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Análise dos Resultados de Avaliação de Consultores usando Redes Sociais

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Resumo

Numa economia cada vez mais orientada ao conhecimento é cada vez mais valioso gerir eficazmente o capital humano em detrimento de gerir eficientemente recursos físicos e financeiros. Para obter retorno do capital humano a camada de gestão necessita de ir para além de noções básicas de produtividade e redução de custos e desenvolver novas formas de capturar conhecimento, criatividade, entre outras competências. Uma ferramenta que permite a captura dos comportamentos e competências dos colaboradores de uma organização é hoje em dia uma necessidade. A resposta é Avaliação 360º, uma ferramenta altamente eficaz, onde um indivíduo recebe informação sobre os seus comportamentos, desempenho e competências. Para se proceder à visualização e análise dos resultados da avaliação, realizou-se o levantamento do estado da arte da Análise de Redes Sociais, tendo sido seleccionado um conjunto adequado de aplicações, atingindo-se a interoperabilidade entre os vários componentes através duma aplicação de conversão que aplica técnicas de transformação de dados. Este trabalho foi validado através da utilização da plataforma de avaliação num caso de estudo real, conduzindo-se uma avaliação a todos os colaboradores de uma organização e avaliando o impacto atingido.

Palavras-chave: Avaliação 360º, Análise de Redes Sociais, Ferramenta de avaliação, Recursos Humanos.

Abstract

In a knowledge-driven economy, it's more valuable to effectively manage human capital than to efficiently manage finance and physical assets. To obtain returns in human capital, management must go beyond notions of productivity and cost effectiveness and develop new approaches to tap knowledge, creativity and other skills. A tool to capture employees' behaviours and competences in order to promote awareness is a necessity nowadays. The answer is 360° Feedback, a highly effective tool by which an individual receives aggregated feedback about behaviours, skills and competences. For evaluation data visualization and analysis, we gathered the state-of-the-art of Social Network Analysis and selected the adequate software packages, achieving interoperability by developing a conversion application that applies data transformation techniques. The work was validated by applying the evaluation framework in a real-world case study, conducting an evaluation with the participation of all collaborators of an organization and assessing its impact.

Keywords: 360° Feedback, Social Network Analysis, Evaluation tool, Human Resources.

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List of Acronyms

BLL   Business Logical Layer

BPO   Business Process Outsourcing

CEO   Chief Executive Office

CM   Configuration Management

CRUD   Create, Read, Update, and Delete

DAL   Database Access Layer

DBMS   DataBase Management System

EIES   Electronic Information Exchange System

GUI   Graphical User Interface

HQ   Headquarters

HR   Human Resources

HRM   Human Resource Management

INSNA   International Network for Social Network Analysis

IQM   Integrated Quality Management

IT   Information Technology

ITIL   Information Technology Infrastructure Library

MAF   Multi-rater Assessment and Feedback system

ONA   Organizational Network Analysis

PL   Presentation Layer

QA   Quality Assurance

QMS   Quality Management Services

ROI   Return On Investment

RUP   Rational Unified Process

SNA   Social Network Analysis

SQL   Structured Query Language

SVG   Scalable Vector Graphics

TQM   Total Quality Management

UML   Unified Modeling Language

XML   eXtensible Markup Language

XP   eXtreme Programming

XSLT   Extensible Stylesheet Language Transformations

1 Introduction

This document presents the work developed regarding the masters in Information Systems. A thoroughly description of all approach steps is described along the report, from the analysis of the state of the art to case study results and evaluation. Some low-level technological implementation details were omitted for its non-relevance matter on the dissertation scope. The appendixes are relevant for the complementary comprehension on specific activities of the project.

1.1 Context

"The world is not a problem; the problem is your unawareness."
Bhagwan Shree Rajneesh (Indian spiritual leader, 1931-1990)

Effective people have a high degree of self-awareness. They recognize their strengths and weaknesses, their likes and dislikes, their personality, and where they are more likely to succeed or where they may have difficulties succeeding. They choose the right path on the basis of this self-awareness. They continuously seek feedback from others in order to get information from the impact of their actions.

360° Feedback is a highly effective tool to enhance effectiveness as an individual, manager or leader. The person receives feedback from a range of people around him/her getting developmental knowledge about behaviours, skills and competencies.

The rationale behind using 360° Feedback is to improve the accuracy of self-perception, as well as to give individuals information about how others perceive this behaviour. This awareness is the direct input of the need for behaviour change, and sometimes maybe the only way to instigate it.

Getting an accurate view of an organization network helps the management with the decision making process. Rather than leave the inner workings of an organization to chance, executives can leverage the insights of a social network analysis to address problems related to the individuals, groups and the organization as a whole.

Research has consistently shown that whom you know has a significant impact on what you come to know, because relationships are critical for obtaining information, solving problems and learning more about people and their work [25].

1.2 Problem

Mapping and understanding social networks within an organization is an approach to understand how social relationships may affect business processes [63]. Network structure and activities influence employees and affect individual and organizational outcomes. This provides motivation to explore this rich field for possible inputs in Human Resources Management (HRM) activities.

We will elaborate on ways in which networks can be analyzed using network mapping software and how the information derived can be used meaningfully for HRM.

How can we map networks within the organization? How do we efficiently construct and analyze these networks? What opportunities exist to use SNA information to improve HRM activities? These questions are important in order to manage social and human capital effectively. Our discussion highlights the capabilities of some SNA software packages, as well as implications for various HRM activities.

1.3 Solution

Our proposal is a 360º Feedback software application easy to customize for a variety of groups across the organization. It's a tool that can capture employees' behaviours and competences, as a way to develop the workforce as much as possible, enabling at the same time the identification of internal talent.

For evaluation data visualization and analysis we selected the adequate SNA software packages and achieved interoperability by developing a conversion application that applies data transformation techniques.

The detailed description of this proposal can be consulted in Chapter 5.

1.4 Thesis Structure

This thesis is organized in the following way:

Chapter 2 introduces the 360º Feedback theme. It briefly explains what 360º Feedback is and its role within an organization, also exposing its main objectives and guidelines to implementation success.

Chapter 3 describes concepts like social networks and social network analysis, discussing

its goals, main aspects and common applications. A state-of-the-art overview of available software for social network analysis is also presented.

Chapter 4 describes the generic problem that this work addresses, applied in the Human Resources Management (HRM) area.

