relate to, as well as the source type, number format, and variable type.

Table 1: A list of all variables in the data.

Variable Name	Source type	Feedback dimension	Number format	Variable type
Time from Idea Max	System	Compressed vs. Stretched	Continuous	Independent
Time from Idea Average	System	Compressed vs. Stretched	Continuous	Independent
Time from Idea STDEV	System	Compressed vs. Stretched	Continuous	Independent
Time from Last Activity Max	System	Compressed vs. Stretched	Continuous	Independent
Time from Last Activity Average	System	Compressed vs. Stretched	Continuous	Independent
Time from Last Activity STDEV	System	Compressed vs. Stretched	Continuous	Independent
Number of Feedback per Idea	System	Number of Feedback per Idea	Continuous	Independent
Unique Contributors	System	Repeated/Iterative	Continuous	Independent
Iterations	System	Repeated/Iterative	Continuous	Independent
Idea Creator Comments	System	Repeated/Iterative	Continuous	Independent
Text Length Sum	System	Formulation/Complexity	Continuous	Independent
Text Length Average	System	Formulation/Complexity	Continuous	Independent
Total Rating Up	System	Confirmation vs. Objection	Continuous	Independent
Total Rating Down	System	Confirmation vs. Objection	Continuous	Independent
Claimed	System	Idea Quality	Binary	Dependent
Claimed Anytime	System	Idea Quality	Binary	Dependent
Additional Information on Solution	Interpreted	Additional Information	Continuous	Independent
Additional Information on Problem	Interpreted	Additional Information	Continuous	Independent
Additional Information on Market	Interpreted	Additional Information	Continuous	Independent
Additional Information on Technology	Interpreted	Additional Information	Continuous	Independent
Confirmation	Interpreted	Confirmation vs. Objection	Continuous	Independent
Objection	Interpreted	Confirmation vs. Objection	Continuous	Independent
Positive	Interpreted	Feedback Valence	Continuous	Independent
Negative	Interpreted	Feedback Valence	Continuous	Independent
Neutral	Interpreted	Feedback Valence	Continuous	Independent
Idea Exists	Interpreted	Additional Information	Continuous	Independent
Idea Exists in IMS	Interpreted	Additional Information	Continuous	Independent
Idea Partly Exists	Interpreted	Additional Information	Continuous	Independent
Idea Evaluation	Interpreted	Additional Information	Continuous	Independent
Innovation Manager Status Request	Interpreted	Feedback Style	Continuous	Independent
Idea Closed	Interpreted	Additional Information	Continuous	Independent
Idea Moved	Interpreted	Additional Information	Continuous	Independent
Idea Implemented	Interpreted	Additional Information	Continuous	Independent
Language Strength Sum	Interpreted	Formulation/Complexity	Continuous	Independent
Language Strength Average	Interpreted	Formulation/Complexity	Continuous	Independent
Semantria Positive	Interpreted	Feedback Valence	Continuous	Independent
Semantria Negative	Interpreted	Feedback Valence	Continuous	Independent
Semantria Neutral	Interpreted	Feedback Valence	Continuous	Independent

3.7 Data preparation

The process of retrieving raw data from an original source and perform operations on the data to make it applicable in another environment is often referred to as ETD, an abbreviation for extract, transform, and load. In our case the raw data from the TeleCom company was extracted from Microsoft SQL Server Management Studio, where all information collected in the IMS is stored. A SQL syntax was written to extract all feedbacks and ideas that were created in the Hungarian R&D general IMS box, along with all associated information of interest. Few ideas had no feedbacks and were extracted separately. The syntax created a table that could be copied to Microsoft Excel. In Excel, all system data, data provided by the idea management system or directly derived from that, could be rearranged and generated. The most time consuming part was to generate the interpreted data. Every single feedback

had to be read with respect to its respective idea and subsequently the columns for variables describing the content of the feedback were manually filled out. Few variables, e.g. *Language Strength*, *Semantria Positive*, etc., were created using Semantria, a text and sentiment analysis software that can be used as add-on to Excel and this added an interesting automated interpretation of text. When all variables had been derived from the feedbacks, the information could be transformed from feedback based to idea based in a separate sheet in Excel, as the data will be analyzed on idea basis in R. To expedite the manipulation of the data in Excel, Visual Basic for Application was commonly used to allow for more conventional programming methods for automation of the tasks. When the idea based sheet had been generated, the excel sheet could be saved as Comma-separated value (CSV) file which is a good format to load into R.

3.8 Limiting the data

When the data was observed in more detail it became obvious that there was an inconsistency in whether ideas got claimed depending on when the ideas had been created. None of the 37 last ideas created in the system were claimed, while prior to that, the average interval between claimed ideas was three ideas. The IMS box was created in 2009 and closed in 2014 due to management decisions of replacing a general box with fewer, more topic specific, boxes. Independent of whether imminent closure caused lack of interest or vice a versa, it was imperative for our study to exclude the "unhealthy" part of the data. Plotting the claimed variable with respect to idea number shows the sudden decrease in interest, *Claimed* represented by 1 and *Not Claimed* by 0 on the y-axis, see figure below.

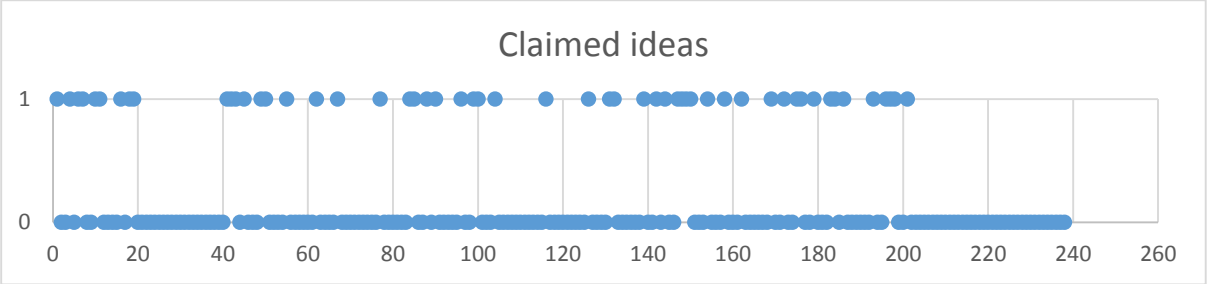

Figure 2: Claimed ideas versus number of ideas.

To include the potential uncertainty of the end point, the average number of ideas between claimed ideas prior to last claimed idea was used in calculating the cutting point for the data. The following formula was used to calculate the end point with the result of the 204 first observations used in the research.

$$N = Index\ of\ last\ idea\ claimed + \frac{Index\ of\ last\ idea\ claimed - Number\ of\ claimed\ ideas}{Number\ of\ claimed\ ideas}$$

$$N = 201 + \frac{201 - 54}{54} = 204$$

3.9 Data analysis

The data was statistically analyzed using R, a free software environment for statistical computing and graphics. To study the relationship between the independent and the

dependent variables a logistic regression method was used to analyze the dataset. The choice of logistic regression is based on the value of the dependent variable, which in our case is binomial, i.e. either 1 for *Claimed* or 0 for *Not Claimed*. Regression analysis is commonly used for research analysis. The method derives models from quantitative data that establish the relationship between independent and dependent variables. If the model has a good fit it can both describe the significance of the different variables and be used for prediction of the dependent variable. In this thesis we aim to use regression analysis to determine to what extent idea quality (dependent variable) can be described by the feedback dimensions (independent variables) of the theoretical framework (Byrne, 2006). Logistic regression applies a non-linear log transformation to the predicted odds ratio, and therefore it does not require the independent variables to have a linear relationship with the dependent variables. The method does also not require multivariate normally distributed variables, homoscedasticity, etc., with the result that all independent variables could be used without any transformation (Statistics Solutions, 2015).

The dependent variable in our model is the *Claimed* variable. *Claimed* represents the target of the process of supplying feedback to an idea, to either arrive at a *Claimed* or a *Not Claimed* state. It also represents idea quality, good ideas are *Claimed* while worse ideas are *Not Claimed*. To create the model that represent the dependent variable in the best way, all the independent variables previously presented will be considered. Data has been generated for 38 independent variables. A subset of these variables will however be used for the final regression model as some of the original variables may turn out to be irrelevant or not of interest. To arrive at the subset of independent variables that will be used in the final regression model the variables were filtered using three methods:

- Generate a correlation matrix to analyze the correlation between the independent variables and the dependent variable, and select a group of variables based on that. Correlation is a measure of association of two numerical variables and will demonstrate which of the independent variables are associated with the dependent variable. Correlating variables are therefore of higher interest than a variable with no association to the dependent variable (Crow, 2006).
- Evaluate multicollinearity with a stepwise method for all independent variables, and either pair groups based on that or exclude variables to eliminate certain level of collinearity. Multicollinearity is the measure of how dependent the variables are to each other. A high degree of multicollinearity increases the standard error of the model and decreases the quality of the model (Martz, 2013).
- Perform an evaluation based on the correlation and multicollinearity and five other factors to arrive at the final set of variables. The five factors are:
    1. *Pairs*. Pairs are variables that are related in nature and are preferably either both presented or none, for example, *Positive* and *Negative*, or *Confirmation* and *Objection*.
    2. *Grouping.* If two or more variables appear to describe the same attribute, then a grouping of the variables may be feasible.
    3. *Similarity to dependent variable*. If variables are describing something that has an obvious relation to the dependent variable, such as a feedback where a feedback provider states that an idea has been implemented, then it is of lower interest.
    4. *Interest due to theoretical framework.* If a variable is highly representative for a feedback dimension in the theoretical framework then it is of higher

interest. A variable with an unclear relation to the theoretical framework is of lower interest.

5. *Pseudo R^2*. Pseudo R^2 is a measure of how well a model fits the data. When there is a question whether a variable should be included or not, Pseudo R^2 can be calculated for the model with and without the variable to determine the effect it has on the fit of the model.

The resulting final set of variables will be used to create the logistic regression model in R. R will then provide all the model parameters and reveal which variables are significant to the model. To validate how well the model fits the data I will use two validation methods for logistic regression models:

- Nagelkerke's pseudo R^2. Conventional R^2 used to determine how well a statistic model fits data does not apply to logistic regression models. Therefore several pseudo R^2 formulas have been developed to perform the same measure for logistic regression. Although ranging from 0 to 1, caution has to be taken in interpretation as it does not measure fit in the same way (Institute for Digital Research and Education, 2011).
- Hosmer-Lemeshow goodness of fit test. The test is a significance test of whether the null hypothesis for the model is significant or not. The outcome of the test is a p-value, and if that value is below a certain criteria, for example the conventional $p<0,05$, then there is evidence that the model fits the data poorly (Bartlett, 2014).

4 Results

In this chapter there is a presentation of the findings from the statistical analysis performed on the data from the TeleCom company's idea management system IMS, more specifically a general R&D IMS box from the TeleCom company's site in Hungary. But first there will be provided general descriptive statistics for the IMS box.

4.1 Descriptive statistics

A number of interesting statistics can be obtained from the data that provide a good description of the performance of this IMS box. After limiting the data the IMS box contains 204 ideas and 919 feedback. The ideas in the data used in the empirical research were created in the time period from the 2nd quarter of 2009 to the 4th quarter of 2011. The number of ideas submitted per quarter can be seen in the figure below.