In **Chapter 5** a solution for the stated problem is proposed. It's a 360º Feedback software application that can support all administrative work in order to obtain feedback of an individual. It also integrates with major SNA software packages for evaluation data visualization and analysis.

Chapter 6 describes the particular case study of this work. It presents the organization (Noesis) and its business area. All phases of software development process (requirements elicitation, analysis and design) are documented. The resulting two prototypes are also illustrated.

Chapter 7 contains the achieved results, the evaluation of the case study and software validation results.

Finally, in **Chapter 8** we analyze the work in a final perspective, stating its impact in the case study and revealing the suggested future related work that could be done.

2 360º Feedback

In this chapter we expose the 360º Feedback tool, define its main objectives and point some guidelines of recommended usage.

2.1 360º Feedback

The 360º Feedback is a tool by which an individual gets his/her aggregated feedback from different categories of individuals:

- **Supervisors** - boss, reporting officer, reviewing officer;
- **Direct reporters** - subordinates;
- **Peers** - colleagues and internal customers;
- **Others** - external customers, suppliers, and other role/set members with whom he/she is interacting.

The candidate's own feedback is also taken and used to draw comparisons between his/her own ratings and ratings provided by other assessors.

One of the earliest books to appear about 360º Feedback was written by Edwards and Ewen [32]. The authors presented, in detail, a conceptual framework for the 360º Feedback and discussed its evolution and variations, design, implementation and evaluation. The 360º Feedback evolved from organizational surveys, Total Quality Management (TQM), development feedback and performance appraisals.

The 360º Feedback is also called "Multi-rater Feedback system", "Multi-source Feedback", "Full Circle Feedback" or "Multi-rater Assessment and Feedback System" (MAFs) [52]. As these names suggest, the feedback comes from all around the employee and "360" obviously refers to the 360 degrees in a circle.

The feedback is obtained on a pre-determined answering instrument, typically a questionnaire of relevance and significance to individuals and their organization. It should be gathered anonymously, by an external agent (consultant) or through a credible internal facilitator (for example the HR department).

The candidate should be assessed periodically (once in a year or half-yearly, depending on subject results) by a number of assessors that should round from 5 to a maximum of 20. Evaluations should be conducted fairly, quickly and simply with a questionnaire response time of less than 15 minutes. The assessment is specially designed to measure behaviour which is consid-

ered to be critical for performance. The assessment should be consolidated, creating feedback profiles and reports that should be given to the participant after a workshop or clarification session.

2.1.1 Just a Tool

The 360º Feedback has tremendous potential to enhance the effectiveness of an individual and to develop competencies or organizational values. Assessments should be taken as indicative and be reflected upon by the individual - rather than conclusive and acted upon by the organization.

Feedback is a sensitive issue. Effective use of feedback requires some preparation to bring down wrong beliefs and create right attitudes to use feedback. It can be very provocative and is intrinsically subjective. The candidate should use it for review, reflection and self-improvement actions, rather than trying to identify those who have given a specific answer. That is, the 360º Feedback should be used as a development tool.

Perceptions of others can be varied and conflicting, or even opposite. For example, some may perceive a person as dynamic and active, while others may see he/she as dominating and manipulative. Perceptions are influenced by experiences and expectations. Every assessor has his/her own perspective.

The 360º Feedback is merely an awareness tool, part of a continuous self-learning process.

2.1.2 Main Objectives

At individual level, the feedback is intended to [52]:

- Provide insights into strong and weak areas of the candidate in terms of effective performance of roles, activities, qualities, competencies and social impact, among others;
- Enhance awareness through communication;
- Identify developmental needs in relation to current or future roles;
- Explore new areas to make impact;
- Develop leadership skills.

At organizational level it's possible to aim at the following:

- Generate data to serve as input to personnel-related decisions;
- Reinforce change management efforts and interventions for organizational effectiveness that may include TQM efforts, customer satisfaction interventions, flat structures, quality-enhancing, cost-reducing, etc.;

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- Align individual and group goals with organization vision and strategy, as individuals, teams and departments tend to focus on their own performance and not on performance of the company as a whole;

- Team and culture-building to create a culture of continuous learning;

- Appraise potential performance.

About the use of feedback for appraisals, many experts discourage using 360º Feedback for purposes other than performance development - such as performance appraisals, salary action or promotion decisions [62]. When ratings affect a person's salary or job assignment, individuals might be less inclined to honestly express their opinion. Thus, it can destroy 360º Feedback effectiveness as a personal development tool.

2.1.3 Extracting Added Value

The multi-perspective evaluation of 360º Feedback is more complete and accurate than traditional top-down evaluation. A 360º evaluation is also valuable because people do not act the same way toward each other. Skills of a manager are probably more accurately reflected in feedback from subordinates or peers rather than exclusively from manager's superiors. So this performance system can help people focus on skills and competences which are important for the organization.

A 360º Feedback program will also help monitor how well a company and its employees are accepting and adapting to changes. Some months after the launch of an organization change effort, it can provide aggregate results about employees' behaviour towards the direction of the change.

One major goal of a corporate strategy is to satisfy a targeted group of customers and keep them loyal. So customer feedback is vital, helping an organization to assess strategic decisions, by receiving data on how customer view the way the product or service is delivered (the process) and corresponding satisfaction level (the outcome).

Nowadays, more than ever, knowledge is the key source of competitive advantage in the business world, so learning is an essential task in organizations. Through continuous learning, a company is better prepared to adapt and anticipate complex and often-changing business environment. The 360º Feedback can help create a learning culture by providing feedback on learning skills and abilities (meaning it's not strictly concerned on skills and competences) and also by linking individual and group development to organization's development needs, mean-

ing it helps people fulfil responsibilities to their jobs in a better manner.

2.1.4 Some Facts and Myths

Experiencing a 360° Feedback is like experiencing a storm. It might seem rough when it is on, however the end result is just the opposite. It leaves the individual much stronger and better charged to face, manage and lead change.

The 360° Feedback is being used to serve multiple objectives ranging from a change management tool for leadership development to a tool to appraise senior managers. There is, however, a fair amount of scepticism about immediate Return On Investment (ROI) as well as other tangible outcomes from the 360° Feedback.

While 360° Feedback doesn't give immediate, tangible results, the faith in this powerful tool is on rise and companies are looking at it as an investment, stating that people are believed to be the most important resource.

The main reasons for slow adoption of feedback systems include: multi-source assessments can be considered as counterculture; organizational inertia to change; little research data available; and inherent technological jargon [32].

The 360° Feedback should not be seen as a substitute for traditional performance appraisals. Traditional appraisal systems are organizational requirements; they establish role clarity, enable performance plans, establish accountabilities and facilitate performance monitoring, assessment and rewards [50].

It's also a myth to expect immediate change from people after a 360° Feedback process. Changes aren't straight visible and it's not fair to make early conclusions, especially because judgments should be retrieved from personal opinions. It's necessary to set expectations realistically.

2.1.5 Misuses

Susan Haworth [40] points out dangers associated with using 360° Feedback ineffectively leading to dramatic and undesirable changing results.

The 360° Feedback assessment tools should address organizational culture, endorsing and reinforcing measurement criteria. Use of unprofessional third-party questionnaires can be a waste of time and energy, especially without validation measures on evaluated skills and competencies, ensuring consistent quality.

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Sometimes 360º Feedback evaluations are only administered for a select group (slow learners or star performers) and then are attached to fear, resentment or overblown expectations. The best solution to this potential problem is introducing the feedback process to the entire work group.

Supervisors with a high number of direct reporters may not be aware of the time commitment involved in a 360º Feedback assessment, as they require efficient administration. A way to combat this problem is writing comprehensive yet not lengthy questionnaires, with items easy to understand and free of technical jargon or complex phrases.

Conditions under which the feedback will be used should be stated right from the beginning, with at least a text attached to feedback material defining the purpose and use of the evaluation.

Once the 360º Feedback tool is implemented, timetables for distribution, collection and debriefing should be established. Typical time values include four to six weeks after questionnaires have been answered to deliver feedback reports.

3 Social Network Analysis

In this chapter we present the concept of social networks, formulating a definition. Next, we discuss Social Network Analysis, its goals, common applications and main aspects to overlook. Finally we present a state-of-the-art overview of available software for social network analysis.

3.1 Social Networks

A social network consists of a set of actors and one or more relations between the actors. The concept of "network" is broad and flexible, and can be applied to a variety of scenarios describing different kinds of actors and relations. Social networks focus on the implications of relations within a collective, assuming interdependency between all actors.

Social networks theories suggest that the behaviour of the actors is influenced by the structure of ties in the network, which in turn also influence relational strength between them.

3.1.1 Historical Vision

Social networks retraces to the 1950's by professor J. Barnes who studied social ties in a Norwegian fishing village [2] concluding that social life could be seen as "a set of points, some of which are joined by lines" to form a "total network of relations".

Jacob L. Moreno, a social scientist extended these insights through the development of the *sociogram* - a graphical representation of relations among persons, consisting of points and lines. This kind of drawing is shown in Fig. 3.1.
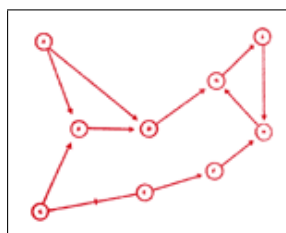
Figure 3.1: Image of who recognized whom among a collection of individuals [47]

Moreno introduced several ideas about the proper construction of images of social networks, using directed graphs with colours and points with different shapes, as a way to display structural features of data. He also identified social leaders and "isolates" in networks to uncover asymmetry and reciprocity in connections, and to map chains of indirect connection [34].

Studies on the topic enabled new ways in which people get jobs, become leaders and develop friendships. The interest also raised outside academic context with best sellers like Malcolm Gladwell's "The Tipping Point" [39], a reflection of social epidemics that surround us, presenting notions like Connectors (persons with wide social circles) or Mavens (knowledgeable people).

Since the work of Harvard Business School professor Elton Mayo in the 1930's on employee feedback research that led to the discovery of the Hawthorne Effect [1] (a phenomenon that states that when people are observed in a study, their behaviour or performance changes temporarily), there has been an acknowledgement of the role of the informal structure within an organisation in challenging the supremacy of the formal organisation chart.

From the early 1990's the ubiquity of knowledge and globalisation afforded mostly by technology has changed organisations, work models and even the work context, breaking the hierarchical structures of the industrial age.

Flatter, more flexible and organic organisations are now a necessity in order to face new paradigms such as outsourcing, virtual organisations and business process networks.

Combined with organisational changes, the emergence of collaborative software (such as blogs and wikis), online communities, social and business networking sites (such as MySpace [48] or LinkedIn [45]) have all contributed to the expansion of social networks, Social Network Analysis (SNA) and Organizational Network Analysis (ONA).

3.1.2 Social Network Definition

A social network consists of <u>nodes</u> (also referred as actors, agents or points), i.e. entities such as persons, collective entities, organizations, or simply objects that may have <u>links</u> (edges, relations or lines) with one another, representing social relations, dependencies, affective expressions, publishing or retrieval of knowledge, flows of information, or exchanges, to name just a few.

Networks can have few or many nodes with different kinds of relations between pairs. Both nodes and links may have additional attributes. Attributes can be of any type, and numerical link attributes may represent the strength of the tie between two nodes.

Links constituting a social network may be directed, undirected, or mixed. Links can also be classified as confirmed or unconfirmed.

3.1.3 Social Network Representation

In order to represent the descriptions of networks in a systematically and compact way, mathematical and graphical techniques are required, since descriptions using textual language can become pretty tedious and unmanageable, specially if the number of actors and relations is large.

We now present a small and simple example of a closed network, containing four elements: Alice, Bob, Carol and David. Let's assume Alice enjoys working with Bob and Carol; Bob enjoys working with Alice; Carol enjoys working with Alice, Bob and David; David enjoys working with Bob.

We can describe this pattern of links with an actor-by-actor matrix where the rows represent choices by each actor. The value "1" represents the concept "enjoys working". The matrix is represented in Table 3.1.

Analyzing data in this format is much easier, since it allows the observation of patterns and stimulates asking some questions. For example, Alice and Carol enjoy working with more elements than Bob and David. Is there a pattern here? Are women more likely to report ties of liking than men are? These and other questions can be raised when analyzing data.

Social network analysts also use graphs to represent information about ties among social actors. A graph is a data structure that consists of a set of nodes and a set of edges that establish connections between the nodes. A graph G is defined as follows: $G = (V, E)$, where V is a finite, non-empty set of vertices and E is a set of links between pairs of vertices [23]. A graph is called directed when its edges have a direction, otherwise it's called undirected.