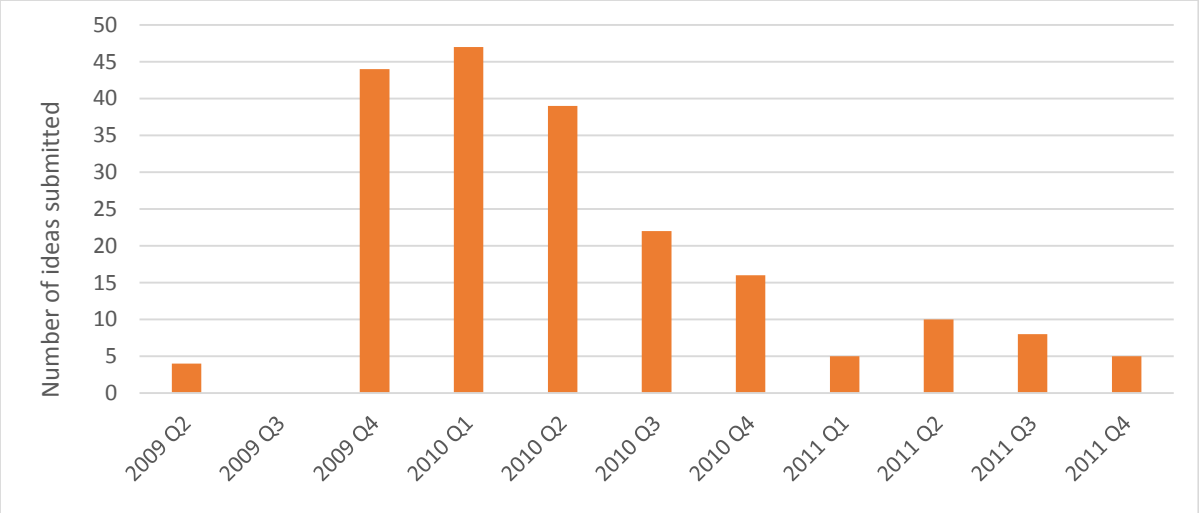

Figure 3: Number of ideas submitted per quarter.

The feedbacks provided for the ideas represented in the graph above were provided from the 2nd quarter of 2009 to the 4th quarter of 2014. The number of feedback per quarter can be seen in the figure below.

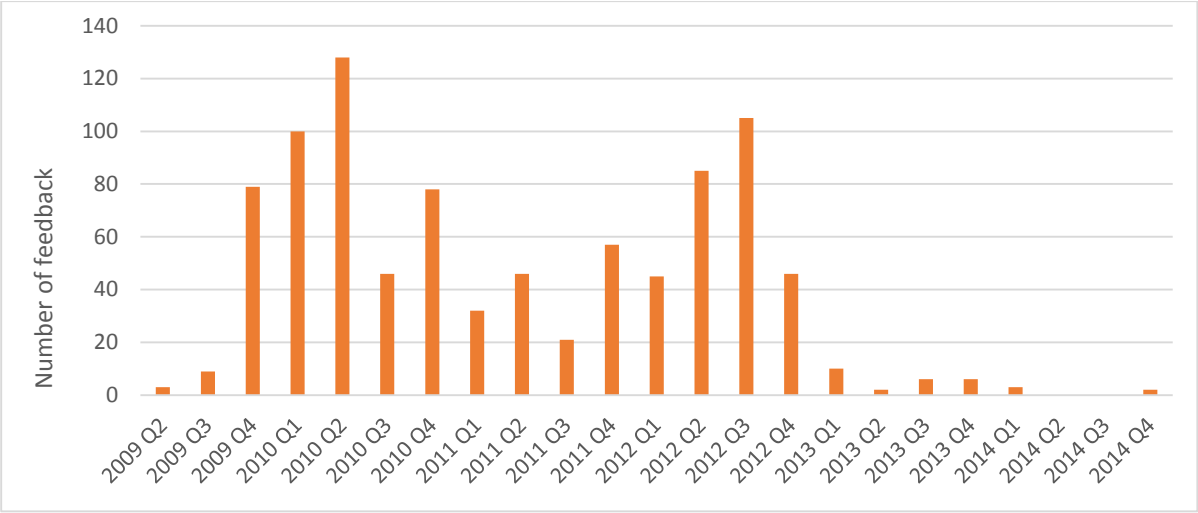

Figure 4: Number of feedback submitted per quarter.

From viewing the two graphs above, it is interesting to see how the number of feedback does not follow the curve of the number of ideas submitted. A table was created for all the ideas in the IMS box to see if there potentially was an increase in submitted ideas that was not presented in the graph because the data was cut. This table can be seen in appendix A. That was however not the case. So for an unknown reason there was great interest in the IMS box both at idea and feedback level in 2010, but on a much greater scale at feedback level in 2012.

As the focus of this thesis is on feedback it is interesting to see a histogram for how often a specific *Number of Feedback per Idea* occurred. The histogram can be seen in the figure below.

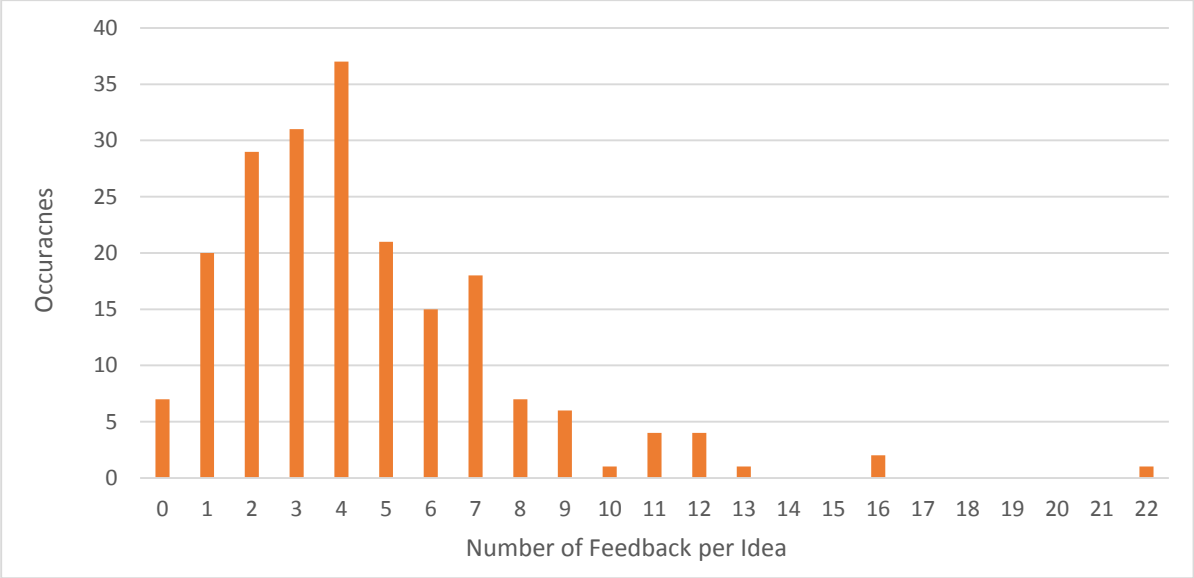

Figure 5: Occurrences for all Numbers of feedback per idea.

We see that the *Number of Feedback per Idea* is ranging from 0 to 22, and the most common value is 4. In the graph below we can see the number of *Claimed* ideas related to *Number of Feedback per Idea*.

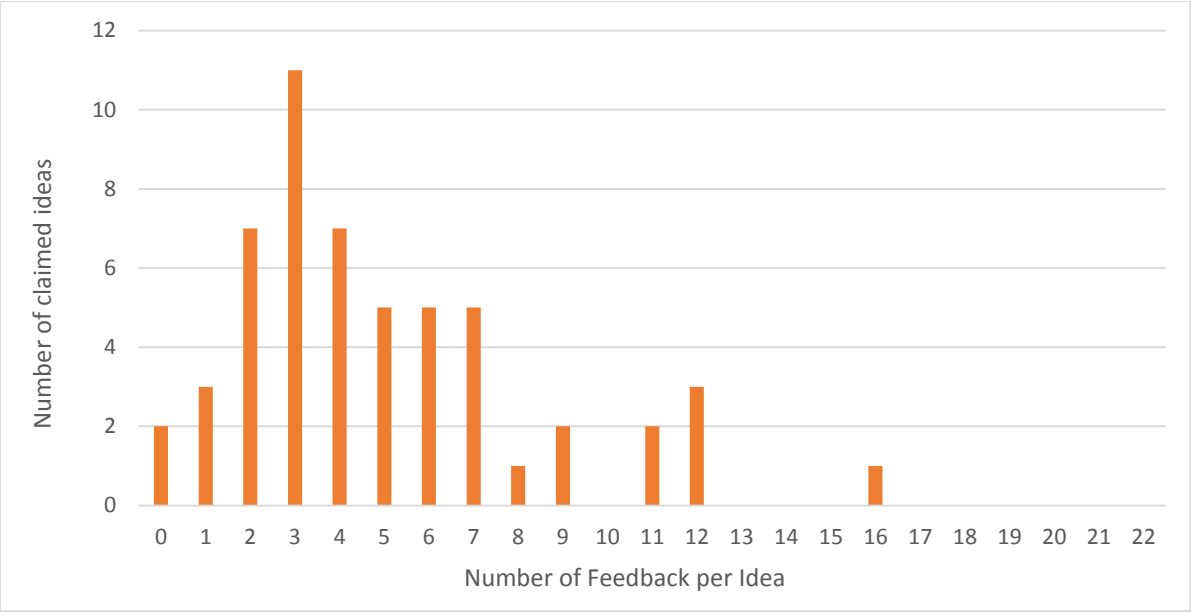

Figure 6: Occurrences for all Numbers of feedback per idea.

Ideas have been claimed for *Number of Feedback per idea* ranging from 0 to 16. This shows that number of ideas with very low *Number of Feedback per Idea* are being claimed, a reminder of the importance of the quality of the original idea. This subject will be addressed in the analysis and discussion chapter.

4.2 Classification observations

After classifying the data manually a few observations are worth noting as they give insight into the working environment of the IMS box and reveal potential flaws.

- The innovations managers for this IMS box regularly create a comment in the system where they ask the idea creator how the idea is progressing, whether they can close the idea or if they should let it remain open. The implication in most instances is that they want to close the idea, making the comment negative in nature. It would be interesting to see the question routinely formulated in a positive manner to appeal to the motivation of the individual, to encourage continued creativity of the individual.
- In a number of instances an idea is closed because the idea creator is transferred within the company or stops working for the company. In some of the instances the idea has received numerous positive feedbacks, leading to the assumptions that the idea possessed a level of quality. Therefore, someone else should potentially have been assigned to the idea instead of closing it.
- Numerous comments reveal that communication regarding ideas are also taking place outside the realms of the idea management system, for example, face-to-face, emails, etc. Face-to-face communication is the most direct and easy route to deeper understanding, so it most likely has a positive effect on the idea development, but may however cause missing information for our empirical research.
- Quite suddenly ideas were not being claimed anymore, it was evident that there was no longer any interest in the IMS box. This drop of interest was taken into account by limiting the data to 204 observations as previously described in section 3.8.

- Some ideas generate more feedback than others due to the nature of the idea. For example, some ideas may touch upon subjects that are emotional to other participants and can therefore result in an argument between participants which has no relation to the development of the idea.

4.3 Human vs. software interpretation of feedback valence

Feedback valence, i.e. *Positive*, *Negative*, and *Neutral*, were interpreted by two different methods that will be briefly compared in this section. Feedback valence was interpreted by the author as well as Semantria, a text and sentiment analysis software. There are clear benefits to being able to automate the interpretation of the content within idea management systems, so filtering of ideas can occur simultaneously to idea activity. Therefore an experiment was made to compare the two methods in an effort to determine whether Semantria could be used to replace the slow process of interpreting feedback valence manually. A comparison of these two methods can be seen in the table below.