We can represent the graph of the example network described before by drawing an arrow from one subject to another, as in Fig. 3.2.

A standard way to represent a graph is using an adjacency matrix, a $|V| * |V|$ binary matrix

Table 3.1: Matrix representation of a sample network

	Alice	Bob	Carol	David
Alice	0	1	1	0
Bob	1	0	0	0
Carol	1	1	0	1
David	0	1	0	0
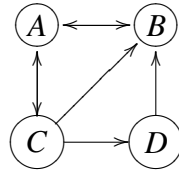
Figure 3.2: Graph representation of a sample network

that represents who is adjacent to whom in the "social space" mapped by the relations that are being measured. For example, Table 3.1 shows the adjacency matrix for the graph in Fig. 3.2.

3.1.4 Proposed Definition

We now present a unified social network model definition (basically a labelled digraph) that is general enough to capture operated data.

Definition. *A social network is a labelled directed graph $G = (V, E = E_C \cup E_U; \omega)$, where V is a set of vertices, E_C and E_U are disjoint sets of confirmed and unconfirmed edges, and $\omega : E \rightarrow \mathbb{R}_{\geq 0}$ a non-negative edge strength.*

A vertex attribute is a partial function assigning values to vertices. The values assigned can be strings (nominal attribute) or non-negative real numbers (numerical attribute).

3.2 Social Network Analysis

Social Network Analysis (SNA) is an approach for analysing organisations focusing on the relationships between people and/or groups as the most important aspect [66]. Going back to the 1950's and before, it is characterised by adopting mathematical techniques, especially from graph theory [38]. It has applications in organisational psychology, sociology and anthropology.

Rob Cross introduced the term Organizational Network Analysis (ONA) as a powerful tool to provide an x-ray into the inner workings of an organization, by showing patterns of information flow and collaboration in strategically important groups [24].

Milgram's small world experiment [46] is probably the most well-known use of SNA. Milgram conducted experiments based on the premise that every individual in the United States is separated to any other individual by no more than six links, which gave rise to the notion of "Six Degrees of Separation". Though its conclusions are controversial and have been disputed, the notion of connectedness is nowadays accepted and SNA is gaining a foothold in the marketplace, especially in the knowledge management area, powered by tools and technologies, such

as collaborative filtering, content management and data mining techniques.

In management, the acceptance of social networks has been supported by several developments in the business world [26]. First was the discovery of the importance of the informal structure within an organization, which coexists with the formal structure. The formal organization chart does not represent the actual interactions between individuals that now communicate in a myriad of ways. Next was the shift in the late 20th century to the organizational paradigm that is more flatter, flexible, team-oriented and reliant on knowledge assets. Another development is the rapid growth in cooperative relationships across organizational boundaries, including outsourcing, joint ventures, alliances and multi-organizational projects. As a result, organizations today face new management issues with the absence of strict reporting relationships.

SNA allows managers to visualize and understand the relationships across the organization, manage change, identify key players and experts and understand the decision making processes. How does information flow within an organization? To whom people turn for advice and help? Are subgroups not sharing information? These questions, as well as many others, can be answered through the analysis of a social network.

3.2.1 SNA Goals

The first goal of SNA is to visualise communication and other relationships between people and/or groups by means of diagrams. The importance of visualisation in this field lies in the complexity of organisational structures, and the need for good visual representations of how an organisation functions [35].

The second goal is to study the factors that influence relationships (for example age, background and training of the people involved) and to study the correlation between relationships. This can be done using traditional statistical techniques such as correlation, analysis of variance, and factor analysis [21] but also requires appropriate visualisation techniques.

The third goal of SNA is to draw out implications of the relational data, including bottlenecks where multiple information flows funnel through one person or section (slowing down business processes) and situations where information flows do not match formal group structures.

The fourth and most important goal of SNA is to make recommendations to improve communication and business processes in an organisation [31].

3.2.2 SNA Applications

SNA can be very helpful in determining the extent of connectivity in specific functions, divisions or business units. These groups include departments in a core business process, distributed practices in professional services, and critical support functions. Important networks in organizations are not described in the formal charts, but must be available to executives. Rob Cross enumerates the following applications for SNA [25]:

1. Supporting partnerships and alliances by exposing the effectiveness of cross-organizational initiatives in terms of information flow, knowledge transfer and decision making;

2. Assessing strategy execution, determining whether departmental collaborations are supporting strategic objectives;

3. Improving strategic decision making;

4. Integrating networks across core processes;

5. Promoting innovation by assessing how a team is integrating its expertise and effectiveness;

6. Ensuring integration post-merger or large-scale change;

7. Developing communities of practice and uncovering key members of the community.

3.2.3 Types of Individuals in a Network

When viewing a full network diagram, managers can identify four key roles [25]. The first role to focus is *central connectors* who have an extensive number of direct relations and might be either:

1. An unrecognized resource that responds to requests for information, engages in problem solving and provides personal support;

2. A bottleneck who are people that become so central to a network that end up holding the group back.

The second role are *boundary spanners* that provide critical links between two groups of people that are defined by functional affiliation, physical location or hierarchy level. They play an important role when people need to share different kinds of expertise for example developing new products.

Information brokers communicate across subgroups of informal networks, so that the group as a whole won't splinter into small segments. Targeting information brokers can help an orga-

nization disseminate information and promote connectivity throughout a network.

Finally, *peripheral people* are outsiders or network outliers. Their skills, expertise and unique perspectives are not leveraged effectively, so they represent underutilized resources. People may be on the periphery because of inapplicable skills or just because they are stuck (especially if they are new in the organization) or because they choose to be intentionally peripheral, for example specialists, gurus or people with low soft skills.

3.2.4 Summary

Analysis of social networks helps determine the extent to which certain people are central to the effective functioning of a network, regardless of subgroups in a network or the overall connection. Some aspects to look for in SNA are [26]:

- Bottlenecks - Central nodes that provide the only link between different parts of the network;
- Number of links - Insufficient or excessive links between subgroups;
- Average distance - Degrees of separation connecting pairs of nodes in the group, as long distances indicate that the transmission is slow and can lead to distortions of information;
- Isolation - People not well integrated in a group, probably with less soft skills;
- Highly expert people - Checking if they are being utilized appropriately;
- Organizational subgroups or cliques - In order to detect subcultures and negative attitudes.

3.3 Software for SNA

We now review existing software packages for the analysis of social networks. Based on the software list page on the International Network for Social Network Analysis (INSNA) website [33] and Freeman's "Models and Methods in Social Network Analysis" book [35], fourteen software packages, both commercial and freely available, were selected and analyzed. The age of the software was not a specific criteria for selection, although the majority of the reviewed software is recent.

Three packages (UCINET, Pajek and MultiNet) were extensively reviewed since they are regarded as general and well-known in their field of expertise, containing a wide range of analysis methods.

The software is illustrated by applying a selection of routines to an example data set, focusing the presentation of three main features that the software does or does not possess:

1. Data entry and data manipulation;

2. Visualization techniques;

3. Social network analysis routines, including:

    (a) Descriptive methods to calculate simple network statistics;

    (b) Procedure-based analysis based on more complex algorithms;

    (c) Statistical modelling based on probability distributions.

We consider the remaining packages to be more specialized and their objectives and properties are discussed only to a limited extent in section 3.3.5.

3.3.1 Sample Data

The sample data used is Freeman's Electronic Information Exchange System (EIES) network [36] composed by three one-mode networks with two relations on a set of actors ($n = 32$). The data was collected as part of a study about the impact of electronic information exchange systems. The complete data set is available on the INSNA website [61] in several formats, including UCINET's.

The two types of relations documented were acquaintanceship and number of messages exchanged. The acquaintanceship relation is longitudinal, measured at two time points coincident with the start and end date of the study, ranging from value 0 (did not know the other) to 4 (close personal friend). Since some analysis procedures may require binary data (relation present or absent), the following dichotomization is used: relation present for values 3 (friend) and 4 (close personal friend) and relation absent for values 0 (did not know), 1 (not having met) and 2 (having met).

The attribute variables are: primary disciplinary affiliation (sociology, anthropology, statistics, psychology), number of citations and internal id numbers.

3.3.2 UCINET

UCINET [9] is a comprehensive package for the analysis of social networks and other proximity data. It contains a large number of network analytic routines, network hypothesis testing procedures and statistical and multivariate analysis tools. The program is a commercial product,

but a free evaluation version is available for a 30 days trial. The manual contains a user's guide (for data management and manipulation) and a reference guide (for network analysis).

UCINET is a menu-driven Windows program and, as written in the manual, "is built for speed, not for comfort" [10]. Every procedure requires filling a parameterization form, where the input of the algorithms is specified. For each procedure two kinds of output are generated: textual output and data sets that can be used as input for other procedures.

3.3.2.1   Data Entry and Manipulation

UCINET is matrix oriented, meaning that data sets are collections of one or more matrices. A UCINET data set consists of two files: one containing the actual data (##D extension) and other containing information about the data (##H extension). Data can be entered via the spreadsheet editor or imported from several types of network data: raw ASCII, ASCII data in DL format, VNA format, Excel spreadsheets and data formats from programs like NEGOPY, KrackPlot and Pajek. The spreadsheet editor, containing the EIES data, is shown in Fig. 3.3.

UCINET provides a large number of data management and transformation tools, such as selecting subsets, merging data sets, permuting, transposing and recoding data. There's also an option to enter attribute data and to specify missing values.
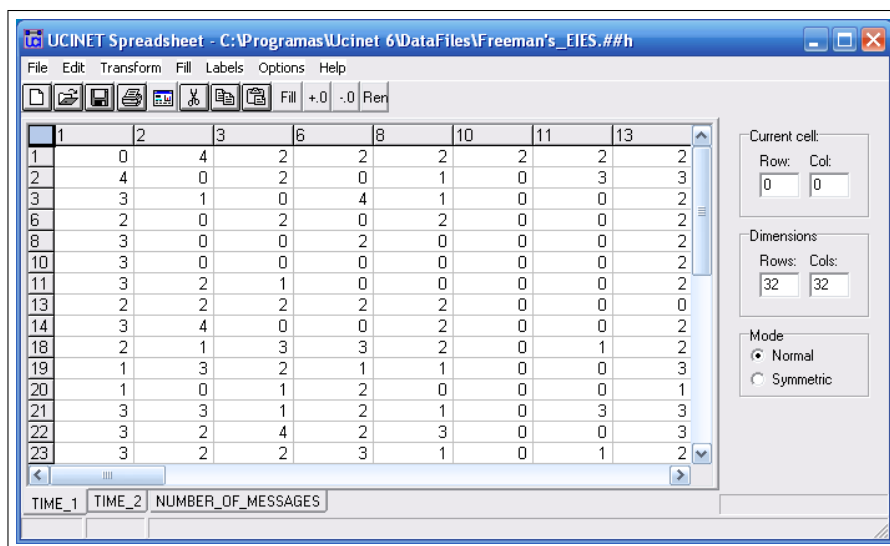
Figure 3.3: UCINET spreadsheet editor containing the EIES data

3.3.2.2 Visualization Techniques

The program itself does not contain graphical procedures to visualize networks, but Pajek, Mage, Keyplayer 2 and NetDraw are four stand-alone programs distributed with UCINET. Net-Draw has advanced graphical properties and reads UCINET files natively (see Section 3.3.5.2 for further discussion). Export functions for the other programs are available.

3.3.2.3 Analysis Routines

The program contains a large number of network analytic routines for the detection of cohesive subgroups and regions, centrality analysis, ego network analysis and structural holes analysis. It also has a full-featured matrix algebra language and can handle two-mode (affiliation) data, and derive one-mode data sets from two-mode data. UCINET has group centrality options, computing the most central subgroup of fixed size, or testing the degree centrality of a specific subgroup. It's also included other procedures such as multidimensional scaling (metric or non-metric), two-mode scaling (singular value decompositions, factor analysis and correspondence analysis), analysis of roles and positions (structural, role and regular equivalence) and fitting core/periphery models.

3.3.3 Pajek

Pajek [3] is a network analysis and visualization program, specially designed to handle large networks having thousands or even millions of vertices.

The main goals in the design of Pajek [4] are:

1. To support abstraction by recursive decomposition of a large network into several smaller networks that can be treated further using more sophisticated methods;
2. To provide the user with some powerful visualization tools;
3. To implement a selection of efficient network algorithms.

The program can be downloaded free of charge and its continually updated by its developers. There is a reference manual [5] with a complete list of commands with a short explanation available and a very helpful textbook [30] on social network analysis integrating theory, applications, and using Pajek for performing network analysis.