Table 2: A comparison of human vs. software interpretation of Feedback Valence

	Positive	Negative	Neutral
Human interpretation (instances)	447	282	190
Semantria interpretation (instances)	332	92	495
Same result	64%	69%	56%
Semantria rates more often	12%	5%	39%
Semantria rates less often	24%	26%	5%
	100%	100%	100%

The feedback is evaluated the same if both methods interpret a specific message equally. The human and software interpretation is the same in 54% to 69% of instances. It can be seen that the software interpretation is much more likely to interpret the feedback as neutral, while the human interpretation is more likely to interpret the feedback more often as positive or negative.

4.4 Correlation between variables

A correlation matrix was generated in R to create a visualization of the correlation between different variables. All 38 variables were used, showing correlation of all variables to one another, where blue represents the value 1, or perfect positive correlation, white represents the value 0, or no correlation, and finally red represents -1, or perfect negative correlation. The variable of interest is the dependent variable *Claimed*, so we will observe from the matrix which other variables correlate with *Claimed*, see figure below.

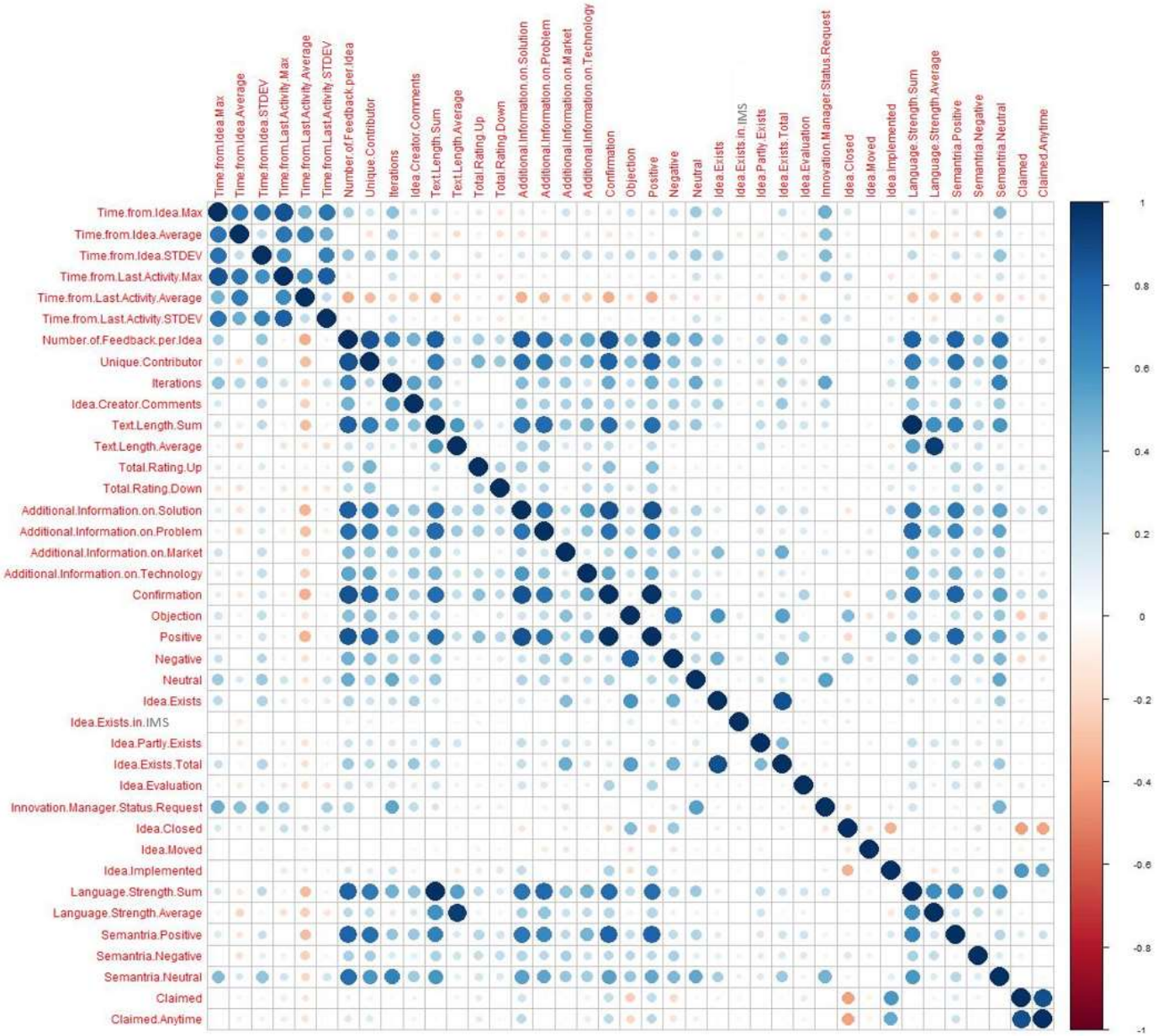

Figure 7: Correlation matrix for all variables.

Same matrix can be generated with numbers instead of colors for more accurate reading and can be seen in appendix B. The correlation of *Claimed* with the other variables ranges from -0,41 for *Idea Closed* to 0,88 for *Claimed Anytime*. Both of these variables will be excluded, as well as *Idea Implemented*, as their relation to *Claimed* is too obvious and therefore not of interest. If we set a threshold of 0,1 in either positive or negative direction we obtain a reasonable amount of variables correlating with *Claimed*. Based on that, the variables of interest are:

- Time from last Activity Max
- Time from last Activity Average
- Additional Information on Solution
- Confirmation
- Objection
- Positive
- Negative
- Idea Evaluation
- Semantria Positive
- Total Rating Up

4.5 Multicollinearity

For logistic regression models it is important to reduce multicollinearity between different variables as logistic regression requires each observation to be independent. The method VIF in R is used to analyze collinearity between all independent variables. When using the function VIF, values greater than 10 indicate significant multicollinearity and should not be used for the regression model. A more stringent practice is to set the threshold to a value of 3. In our case we will use a stepwise method and iterate the VIF function until all remaining variables have a multicollinearity factor less than 3, however allowing reintroduction of variables of interest as long as they do not exceed the value 10 (Zuur, et al., 2010). The table below displays the multicollinearity results for all variables.

Table 3: Multicollinearity for all variables of the data set.

Variables	VIF
Time.from.Idea.Max	21,3
Time.from.Idea.Average	9,2
Time.from.Idea.STDEV	6,5
Time.from.Last.Activity.Max	22,6
Time.from.Last.Activity.Average	10,7
Time.from.Last.Activity.STDEV	9,7
Number.of.Feedback.per.Idea	Inf
Unique.Contributor	30,2
Iterations	6,9
Idea.Creator.Comments	4,6
Text.Length.Sum	185,7
Text.Length.Average	32,0
Total.Rating.Up	1,8
Total.Rating.Down	1,6
Additional.Information.on.Solution	5,9
Additional.Information.on.Problem	4,4
Additional.Information.on.Market	2,1
Additional.Information.on.Technology	2,4
Confirmation	53,0
Objection	9,7
Positive	48,7
Negative	5,2
Neutral	3,9
Idea.Exists	2,4
Idea.Exists.in.IMS	1,3
Idea.Partly.Exists	1,4
Idea.Evaluation	1,3
Innovation.Manager.Status.Request	3,9
Idea.Closed	2,1
Idea.Moved	1,2
Idea.Implemented	1,9
Language.Strength.Sum	181,0
Language.Strength.Average	31,9
Semantria.Positive	Inf
Semantria.Negative	Inf
Semantria.Neutral	Inf

The function is iterated by deleting the variables with the highest VIF factor one at a time, until all variables have VIF factor values less than 3. The final set of variables for the multicollinearity analysis can be seen in the figure below.

Table 4: Multicollinearity iterated until all variables values are less than 3.

Variables	VIF
Time.from.Idea.STDEV	2,7
Time.from.Last.Activity.Average	1,3
Time.from.Last.Activity.STDEV	2,4
Iterations	2,6
Idea.Creator.Comments	1,8
Text.Length.Average	1,3
Total.Rating.Up	1,4
Total.Rating.Down	1,3
Additional.Information.on.Problem	2,0
Additional.Information.on.Market	1,6
Additional.Information.on.Technology	1,5
Negative	2,1
Neutral	1,8
Idea.Exists	1,8
Idea.Exists.in.IMS	1,1
Idea.Partly.Exists	1,2
Idea.Evaluation	1,1
Innovation.Manager.Status.Request	2,2
Idea.Closed	1,7
Idea.Moved	1,1
Idea.Implemented	1,4

4.6 Final evaluation of variable selection

The correlation and multicollinearity analysis in the previous sections have presented us with two different criteria for selecting variables for the logistic regression model. There are however other factors to consider, which are presented here below:

1. Some variables are preferably presented in pairs, e.g. *Positive* and *Negative*, *Confirmation* and *Objection*, *Additional Information on Solution* and *Additional Information on Problem*.
2. Some variables can be grouped if it serves to simplify the model and their definition is comparable.
3. Some variables are too obviously related to the dependent variable and therefore not of interest, e.g. *Idea Closed*, which expresses that a feedback provider has written a feedback stating that the idea was closed.
4. The interest for different variables varies based on their background in previous research and the tentative theoretical framework for feedback in collective ideation.
5. Pseudo R^2 can be used to evaluate competing models if the dependent variable and the dataset is fixed, and can therefore be used to determine whether variables can be omitted based on low impact on the pseudo R^2 for the model.

4.6.1 Reintroductions and omissions from the variable selection

Based on the factors described above the following actions were taken to finalize the selection of variables.

- *Time from Idea Max* is reintroduced to the model due to interest based on the theoretical framework.
- The standard deviation measurements selected by the stepwise method are removed because of lower interest, low correlation to *Claimed* and low pseudo R^2 impact on model.
- *Time from last Activity Average* is supported in both the correlation and multicollinearity analysis and is therefore selected.
- *Number of Feedback per Idea* is of great interest and is therefore reintroduced.
- *Additional Information on Solution* and *Positive* are pairs to *Additional Information on Problem* and *Negative*, as well as being of great interest, and are therefore also reintroduced to the selection.
- *Additional Information on Market* and *Additional Information on Technology* are removed due to low correlation, and low pseudo R^2 impact on the model.
- *Idea Exists* and *Idea Partly Exists* are related in definition and will be grouped as one variable, named *Idea Exists Total*.
- *Idea Exists in IMS box* is not included in the grouping because pre-modeling tests shows that it affects the dependent variable negatively whereas *Idea Exists* and *Idea Partly Exists* both affect it positively.
- *Idea Closed*, *Idea Moved*, and *Idea Implemented* are omitted from the selection as they are too obviously related with the claimed variable and therefore not of interest.

4.6.2 Validation of the final variable selection

Then we have arrived at the final selection of variables which will construct the independent variables for the logistic regression model. To validate the selection a final correlation matrix and multicollinearity analysis are generated to confirm the selections validity, the results from those analysis can be seen in figures below.