Pajek provides tools for analysis and visualization of networks such as: collaboration networks, organic molecule in chemistry, protein-receptor interaction networks, genealogies, In-

ternet networks, citation networks, etc. Pajek can handle multiple networks simultaneously, including two-mode networks and time event networks. It can handle very large networks reaching more than one million nodes; actually the available memory on the computer sets the limit.

With Pajek it's possible to find clusters (components, neighbourhoods of vertices, cores) in a network, extract vertices that belong to the same clusters and show them separately, shrink vertices in clusters and show relations among clusters.

In order to visualize large networks, substructures have to be identified and visualized separately. For that matter, Pajek uses six different data structures:

1. Networks - main objects, composed of vertices and lines;
2. Partitions - classifications of vertices, where each vertex is assigned exclusively to one class;
3. Permutations - reordering of vertices;
4. Clusters - subsets of vertices;
5. Hierarchies - hierarchically ordered clusters and vertices;
6. Vectors - properties of vertices.

Permutations, partitions and vectors can be used to store properties of vertices measured in different scales: ordered, nominal (categorical) and numeric.

The structure of the program is based on these six types of data structures and on transitions among these structures. The main window (see Fig. 3.4) is organized according to the types of data objects, with buttons to open, save and edit. The program is menu-driven and the results generated can be used as input in other procedures, including visualization methods.

3.3.3.1   Data Entry and Manipulation

Network data can be entered in several ways: by editing a network inside the program (not very friendly since it requires editing the network vertex by vertex); by importing a ASCII network data from a NET file; by importing data from other data formats (e.g., UCINET DL files, GEDCOM (GEnealogical Data COMmunication) files, MDL Molfiles, Ball and Stick files); and by opening a Pajek project file (PAJ) which combines several data structures in a single file.

The NET format consists of a vertex list and arcs/edges list, especially designed to handle large networks. It also supports an adjacency matrix for smaller networks. For attribute data is
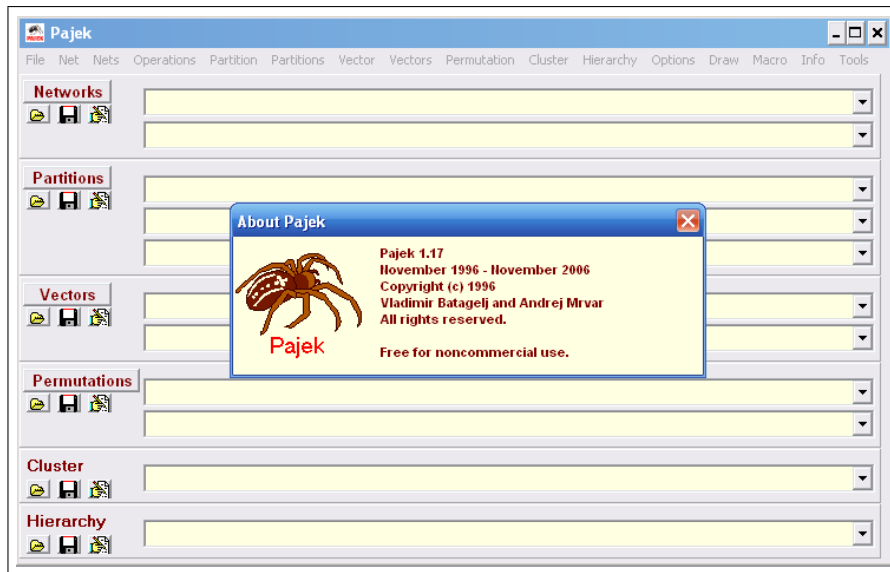
Figure 3.4: Pajek main window

necessary to use partitions in ASCII data files (CLU extension) or vectors (VEC extension). All data objects can be saved together in a PAJ file.

Pajek contains manipulation options for all its data structures. For example, networks can be transposed, vertices and edges can be added or removed, directed graphs changed into undirected graphs, or networks can be reduced. The program also allow basic network operations like intersection, cross-intersection, union of vertices, recoding or dichotomization. Also, there are transformations for attributes and options to create other data objects on the basis of the attributes (hierarchies and clusters).

Besides ordinary (directed, undirected, mixed) networks Pajek also supports temporal networks (networks changing over time), using time indicators to identify observations. Analyses can be performed on these networks, generating a series of cross-sectional networks.

3.3.3.2 Visualization Techniques

Pajek offers advanced graphical properties, allowing the user to manipulate graphs and obtain graphical representations of partitions, vectors and combinations of partitions and vectors.

The network drawing is based on the principle that distances between nodes should reveal the structural pattern of the network [35]. Network drawing can be based on simple procedures (circular, using permutation, using partition and random), procedures using eigenvectors, special procedures for layer drawing of acyclical networks and spring embedders.

The spring embedding algorithms are so called because, in those algorithms, it is assumed

that the nodes are connected by springs and therefore repel or attract each other (minimizing the stress). The Kamada-Kawai and Fruchterman-Reingold are the spring embedders that are implemented in Pajek. The Kamada-Kawai graph layout attempts to position nodes on the space so that the geometric (Euclidean) distance between them is approximately proportional to the geodesic distance [43]. It produces more stable results, but is slower and less suited for large networks. The Fruchterman-Reingold is faster and can handle large networks [37]. Both are optimization procedures that do not yield the same mapping each time they are executed, however the graphs are largely resembled.