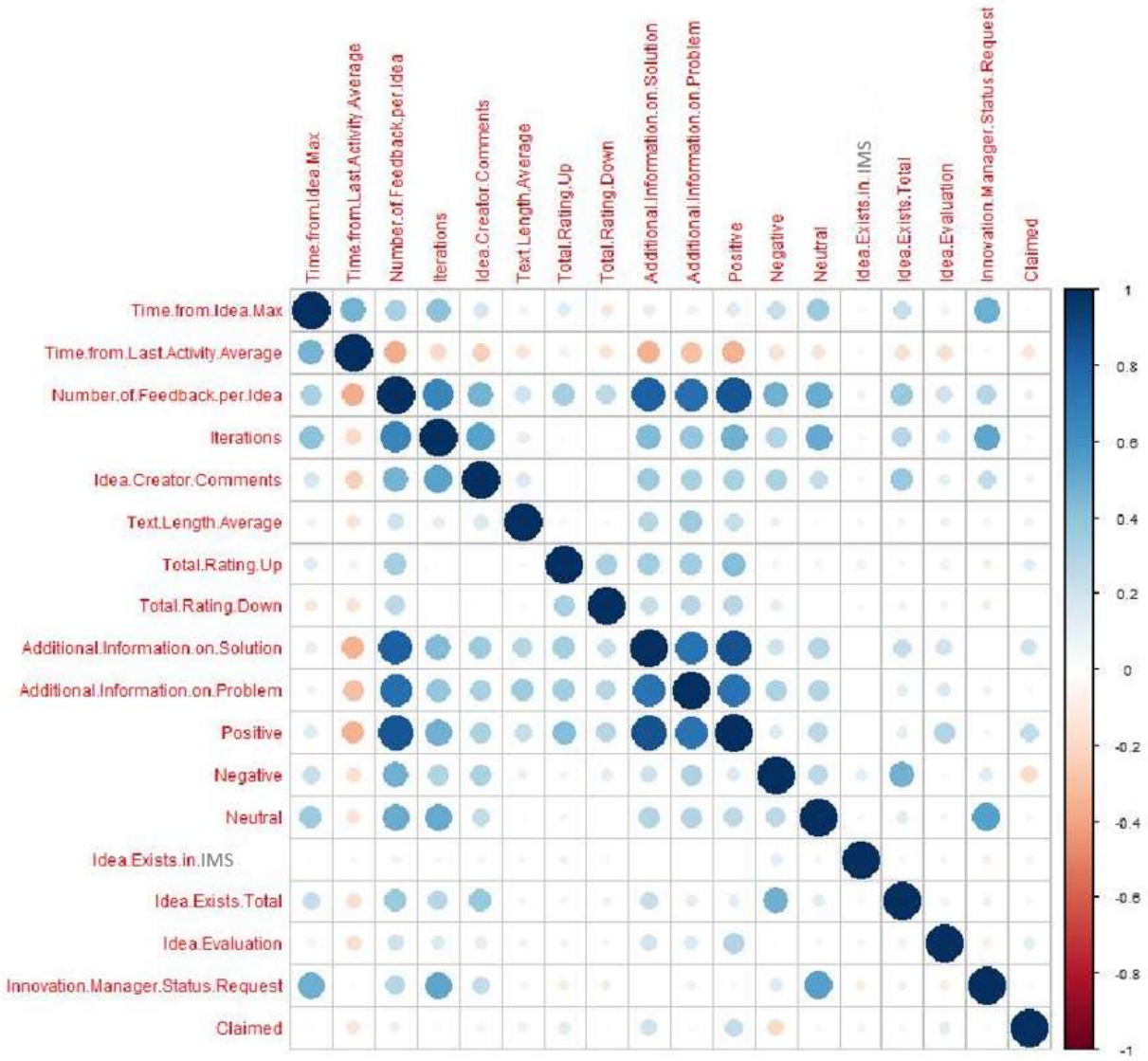

Figure 8: Correlation plot for the final set of variables.

All variables that do not have a strong correlation to *Claimed* have been selected based on the five factors listed in section 4.6.1.

Table 5: Multicollinearity analysis of final set of variables.

Variables	VIF
Time.from.Idea.Max	3,1
Time.from.Last.Activity.Average	2,3
Number.of.Feedback.per.Idea	17,7
Iterations	2,8
Idea.Creator.Comments	1,6
Text.Length.Average	1,2
Total.Rating.Up	1,5
Total.Rating.Down	1,3
Additional.Information.on.Solution	5,1
Additional.Information.on.Problem	3,3
Positive	10,8
Negative	2,2
Neutral	2,0
Idea.Exists.in.IMS	1,1
Idea.Exists.Total	1,9
Idea.Evaluation	1,2
Innovation.Manager.Status.Request	2,3

Few variables do now exceed the previously discussed threshold of 3, but most of them are within the reintroduction threshold of 10. *Number of Feedback per Idea* is the only variable considerably larger than the set threshold, however Nagelkerke's pseudo R^2 value drops by 18% when omitting the variable from the model, therefore it was not omitted.

4.7 Logistic regression model

The logistic regression model is created in R with the following results:

Table 6: Results from logistic regression model produced by R.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1,82E-01	5,62E-01	-0,324	0,746	
Time.from.Idea.Max	1,10E-08	1,31E-08	0,839	0,402	
Time.from.Last.Activity.Average	-4,22E-08	3,04E-08	-1,389	0,165	
Number.of.Feedback.per.Idea	-1,06E+00	3,81E-01	-2,775	0,006	**
Iterations	-3,68E-01	2,91E-01	-1,265	0,206	
Idea.Creator.Comments	4,30E-01	2,58E-01	1,664	0,096	.
Text.Length.Average	-1,62E-03	1,53E-03	-1,061	0,289	
Total.Rating.Up	1,55E-02	1,22E-02	1,273	0,203	
Total.Rating.Down	9,33E-02	8,43E-02	1,107	0,268	
Additional.Information.on.Solution	4,06E-01	2,35E-01	1,726	0,084	.
Additional.Information.on.Problem	-6,53E-01	2,37E-01	-2,753	0,006	**
Positive	1,21E+00	3,62E-01	3,348	0,001	***
Negative	-1,46E-01	3,20E-01	-0,458	0,647	
Neutral	3,79E-01	3,22E-01	1,177	0,239	
Idea.Exists.in.IMS	-2,08E-02	8,92E-01	-0,023	0,981	
Idea.Exists.Total	8,36E-01	2,93E-01	2,849	0,004	**
Idea.Evaluation	6,12E-01	4,54E-01	1,347	0,178	
Innovation.Manager.Status.Request	1,03E+00	4,46E-01	2,300	0,021	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Test method	Value
Nagelkerke's pseudo R^2	0,401
Hosmer & Lemeshow p-value	0,591

If we look at variables with a significance level p > 0,05, we see that *Number of Feedback per idea* and *Additional Information on Problem* are both significantly and negatively related to ideas being *Claimed*, with estimates of -0,106 and -0,653 respectively. Other significant variables are positively related to ideas being claimed and they are: *Positive* feedback (1,213), *Idea Exists Total* (0,836), and *Innovation Manager Status Request* (1,026). Two additional variables are significant within p > 0,1 and they are both positively related to ideas being claimed, they are: *Additional Information on Solution* and *Idea Creator Comments*, with estimates of 0,406 and 0,430 respectively. Other variables are insignificant in this logistic regression model.

To validate the regression model we use both Nagelkerke's pseudo R^2 and Hosmer and Lemeshow goodness of fit test. The results from the Nagelkerke function in R can be seen in table 6 above. For N=204 observations, the pseudo R^2 value is 0,401, scaled from 0 to 1, where 1 is the maximum value. Pseudo R^2 however cannot be considered a replacement to the conventional R^2 in predicting total variability of the outcome accounted for by the model. Pseudo R^2 is generally only considered valuable in estimating improvement in the models

and was therefore correctly used in evaluating whether variables should be introduced or omitted.

A Hosmer-Lemeshow goodness of fit test was also produced in R, the results from the hoslem.test in R can also be seen in table 6 above. From the results we see that the chi-square value is 6,591 and the degrees of freedom used are 8. The value of interest is the p-value, which is 0,591, considerably greater than the conventional significance threshold of $p < 0,05$. This means that there is no evidence suggesting that the model is not fitting the data, implying a good fit of the data. The Hosmer-Lemeshow test is however more reliable in providing evidence of a bad fit than a good fit. So a reliable reading of the results is that there is no evidence we have failed fitting the data with this model. The Hoslem-Lemeshow function in R can be used to generate values for expected values versus observed values for the logistic regression model, these values can be seen in the figure below.

Table 7: Hosmer and Lemeshow's observed vs. expected values.

Range	Expected 0	Expected 1	Observed 0	Observed 1
[4.89e-05,0.0208]	20,7	0,3	20	1
(0.0208,0.0452]	19,4	0,6	20	0
(0.0452,0.071]	18,8	1,2	20	0
(0.071,0.126]	18,9	2,1	18	3
(0.126,0.183]	16,9	3,1	18	2
(0.183,0.251]	15,6	4,4	16	4
(0.251,0.368]	14,3	6,7	14	7
(0.368,0.465]	11,5	8,5	9	11
(0.465,0.676]	9,3	10,7	10	10
(0.676,0.958]	4,5	16,5	5	16

The *Observed 0* and *Observed 1* column in the figure above represents the number of observed claimed (1) and not claimed (0) values, as *Expected 0* and *Expected 1* represent the number of expected claimed (1) and not claimed (0) according to the logistic regression model. The values are produced for ten equally sized ranges, represented in the column furthest to left. It is interesting to see that the difference between observed and expected values are relatively small.

4.8 System vs. interpreted data

It is interesting to investigate how much of the logistic regression models fit to the data is accounted for by either system or interpreted data. We have used Nagelkerke's pseudo R^2 to measure the fit of the model to the data, and the value obtained for the model is 0,401. We can create two separate models from our previous model to calculate the contributions of each category. The results can be seen in the table below.

Table 8: Logistic regression models for system and interpreted variables.

Model for system variables	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-4,03E-01	4,85E-01	-0,831	0,406
Time.from.Idea.Max	3,37E-09	8,94E-09	0,377	0,706
Time.from.Last.Activity.Average	-3,49E-08	2,43E-08	-1,437	0,151
Number.of.Feedback.per.Idea	-8,88E-05	8,79E-02	-0,001	0,999
Iterations	-5,09E-02	2,30E-01	-0,221	0,825
Idea.Creator.Comments	1,21E-01	1,87E-01	0,645	0,519
Text.Length.Average	-1,89E-03	1,24E-03	-1,524	0,127
Total.Rating.Up	1,57E-02	1,17E-02	1,341	0,180
Total.Rating.Down	-3,27E-02	7,15E-02	-0,458	0,647

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Test method	Value
Nagelkerke's pseudo R^2	0,069
Hosmer & Lemeshow p-value	0,591

Model for interpreted variables	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1,543	0,348	-4,434	9,23E-06	***
Additional.Information.on.Solution	0,146	0,208	0,701	4,83E-01	
Additional.Information.on.Problem	-0,681	0,200	-3,414	6,41E-04	***
Positive	0,466	0,164	2,833	4,61E-03	**
Negative	-0,445	0,180	-2,480	1,32E-02	*
Neutral	0,114	0,207	0,553	5,80E-01	
Idea.Exists.Total	0,327	0,210	1,556	1,20E-01	
Idea.Exists.in.IMS	-0,431	0,740	-0,582	5,61E-01	
Idea.Evaluation	0,327	0,409	0,800	4,24E-01	
Innovation.Manager.Status.Request	0,126	0,326	0,387	6,99E-01	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Test method	Value
Nagelkerke's pseudo R^2	0,276
Hosmer & Lemeshow p-value	0,723

From the results in the table above we can see that the impact of the interpreted variables is considerably higher than the system variables. Nagelkerke's pseudo R^2 for system variables is 0,069 while for interpreted variables the value is 0,276. The Hosmer and Lemeshow goodness of fit test also yields a better result for the interpreted variables.

4.9 Confirmation vs. Objection investigated

The independent variables *Confirmation* and *Objection* are not selected because of their multicollinearity with *Positive* and *Negative*. To be able to evaluate the effect of the dimension Confirmation vs. Objection in the theoretical framework, I will replace *Confirmation* and *Objection* with *Positive*, *Negative*, and *Neutral* in the logistic regression model. The results can be seen below:

Table 9: Linear regression model for evaluation of Confirmation vs. Objection dimension.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1,64E-01	5,70E-01	-0,287	0,7743	
Time.from.Idea.Max	1,94E-08	1,40E-08	1,382	0,1669	
Time.from.Last.Activity.Average	-5,24E-08	3,24E-08	-1,618	0,1057	
Number.of.Feedback.per.Idea	-1,15E+00	4,09E-01	-2,819	0,0048	**
Iterations	-4,04E-01	2,95E-01	-1,372	0,1701	
Idea.Creator.Comments	4,10E-01	2,60E-01	1,579	0,1143	
Text.Length.Average	-1,72E-03	1,57E-03	-1,092	0,2750	
Total.Rating.Up	1,38E-02	1,24E-02	1,119	0,2633	
Total.Rating.Down	1,16E-01	8,89E-02	1,304	0,1924	
Additional.Information.on.Solution	4,12E-01	2,40E-01	1,721	0,0853	.
Additional.Information.on.Problem	-6,35E-01	2,46E-01	-2,583	0,0098	**
Confirmation	1,33E+00	3,94E-01	3,375	0,0007	***
Objection	-2,69E-01	3,36E-01	-0,802	0,4224	
Idea.Exists.in.IMS	-1,32E-02	8,81E-01	-0,015	0,9881	
Idea.Exists.Total	9,68E-01	3,13E-01	3,092	0,0020	**
Idea.Evaluation	5,71E-01	4,50E-01	1,269	0,2044	
Innovation.Manager.Status.Request	1,32E+00	5,12E-01	2,582	0,0098	**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Test method	Value
Nagelkerke's pseudo R^2	0,417
Hosmer & Lemeshow p-value	0,367

From the results we can see that *Confirmation* is positively significant with the dependent variable *Claimed*, *Objection* is however not significant. According to Nagelkerke's pseudo R^2 the quality of the model is 0,417, marginally better than our previously derived model. And the Hosmer-Lemeshow goodness of fit test yields a p-value of 0,367, which does not provide any evidence that the model does not fit the data, but the value is considerably lower than in our previous model.

4.10 *Claimed Anytime* investigated

The dependent variable *Claimed Anytime* indicates whether an idea has been claimed at any point in the history of the IMS box, irrelevant of whether of it was unclaimed later or not. To create the model we use the same set of variables as were used in section 4.4, only replacing *Claimed* with *Claimed Anytime*. The results for that model can be seen in the figures below.

Table 10: Logistic regression model for dependent variable Claimed Anytime.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-2,40E-01	5,27E-01	-0,456	0,6487	
Time.from.Idea.Max	3,38E-09	1,12E-08	0,301	0,7633	
Time.from.Last.Activity.Average	-2,33E-08	2,44E-08	-0,956	0,3390	
Number.of.Feedback.per.Idea	-1,20E+00	1,36E+00	-0,885	0,3764	
Iterations	-4,32E-01	2,78E-01	-1,556	0,1198	
Idea.Creator.Comments	1,82E-01	2,27E-01	0,802	0,4223	
Text.Length.Average	-7,19E-04	1,29E-03	-0,558	0,5765	
Total.Rating.Up	7,41E-03	1,14E-02	0,653	0,5140	
Total.Rating.Down	3,41E-02	8,64E-02	0,394	0,6933	
Additional.Information.on.Solution	4,11E-01	2,13E-01	1,929	0,0537	.
Additional.Information.on.Problem	-5,53E-01	2,04E-01	-2,717	0,0066	**
Positive	1,47E+00	1,35E+00	1,082	0,2792	
Negative	5,86E-01	1,34E+00	0,437	0,6620	
Neutral	1,17E+00	1,36E+00	0,859	0,3906	
Idea.Exists.in.IMS	-1,17E-01	6,65E-01	-0,176	0,8606	
Idea.Exists.Total	3,87E-01	2,46E-01	1,572	0,1159	
Idea.Evaluation	-3,14E-02	4,16E-01	-0,076	0,9398	
Innovation.Manager.Status.Request	3,97E-01	3,76E-01	1,056	0,2909	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Test method	Value
Nagelkerke's pseudo R^2	0,312
Hosmer & Lemeshow p-value	0,321

From the results in the table above we can see that only *Additional Information on Solution* and *Additional Information on Problem* show any sign of significance. *Additional Information on Solution* is positively related to *Claimed Anytime* to a p-value < 0,1, and *Additional Information on solution* is negatively related to *Claimed anytime* to a p-value < 0,01. Nagelkerke's pseudo R^2 shows that the fit of the model is 0,312, and Hosmer-Lemeshow goodness-of-fit test yields a p-value of 0,487. Both the pseudo R^2 and the Hosmer-Lemseshow test values are lower than our main model from section 4.7.

4.11 Lack of control for original idea quality

The original quality of the idea when submitted to the idea management system cannot be neglected. The greatest determining factor of whether an idea is claimed or not, is most likely the quality of the original idea. With that in mind, it is interesting to plot the ratio of *Claimed* ideas verus *Number of Feedback per Idea*, see figure below.

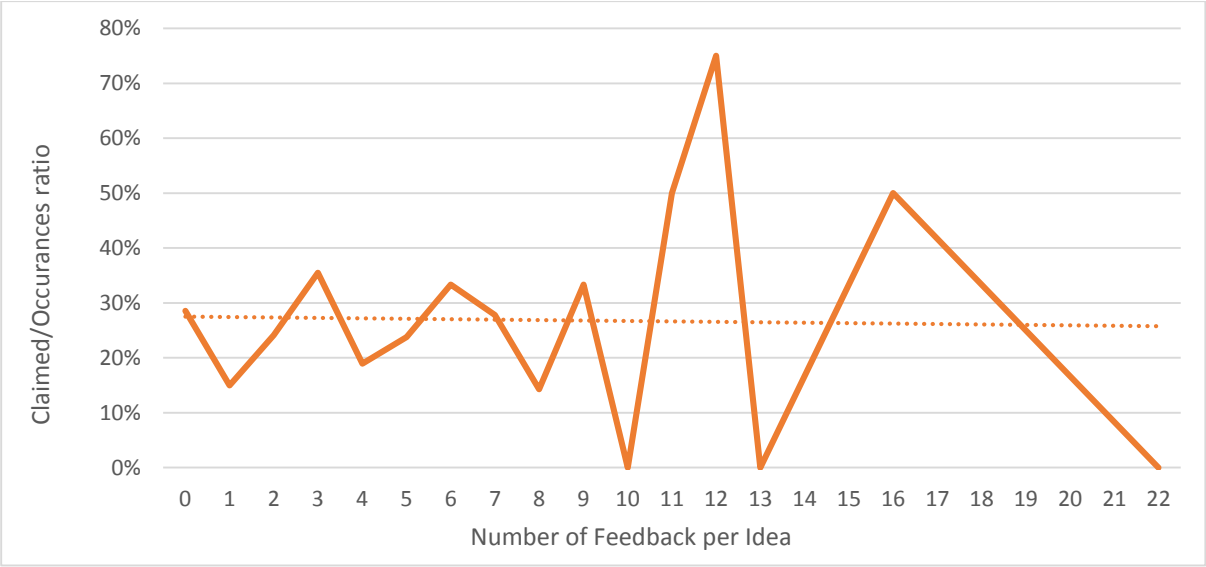

Figure 9: Ratio of claimed ideas versus Number of Feedback per Idea.

From the trend line on the plot we can see that the ratio of *Claimed* ideas does not improve with higher *Number of Feedback per Idea*. The ratio of *Claimed* ideas for ideas with no feedback is 30%, which is very average for the plot, suggesting that the feedback provided may not affect the idea quality in a significant way. And since showing significant relation in the logistic regression model, the variables may act rather as a filtering mechanism. Ideas with good quality will for example, derive positive or confirmative feedback. However if we redo the same plot in order to make it more statistically sound, by excluding all *Number of Feedback per Idea* instances with less than four occurrences, then we get a different result, see figure below.

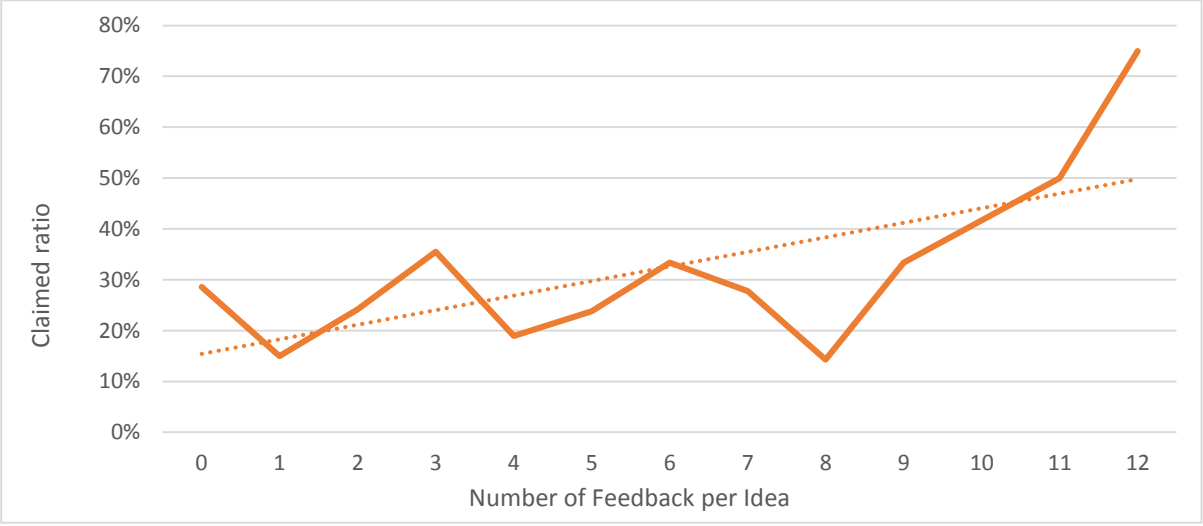

Figure 10: Ratio of claimed ideas versus Number of Feedback per Idea.

From viewing the plot and the trend line above, there does seem to be a relation between *Number of Feedback per Idea* and likelihood of the idea being claimed, as the ratio improves especially in the higher end. Taking both plots into consideration it is hard to conclude whether the feedback actually improves the ideas since there is evidence supporting both cases. Further evaluation of this subject is an opportunity for further research.

5 Analysis and discussion

In this chapter there is an evaluation of to what extent the research questions can be answered by the preceding results. The consistency of the results will also be analyzed with respect to existing theory. The evaluation of the research questions will derive managerial implications for practice and provide a basis for discussing potential future research within the field of collective ideation.

5.1 Evaluation of research questions

The research questions, constructed in section 1.1, are:

RQ1: How do different dimensions of feedback affect the quality of an idea in an idea management system?

RQ2: What are the key challenges to managing feedback in idea management systems?

It is worth noting that the analysis of the different dimensions of feedback in this thesis was limited to two of three fundamental dimensions for feedback in collective ideation, feedback process and feedback content. Information on the third dimension, feedback providers, was not available for this thesis so we cannot draw any conclusions on the different dimensions related to feedback providers. The different dimensions of feedback content and feedback process is represented by the independent variables described previously in the thesis. All dimensions are presented with respect to their results from the variable selection and the logistic regression model in the table below.

Table 11: Results for all dimensions of the theoretical framework.