The drawing interface of Pajek is presented in figure 3.5, containing a graph of the first observation of the EIES acquaintanceship network obtained with spring embedding algorithm of Kamada-Kawai. The nodes can be dragged and dropped to improve the graph and by right-clicking a node it shows textually to which other nodes it is tied. Pajek has the functionality to set node shape, colour and size according to attribute variables.
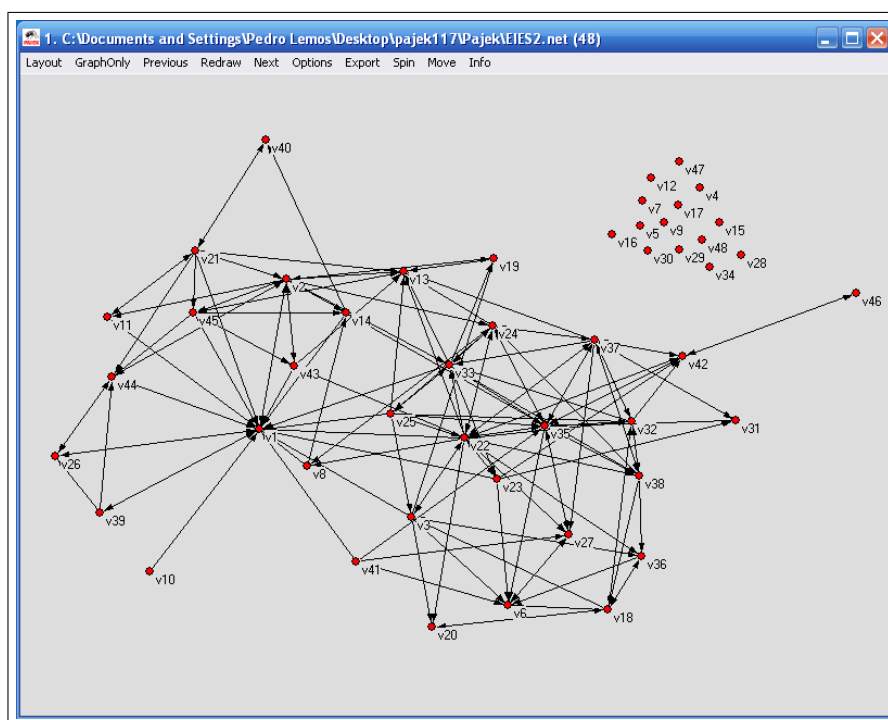
Figure 3.5: Pajek draw window presenting a graph

The visualizations can be saved in several formats, including 2D formats like encapsulated postscript file (EPS), scalable vector graphics file (SVG), bitmap file (BMP) and 3D formats such as 3D computer graphics file (X3D), kinemages file (KIN), virtual reality file (VRML) and MDL Molfiles.

3.3.3.3 Analysis Routines

Most of the descriptive methods are available for networks, such as computation of degrees, depths, cores, cliques, centrality (closeness and betweenness), detection of components (weak, strong, biconnected, symmetric), paths, flows, structural holes and some binary operations on two networks.

Identifying cliques in large networks is difficult, mainly because of the large number of nodes. Instead of a conventional clique-procedure, Pajek contains the procedure p-cliques, which creates a partition of the network into clusters such that the nodes within one cluster have at least a proportion of p neighbours inside the cluster. For large networks it's preferable to use k-cores instead of cliques, because of computational restrictions.

Pajek also contains several procedures for detecting structural balance and clusterability, hierarchical decomposition and block-modelling (structural and regular equivalence). For the analysis of structural equivalent actors, dissimilarities between nodes can be computed (using Euclidean or Manhattan distances) resulting in clusters that can be represented by dendrograms.

3.3.4 MultiNet

MultiNet [54] is a program designed for interactive exploratory data analysis of social and other networks. It is divided into modules that allow the analysis and visualization of complex networks, detailing the values of the link and node variables that make up the networks. It is menu-driven, where higher level menus and extra menu items become available after the necessary options are specified.

In order to obtain a copy of the program is necessary to write a motivational e-mail, presenting the user and describing the objectives to accomplish with the software.

There's a complete user's manual [58] that presents all concepts and instructions to use and explore MultiNet to its full extent and also some papers on specific MultiNet modules [59] [57].

Some of the network analysis methods and procedures in MultiNet were originally contained in separate programs. FATCAT [53], for instance, produces the accompanying contingency tables and panigrams (graphical representations of two-dimensional cross tabulation tables) as MultiNet, by working with categorical who-to-whom matrices, in which a variable that describes nodes is selected to determine the categories for rows (who) and another one to determine the categories for columns (whom). FATCAT is still freely available as a stand-alone DOS program. Another program integrated in MultiNet is PSPAR [56] which was designed to

handle large networks and estimate the p^* model for sparse matrices.

3.3.4.1 Data Entry and Manipulation

Because MultiNet is designed for the analysis of large networks it uses node and link lists as data input instead of adjacency matrices, like Pajek. The lists contain all actors in the network with respective attributes and the existing relations between the actors.

MultiNet supports three options to enter data: by opening a binary MultiNet system file (MNW), by importing data from node (NOD) and link (LIN) files, or by opening data in comma-separated files (CSV). Data can be saved in MNW files or exported to ASCII NOD and LIN files. Multiple link variables, like two different observations of the EIES data have to be included in only one link file. It's possible to assign a value for missing observations and there's also an option to treat missing links as zero values. Two standalone applications ADJ2NEG and FREEFIX are included to create node and link import files.

3.3.4.2 Visualization Techniques

MultiNet generates graphical representations of the output generated by the analysis routines. It contains graphical tools to draw histograms, line diagrams and cumulative distribution functions. For visualizing networks the main tool provided is eigendecompositions (see Fig. 3.6) a method to rearrange nodes based on their eigenvector coordinates. MultiNet allows real-time manipulation of up to three spatial dimensions and colour notifications to help understand patterns in the networks. Matrices are also available to detect clustering and other analysis on large networks adjacency.

All graphical representations are interactive, which means that the user can click on objects to inspect attribute values, explore effects, permute displays or find information on nodes or links. For that matter several interaction functionalities are offered, such as rotation, translation and magnification. Graphs can be exported to postscript or bitmap files.

3.3.4.3 Analysis Routines

The network statistics available on MultiNet include degree methods, calculation of centrality measures (betweenness, closeness, influence, integration, radiality), together with frequency distributions of these statistics.

The structure of the network can be analyzed with several eigenspace methods, assuming that the location of actors reveals patterns on relationships. Eigenmethods pursue the same objective as spring-embedding algorithms (used for example in Pajek). These methods require dichotomized and symmetrized data. The result of an eigendecomposition is an eigenspace that can be used to visualize the network structure [57]. The coordinates of the nodes are based on the coordinates of the first two or three eigenvectors, yielding 2D and 3D displays, respectively. Associated with each dimension is a certain amount of variance in the original data, distributed accordingly with the number of the dimension.