Fundamental Dimension	Secondary Dimension	Independent Variable	Results	Reason for selected/not selected
Feedback Providers	Hierarchical Position	N/A	N/A	N/A
	Network Position	N/A	N/A	N/A
	Skill Level	N/A	N/A	N/A
	Previous Interaction	N/A	N/A	N/A
	Activity Level	N/A	N/A	N/A
	Diversity	N/A	N/A	N/A
	Distance	N/A	N/A	N/A
Feedback Process	Compressed vs. Stretched	Time from Idea Max	Not significant	Theoretical framework
		Time from Idea Average	Not selected	Multicollinearity
		Time from Idea STDEV	Not selected	Low interest
		Time from Last Activity Max	Not selected	Multicollinearity
		Time from Last Activity Average	Not significant	Theoretical framework/correlation
		Time from Last Activity STDEV	Not selected	Low interest
	Repeated/iterative	Iterations	Not significant	Theoretical interest
		Idea Creator Comments	**Significant (p < 0,1), Positive**	Multicollinearity/R^2 impact
		Unique Contributors	Not selected	Multicollinearity
	Number of Feedback per Idea	Number of Feedback per Idea	**Significant (p < 0,05), Negative**	Theoretical framework/correlation
Feedback Content	Additional Information	Solution	**Significant (p < 0,1), Positive**	Theoretical framework/correlation
		Problem	**Significant (p < 0,05), Negative**	Theoretical framework/pair
		Market	Not selected	Low correlation/low R^2 impact
		Technical	Not selected	Low correlation/low R^2 impact
		Idea Exists Total	**Significant (p < 0,05), Positive**	Multicollinearity/R^2 impact
		Idea Exists in IMS	Not significant	Multicollinearity/R^2 impact
		Idea Evaluation	Not significant	Correlation
		Idea Closed	Not selected	Low interest/familiarity with claimed
		Idea Moved	Not selected	Low interest/familiarity with claimed
		Idea Implemented	Not selected	Low interest/familiarity with claimed
	Confirmation vs. Objection	Confirmation	**(Significant (p<0,05), Positive*)**	Multicollinearity
		Objection	(Not significant*)	Multicollinearity
		Total Rating Up	Not significant	Correlation
		Total Rating Down	Not significant	Pair
	Feedback Valence	Positive	**Significant (p < 0,05), Positive**	Correlation
		Negative	Not significant	Correlation
		Neutral	Not significant	Pair
		Semantria Positive	Not selected	Multicollinearity
		Semantria Negative	Not selected	Multicollinearity
		Semantria Neutral	Not selected	Multicollinearity
	Feedback Style	Innovation Manager Status Request	**Significant (p < 0,05), Positive**	Multicollinearity/R^2 impact
	Formulation/Complexity	Language Strength Sum	Not selected	Multicollinearity
		Language Strength Average	Not selected	Multicollinearity
		Text Length Sum	Not selected	Multicollinearity
		Text Length Average	Not significant	Theoretical framework

* Confirmation and Objection were not selected due to multicollinearity, however a replacement model was created, see section 4.9

5.2 How do different dimensions of feedback affect the quality of an idea in an idea management system?

RQ1 can be answered with the help of table 11 above. We have provided evidence that *Repeated/Iterative* feedbacks, *Number of Feedback per Idea*, *Additional Information*, *Confirmation vs. Objection* (replacement model), *Feedback Valence*, and *Feedback Style*, cam affect the quality of an idea in an idea management system. Other dimensions have not proven to be significant or were not tested in this study.

Repeated, or iterative, feedbacks showed signs of positive relation to idea quality. The dimension was tested with two variables in the model, whereas one proved to be significant. The variable *Idea Creator Comments* is positively related to idea quality while *Iterations* was not significant. *Idea Creator Comments*, counts the number of instances when the idea creator makes an additional contribution to the ideation process. The idea creator shows interest and advert in the subject, adding value to the subject with repeated interaction, consistent with Jonathan Mell (2015) on repeated interaction. The dimension *Number of Feedback per Idea* is negatively related to idea quality. *Number of Feedback per Idea* is therefore partly inconsistent with theory on amount of communication, where amount of communication is promoted as a good measure of effectiveness of collaboration (Karakaya & Demirkan, 2015). However, Leiponen and Helfat (2010) described a potential saturation of information, implying that a point can be reached when adding more feedbacks can start to become detrimental to the process.

Additional Information can affect the quality of the idea both positively and negatively. Information on the solution and information on ideas existing, or partly existing as products, relates positively to idea quality, while information on the problem relates negatively. This is consistent with theory on additional information. Depending on the nature of the information it can either strengthen or diminish the validity of the idea. Additional information on the problem is potentially increasing the complexity of the problem, making it harder to solve. It may be surprising at first that information stating that the product already exists relates positively to idea quality. There can however be multiple reasons for that, such information can for example confirm that there is a market for that specific type of product/service. The existing product can also provide a faster understanding of the solution, allowing the new innovation to compete perhaps on additional features, price, or marketing. *Feedback Valence* is studied with the *Positive*, *Negative* and *Neutral* variables. *Positive* feedback relates positively to idea quality while *Negative* and *Neutral* feedbacks were not significant in our model. This is mostly consistent with theory on *Feedback Valence*, where positive feedback has proven to be related to higher creative performance and negative feedback associated with lower (Zhou, 1998). Therefore a negative relation was expected of negative feedback but in our study the negative variable was not significant in the model. *Feedback Style* is defined as informative feedback versus controlling feedback. One variable in our study can be related to a controlling way of providing feedback. The variable *Innovation Manager Status Request* counts the number of instances when an innovation manager asks the idea creator to provide the status of the idea, in most cases to either close it or let it remain open. This variable showed positive relation to idea quality, which is surprising as controlling feedback has shown to affect performance in a negative way. This can potentially be explained by that the feedback provided exhibits interest by the innovation manager in the idea, stimulating the idea creator's intrinsic motivation, which is one of the key drivers of creativity (Zhou, 1998).

Two of the dimensions tested did not show any evidence of affecting quality in collective ideation in our main model. Those dimensions are *Compressed vs. Stretched* in feedback process and *Confirmation vs. Objection* in feedback content. For *Compressed vs. Stretched* feedback process the variable *Time from Idea Max* and *Time from last Activity Average* were not significant in the regression model. Despite the theory highlighting that timely responses is one of the main motivational factors for participants in idea generation (Jung, et al., 2010). The variables for *Confirmation vs. Objection* were not tested in the main model due to collinearity with the *Feedbak Valence* variables. However, a replacement model was created

where *Confirmation* and *Objection* was replaced for *Positive*, *Negative*, and *Neutral*, showing that *Confirmation* is significantly positively related to *Claimed* while *Objection* is not significant.

5.3 What are the key challenges to managing feedback in idea management systems?

In this section an effort will be made to answer RQ2 and derive at managerial implications for collective ideation in idea management systems. The aim is to identify key factors in managing feedback in collective ideation with reference to the tentative theoretical framework and previous research presented in this thesis, as well as the results from the empirical study on the data from the TeleCom company. It can be difficult to draw concrete conclusions based on a single explorative study, especially since not all dimensions of the theoretical framework were examined. There are however number of interesting observations that can contribute to the answer of RQ2 and the field of collective ideation as implications for practice.

Managing feedback in idea management systems involves controlling three fundamental dimensions of feedback in collective ideation:

- Ensure a heterogeneous blend of feedback providers.
- Support a motivating feedback process
- Encourage appropriate feedback content

The feedback provider dimension of the theoretical framework was not included in the empirical study which limits the ability to draw any conclusions on the subject. Previous research have however shown that novel ideas are commonly created on the boundaries of different knowledge areas, where expertise from one context solves a problem defined with expertise in another context (Magnusson, 2015). And the best ideas often originate from the least likely participants (Simula & Ahola, 2014). According to that, it should be beneficial to management to motivate use of an idea management system for a diverse group of individuals, in order to create an environment where knowledge sharing can contribute to the development of ideas. Diversity in gender, ethnicity, and education, have all shown to increase innovative performance (Ostergaard, et al., 2011). Heterogeneity promotes knowledge sharing, but also contains different levels of credibility. It is more important that supervisors, leaders, and experts, consider how their feedback is formulated, as their feedback will weigh more in the ideation process (Ashish Gupta & Sharda, 2013). Negative feedback from individuals with high credibility can therefore have detrimental effect on idea development.

According to previous research on idea generation it is important that the flow of action and cognition is not broken as timely responses increase the motivation of participants (Zhang, 2008). The empirical study shows that it is important for the idea development that the idea creator stays active in the feedback conversation after he has submitted the idea. Responses by the idea creator may help to form trust between participants, stimulate intrinsic motivation of feedback providers, as well as allowing the value-creation through repeated interaction (Hsu, et al., 2007; Mell, et al., 2015; Zhou, 1998).

Access to a great amount of knowledge and information is one of the reasons for using an idea management system. Leiponen and Helfat (2010) have however reasoned that a potential saturation of information can be achieved, suggesting that after a certain amount of feedback has been received additional feedback may be of lower value. This may be a reason for why *Number of Feedback per Idea* provided is not positively related to idea quality. Another potential explanation to the negative relation is that intrinsic motivation is often driven by interest in novel and complicated tasks, participants may feel highly motivated to discuss tasks that are complex and possibly less likely to be solved (Zhou, 1998). Ideas may also generally be fully developed when they are submitted to the system, and the feedback provided has therefore minimal effect on whether ideas are claimed or not. Based on this, participants are advised to avoid clogging discussions with irrelevant information and stick to feedback relevant to the development of the idea.

It is important to attain additional information from feedback providers, independent of whether the information will contribute to solving the problem by adding information to the solution, or possibly make it fail faster by adding to the definition of the problem. Realizing whether ideas are feasible is important to the ideation process and getting information from individuals that have the capability to contribute is essential. Confirmation is associated with greater idea quality in our replacement model, acting either as a motivator or potentially a filter indicating good ideas. Positivity in feedbacks is encouraged as positive feedbacks relate to greater idea quality. Previous studies have also shown relation between positivity and higher creativity (Zhou, 1998). We should however consider how much the relationship between the variables and the quality of the idea depends on the original quality of the idea when it is submitted to the system. If a good idea is submitted, feedbacks are likely to be positive and are likely to act as indicators of quality rather than to add to the development of the idea. It is important for managers to show their interest in the ideas and the system to stimulate the motivation of the participants. By showing the participants that they care about their contribution, managers indicate the competency of the participants and show that they value their input, stimulating their motivation for further contributions (Fischer & Rohde, 2013). Feedback formulation was not significant in the empirical study, but previous research shows that individuals are differently acceptable to complex feedbacks. Some people may enjoy complex feedbacks while others prefer straight-to-the-point feedbacks (See, et al., 2009). It can be useful to have that in mind when sharing knowledge with colleagues. As well as using vocabulary that is suitable to the audience, technical vocabulary can vary greatly between participants.

6 Conclusions

The fundamental reasoning for practicing collective ideation is the value-adding potential of creating ideas collectively. Participants share information, define problems and solutions derived from the collective knowledge of the group, that otherwise would have been out of reach for the knowledge set of one individual. With the use of web-enabled idea management systems, companies can now easily access a large heterogeneous source for creating innovative ideas.

The aim of this thesis was to define how access to a large source of heterogeneous knowledge through an idea management system can improve the development of ideas. A theoretical framework was constructed with the aim of explaining all potential factors that can affect the impact of the feedback, based on who are the feedback providers. How is the feedback process constructed? And what is the message content? The theoretical framework was put to a test in an empirical study on data from the TeleCom company's idea management system IMS. The results showed significant relation of the quality of the ideas to most of the factors tested. No factors related to feedback providers were tested, but all factors related to the feedback process and feedback content were tested to some extent. The results showed significant relation of the following factors to ideas being claimed or not: *Repeated/Iterative*, *Number of Feedback per Idea*, *Additional Information*, *Confirmation vs. Objection* (replacement model), *Feedback Valence*, and *Feedback Style*. These results provide evidence for the validity of the theoretical framework presented in this thesis and provide motivation for further validation of the framework in future research. The following factors did however not show significant relation: *Compressed vs. Stretched*, and *Formulation/Complexity*. Which potentially decreases the relevance of these factors in the theoretical framework. However, as with the factors showing significant relation to idea quality, further research is needed to create a greater body of evidence to draw such definite conclusions.

6.1 Future research

It is most evident in this study that the feedback provider is not included in the empirical research. It would be interesting to see a research where data from human resource on different attributes of participants can be included. Feedback providers contain many interesting dimensions that have been thoroughly investigated in different settings, so it would be highly interesting to the comparability of those setting to collective ideation in idea management systems. The potential interaction between both *Feedback Providers* and *Feedback Process* with *Feedback Content* is also an interesting subject for future research. The attributes of the *Feedback Provider* potentially establishes the foundation for how *Feedback Content* is perceived by the other participants, as well as the dynamics of the *Feedback Process* may affect the reaction to the Feedback Content. The interaction between these dimensions is therefore of great interest and suggested as future research. A limitation to this research is that it is hard to determine to what extent the idea management system acts as a tool for developing ideas or as a mechanism to filter ideas. Factors such as confirmation and positivity most likely have similar relation with idea quality in both cases. It would therefore be interesting if more attention could be raised to original idea quality in future research, possibly evaluating ideas at submission and then at second point in time when feedback has been provided to the idea. Another limitation is that this research is conducted on a single IMS box from the TeleCom company which limits the generality of the thesis.

Firstly, it would be interesting to increase the sample size to several IMS boxes. In this study the limiting factor was the time consuming act of classifying the content of the feedbacks. If more time could be devoted to that assignment or if the process could be automated to a greater extent, a larger sample size would be feasible. Secondly a comparison of IMS boxes from different sites of the TeleCom companies could be compared to study difference in location and culture. Thirdly, it would be highly interesting to see a comparison of the TeleCom company's IMS to other idea management systems, especially if there is some principal difference between the systems. In companies such as IBM and Volvo, so called Innovation Jams are used to create a great amount of ideas in a short time interval. Innovation Jams are quite different dynamically as they are typically organized as time compressed workshops, lasting from 24 hours to a week (Bergh, 2013). A comparison of the theoretical framework in these two systems could be highly interesting. Finally, it would be interesting to see further research based on the theoretical framework presented in this thesis in order to validate the different dimensions. A single explorative study as this one is not sufficient to validate the complete theoretical framework but nevertheless manages to provide unique and interesting relation of considerable part of the framework with idea quality.

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Appendix A

Number of feedback in IMS box

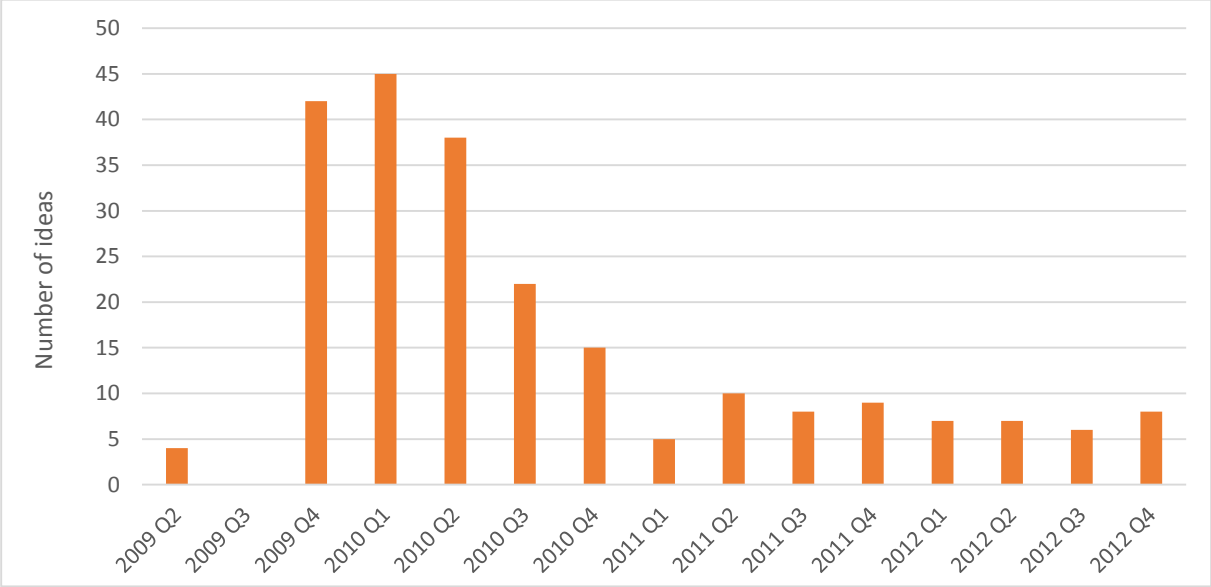
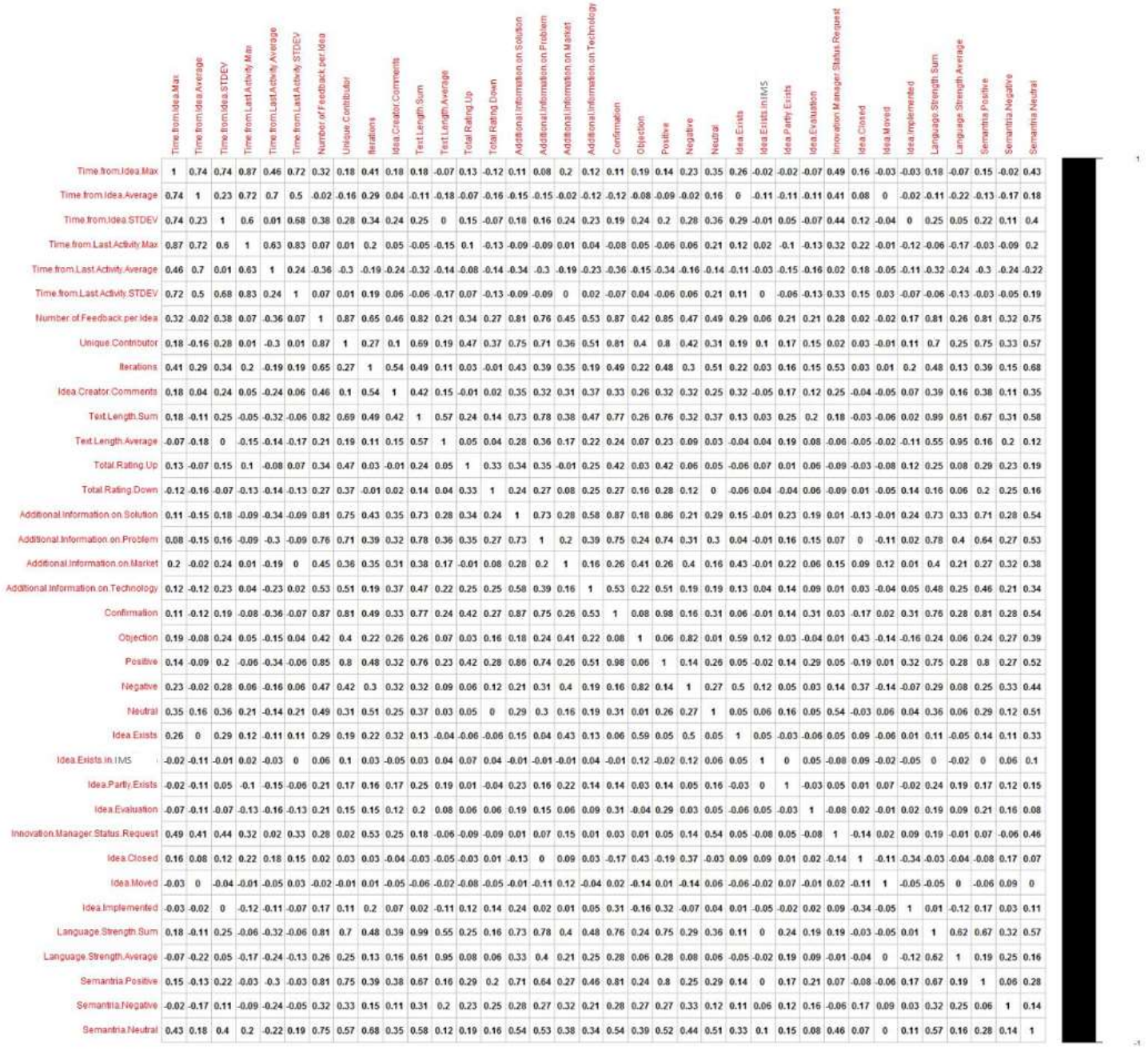


Figure 11: Number of feedback per quarter for all ideas in IMS box.

Appendix B

Correlation



	Time.from.Idea.Max	Time.from.Idea.Average	Time.from.Idea.STDEV	Time.from.Last.Activity.Max	Time.from.Last.Activity.Average	Time.from.Last.Activity.STDEV	Number.of.Feedback.per.Idea	Unique.Contributor	Iterations	Idea.Creator.Comments	Text.Length.Sum	Text.Length.Average	Total.Rating.Up	Total.Rating.Down	Additional.Information.on.Solution	Additional.Information.on.Problem	Additional.Information.on.Market	Additional.Information.on.Technology	Confirmation	Objection	Positive	Negative	Neutral	Idea.Exists	Idea.Exists.in.IMS	Idea.Partly.Exists	Idea.Evaluation	Innovation.Manager.Status.Request	Idea.Closed	Idea.Moved	Idea.Implemented	Language.Strength.Sum	Language.Strength.Average	Semantria.Positive	Semantria.Negative	Semantria.Neutral
Time.from.Idea.Max	1	0.74	0.74	0.87	0.46	0.72	0.32	0.18	0.41	0.18	0.18	-0.07	0.13	-0.12	0.11	0.08	0.2	0.12	0.11	0.19	0.14	0.23	0.35	0.26	-0.02	-0.02	-0.07	0.49	0.16	-0.03	-0.03	0.18	-0.07	0.15	-0.02	0.43
Time.from.Idea.Average	0.74	1	0.23	0.72	0.7	0.5	-0.02	-0.16	0.29	0.04	-0.11	-0.18	-0.07	-0.16	-0.15	-0.15	-0.02	-0.12	-0.12	-0.08	-0.09	-0.02	0.16	0	-0.11	-0.11	-0.11	0.41	0.08	0	-0.02	-0.11	-0.22	-0.13	-0.17	0.18
Time.from.Idea.STDEV	0.74	0.23	1	0.6	0.01	0.68	0.38	0.28	0.34	0.24	0.25	0	0.15	-0.07	0.18	0.16	0.24	0.23	0.19	0.24	0.2	0.28	0.36	0.29	-0.01	0.05	-0.07	0.44	0.12	-0.04	0	0.25	0.05	0.22	0.11	0.4
Time.from.Last.Activity.Max	0.87	0.72	0.6	1	0.63	0.83	0.07	0.01	0.2	0.05	-0.05	-0.15	0.1	-0.13	-0.09	-0.09	0.01	0.04	-0.08	0.05	-0.06	0.06	0.21	0.12	0.02	-0.1	-0.13	0.32	0.22	-0.01	-0.12	-0.06	-0.17	-0.03	-0.09	0.2
Time.from.Last.Activity.Average	0.46	0.7	0.01	0.63	1	0.24	-0.36	-0.3	-0.19	-0.24	-0.32	-0.14	-0.08	-0.14	-0.34	-0.3	-0.19	-0.23	-0.36	-0.15	-0.34	-0.16	-0.14	-0.11	-0.03	-0.15	-0.16	0.02	0.18	-0.05	-0.11	-0.32	-0.24	-0.3	-0.24	-0.22
Time.from.Last.Activity.STDEV	0.72	0.5	0.68	0.83	0.24	1	0.07	0.01	0.19	0.06	-0.06	-0.17	0.07	-0.13	-0.09	-0.09	0	0.02	-0.07	0.04	-0.06	0.06	0.21	0.11	0	-0.06	-0.13	0.33	0.15	0.03	-0.07	-0.06	-0.13	-0.03	-0.05	0.19
Number.of.Feedback.per.Idea	0.32	-0.02	0.38	0.07	-0.36	0.07	1	0.87	0.65	0.46	0.82	0.21	0.34	0.27	0.81	0.76	0.45	0.53	0.87	0.42	0.85	0.47	0.49	0.29	0.06	0.21	0.21	0.28	0.02	-0.02	0.17	0.81	0.26	0.81	0.32	0.75
Unique.Contributor	0.18	-0.16	0.28	0.01	-0.3	0.01	0.87	1	0.27	0.1	0.69	0.19	0.47	0.37	0.75	0.71	0.36	0.51	0.81	0.4	0.8	0.42	0.31	0.19	0.1	0.17	0.15	0.02	0.03	-0.01	0.11	0.7	0.25	0.75	0.33	0.57
Iterations	0.41	0.29	0.34	0.2	-0.19	0.19	0.65	0.27	1	0.54	0.49	0.11	0.03	-0.01	0.43	0.39	0.35	0.19	0.49	0.22	0.48	0.3	0.51	0.22	0.03	0.16	0.15	0.53	0.03	0.01	0.2	0.48	0.13	0.39	0.15	0.68
Idea.Creator.Comments	0.18	0.04	0.24	0.05	-0.24	0.06	0.46	0.1	0.54	1	0.42	0.15	-0.01	0.02	0.35	0.32	0.31	0.37	0.33	0.26	0.32	0.32	0.25	0.32	-0.05	0.17	0.12	0.25	-0.04	-0.05	0.07	0.39	0.16	0.38	0.11	0.35
Text.Length.Sum	0.18	-0.11	0.25	-0.05	-0.32	-0.06	0.82	0.69	0.49	0.42	1	0.57	0.24	0.14	0.73	0.78	0.38	0.47	0.77	0.26	0.76	0.32	0.37	0.13	0.03	0.25	0.2	0.18	-0.03	-0.06	0.02	0.99	0.61	0.67	0.31	0.58
Text.Length.Average	-0.07	-0.18	0	-0.15	-0.14	-0.17	0.21	0.19	0.11	0.15	0.57	1	0.05	0.04	0.28	0.36	0.17	0.22	0.24	0.07	0.23	0.09	0.03	-0.04	0.04	0.19	0.08	-0.06	-0.05	-0.02	-0.11	0.55	0.95	0.16	0.2	0.12
Total.Rating.Up	0.13	-0.07	0.15	0.1	-0.08	0.07	0.34	0.47	0.03	-0.01	0.24	0.05	1	0.33	0.34	0.35	-0.01	0.25	0.42	0.03	0.42	0.06	0.05	-0.06	0.07	0.01	0.06	-0.09	-0.03	-0.08	0.12	0.25	0.08	0.29	0.23	0.19
Total.Rating.Down	-0.12	-0.16	-0.07	-0.13	-0.14	-0.13	0.27	0.37	-0.01	0.02	0.14	0.04	0.33	1	0.24	0.27	0.08	0.25	0.27	0.16	0.28	0.12	0	-0.06	0.04	-0.04	0.06	-0.09	0.01	-0.05	0.14	0.16	0.06	0.2	0.25	0.16
Additional.Information.on.Solution	0.11	-0.15	0.18	-0.09	-0.34	-0.09	0.81	0.75	0.43	0.35	0.73	0.28	0.34	0.24	1	0.73	0.28	0.58	0.87	0.18	0.86	0.21	0.29	0.15	-0.01	0.23	0.19	0.01	-0.13	-0.01	0.24	0.73	0.33	0.71	0.28	0.54
Additional.Information.on.Problem	0.08	-0.15	0.16	-0.09	-0.3	-0.09	0.76	0.71	0.39	0.32	0.78	0.36	0.35	0.27	0.73	1	0.2	0.39	0.75	0.24	0.74	0.31	0.3	0.04	-0.01	0.16	0.15	0.07	0	-0.11	0.02	0.78	0.4	0.64	0.27	0.53
Additional.Information.on.Market	0.2	-0.02	0.24	0.01	-0.19	0	0.45	0.36	0.35	0.31	0.38	0.17	-0.01	0.08	0.28	0.2	1	0.16	0.26	0.41	0.26	0.4	0.16	0.43	-0.01	0.22	0.06	0.15	0.09	0.12	0.01	0.4	0.21	0.27	0.32	0.38
Additional.Information.on.Technology	0.12	-0.12	0.23	0.04	-0.23	0.02	0.53	0.51	0.19	0.37	0.47	0.22	0.25	0.25	0.58	0.39	0.16	1	0.53	0.22	0.51	0.19	0.19	0.13	0.04	0.14	0.09	0.01	0.03	-0.04	0.05	0.48	0.25	0.46	0.21	0.34
Confirmation	0.11	-0.12	0.19	-0.08	-0.36	-0.07	0.87	0.81	0.49	0.33	0.77	0.24	0.42	0.27	0.87	0.75	0.26	0.53	1	0.08	0.98	0.16	0.31	0.06	-0.01	0.14	0.31	0.03	-0.17	0.02	0.31	0.76	0.28	0.81	0.28	0.54
Objection	0.19	-0.08	0.24	0.05	-0.15	0.04	0.42	0.4	0.22	0.26	0.26	0.07	0.03	0.16	0.18	0.24	0.41	0.22	0.08	1	0.06	0.82	0.01	0.59	0.12	0.03	-0.04	0.01	0.43	-0.14	-0.16	0.24	0.06	0.24	0.27	0.39
Positive	0.14	-0.09	0.2	-0.06	-0.34	-0.06	0.85	0.8	0.48	0.32	0.76	0.23	0.42	0.28	0.86	0.74	0.26	0.51	0.98	0.06	1	0.14	0.26	0.05	-0.02	0.14	0.29	0.05	-0.19	0.01	0.32	0.75	0.28	0.8	0.27	0.52
Negative	0.23	-0.02	0.28	0.06	-0.16	0.06	0.47	0.42	0.3	0.32	0.32	0.09	0.06	0.12	0.21	0.31	0.4	0.19	0.16	0.82	0.14	1	0.27	0.5	0.12	0.05	0.03	0.14	0.37	-0.14	-0.07	0.29	0.08	0.25	0.33	0.44
Neutral	0.35	0.16	0.36	0.21	-0.14	0.21	0.49	0.31	0.51	0.25	0.37	0.03	0.05	0	0.29	0.3	0.16	0.19	0.31	0.01	0.26	0.27	1	0.05	0.06	0.16	0.05	0.54	-0.03	0.06	0.04	0.36	0.06	0.29	0.12	0.51
Idea.Exists	0.26	0	0.29	0.12	-0.11	0.11	0.29	0.19	0.22	0.32	0.13	-0.04	-0.06	-0.06	0.15	0.04	0.43	0.13	0.06	0.59	0.05	0.5	0.05	1	0.05	-0.03	-0.06	0.05	0.09	-0.06	0.01	0.11	-0.05	0.14	0.11	0.33
Idea.Exists.in.IMS	-0.02	-0.11	-0.01	0.02	-0.03	0	0.06	0.1	0.03	-0.05	0.03	0.04	0.07	0.04	-0.01	-0.01	-0.01	0.04	-0.01	0.12	-0.02	0.12	0.06	0.05	1	0	0.05	-0.08	0.09	-0.02	-0.05	0	-0.02	0	0.06	0.1
Idea.Partly.Exists	-0.02	-0.11	0.05	-0.1	-0.15	-0.06	0.21	0.17	0.16	0.17	0.25	0.19	0.01	-0.04	0.23	0.16	0.22	0.14	0.14	0.03	0.14	0.05	0.16	-0.03	0	1	-0.03	0.05	0.01	0.07	-0.02	0.24	0.19	0.17	0.12	0.15
Idea.Evaluation	-0.07	-0.11	-0.07	-0.13	-0.16	-0.13	0.21	0.15	0.15	0.12	0.2	0.08	0.06	0.06	0.19	0.15	0.06	0.09	0.31	-0.04	0.29	0.03	0.05	-0.06	0.05	-0.03	1	-0.08	0.02	-0.01	0.02	0.19	0.09	0.21	0.16	0.08
Innovation.Manager.Status.Request	0.49	0.41	0.44	0.32	0.02	0.33	0.28	0.02	0.53	0.25	0.18	-0.06	-0.09	-0.09	0.01	0.07	0.15	0.01	0.03	0.01	0.05	0.14	0.54	0.05	-0.08	0.05	-0.08	1	-0.14	0.02	0.09	0.19	-0.01	0.07	-0.06	0.46
Idea.Closed	0.16	0.08	0.12	0.22	0.18	0.15	0.02	0.03	0.03	-0.04	-0.03	-0.05	-0.03	0.01	-0.13	0	0.09	0.03	-0.17	0.43	-0.19	0.37	-0.03	0.09	0.09	0.01	0.02	-0.14	1	-0.11	-0.34	-0.03	-0.04	-0.08	0.17	0.07
Idea.Moved	-0.03	0	-0.04	-0.01	-0.05	0.03	-0.02	-0.01	0.01	-0.05	-0.06	-0.02	-0.08	-0.05	-0.01	-0.11	0.12	-0.04	0.02	-0.14	0.01	-0.14	0.06	-0.06	-0.02	0.07	-0.01	0.02	-0.11	1	-0.05	-0.05	0	-0.06	0.09	0
Idea.Implemented	-0.03	-0.02	0	-0.12	-0.11	-0.07	0.17	0.11	0.2	0.07	0.02	-0.11	0.12	0.14	0.24	0.02	0.01	0.05	0.31	-0.16	0.32	-0.07	0.04	0.01	-0.05	-0.02	0.02	0.09	-0.34	-0.05	1	0.01	-0.12	0.17	0.03	0.11
Language.Strength.Sum	0.18	-0.11	0.25	-0.06	-0.32	-0.06	0.81	0.7	0.48	0.39	0.99	0.55	0.25	0.16	0.73	0.78	0.4	0.48	0.76	0.24	0.75	0.29	0.36	0.11	0	0.24	0.19	0.19	-0.03	-0.05	0.01	1	0.62	0.67	0.32	0.57
Language.Strength.Average	-0.07	-0.22	0.05	-0.17	-0.24	-0.13	0.26	0.25	0.13	0.16	0.61	0.95	0.08	0.06	0.33	0.4	0.21	0.25	0.28	0.06	0.28	0.08	0.06	-0.05	-0.02	0.19	0.09	-0.01	-0.04	0	-0.12	0.62	1	0.19	0.25	0.16
Semantria.Positive	0.15	-0.13	0.22	-0.03	-0.3	-0.03	0.81	0.75	0.39	0.38	0.67	0.16	0.29	0.2	0.71	0.64	0.27	0.46	0.81	0.24	0.8	0.25	0.29	0.14	0	0.17	0.21	0.07	-0.08	-0.06	0.17	0.67	0.19	1	0.06	0.28
Semantria.Negative	-0.02	-0.17	0.11	-0.09	-0.24	-0.05	0.32	0.33	0.15	0.11	0.31	0.2	0.23	0.25	0.28	0.27	0.32	0.21	0.28	0.27	0.27	0.33	0.12	0.11	0.06	0.12	0.16	-0.06	0.17	0.09	0.03	0.32	0.25	0.06	1	0.14
Semantria.Neutral	0.43	0.18	0.4	0.2	-0.22	0.19	0.75	0.57	0.68	0.35	0.58	0.12	0.19	0.16	0.54	0.53	0.38	0.34	0.54	0.39	0.52	0.44	0.51	0.33	0.1	0.15	0.08	0.46	0.07	0	0.11	0.57	0.16	0.28	0.14	1

Figure 12: Correlation for all variables presented in numbers.