Results can be rotated, resized and rescaled to obtain better presentation of the data. In Fig. 3.6 the three dimensional normal eigendecomposition of the dichotomized EIES acquaintance-ship data (first observation) is shown.
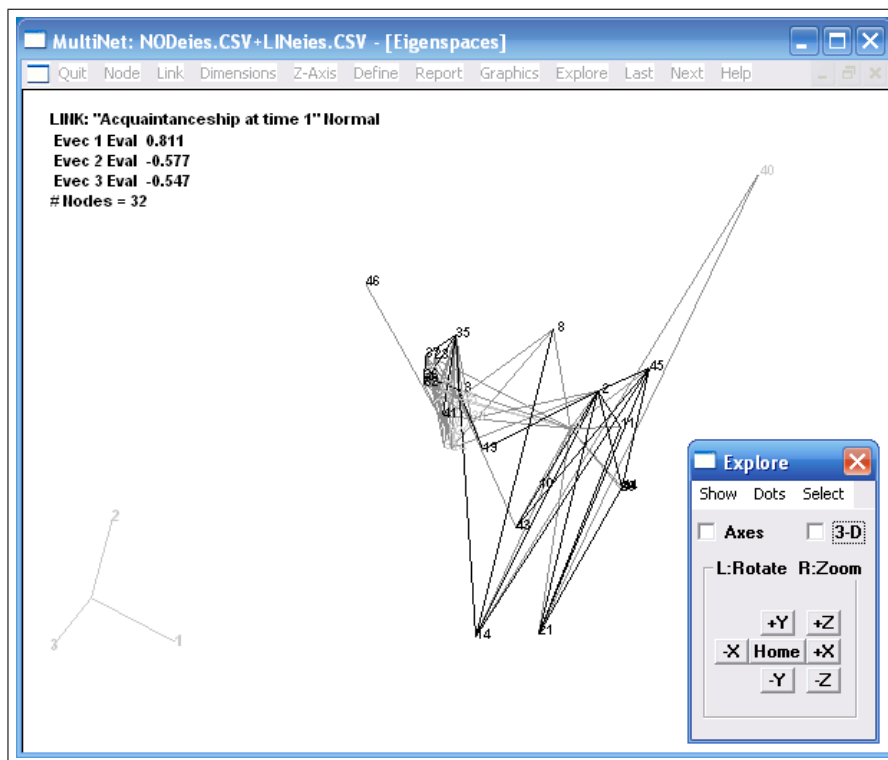
Figure 3.6: MultiNet showing a normal eigendecomposition for the dichotomized EIES acquaintanceship data (first observation)

MultiNet contains four statistical techniques to analyze network data: 1) crosstables and χ^2-tests, 2) ANOVA, 3) correlations and 4) the p^* exponential random graph model [65].

Crosstables are visualized using panigrams. The tables and panigrams are used to explore the association within networks (out- and in- degrees) or the association between networks and an attribute. An example is presented in Fig. 3.7, showing the association between partition

discipline and incoming links (receiver effects) of the first observation of the acquaintanceship network. Interactive help is available, explaining the meaning of the cells.
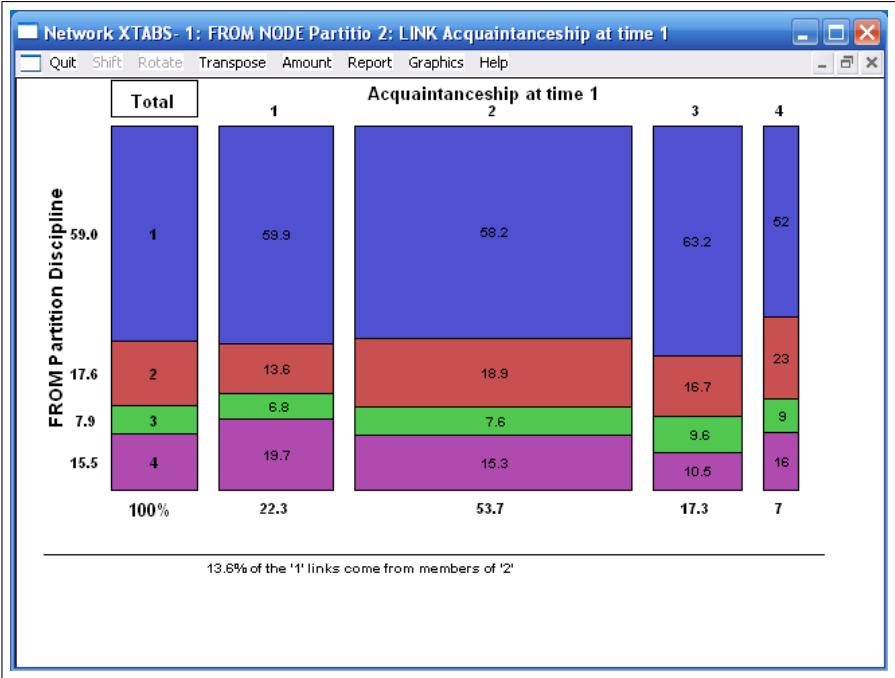
Figure 3.7: MultiNet presenting the panigram of discipline and the first observation of the EIES acquaintanceship network (incoming links)

3.3.5 More SNA Software

In this section, other available applications for social network analysis are briefly presented. Applications are categorized in four groups: general applications, for visual exploration, for knowledge networks, and for statistical testing. For space reasons, only the most relevant features are mentioned.

3.3.5.1 General Applications

Agna (Applied Graph & Network Analysis) [6] is a freeware platform-independent application designed for social network analysis, sociometry and sequential analysis. Agna is designed to study communication relations in groups, kinship relations and the structure of animal behaviour. The analysis methods include general descriptives, shortest path analysis, centrality and sociometric coefficients. The program has ample visualization options.

NetMiner [29] is a commercial software tool that combines social network analysis and visual exploration techniques. It allows users to explore data visually and interactively ensuring the

detection of underlying patterns and structures of the network. All results are presented both textually and graphically. It contains routines for multidimensional scaling, correspondence analysis, cluster analysis and matrix decompositions (eigen, singular, spectral). NetMiner also supports the following standard statistical routines: descriptive statistics, ANOVA, correlations and regression.

Visone [12] is a long-term research project, which goal is to develop models and algorithms to integrate and advance the analysis and visualization of social networks. Its origins lie in the interdisciplinary cooperation with researchers from mathematics, computer and information sciences.

The main features include: interactive graphical user interface; support of unconfirmed relations; portability; import and export of standard formats for social networks data. Visone contains several algorithms (spring embedders, spectral layouts, radial layouts) for drawing graphs and representing results of analysis. The analysis methods include local measures (degrees), distance measures (betweenness, closeness) and feedback measures (eigenvector, authority).

3.3.5.2 Visual Exploration

InFlow [44] is commercial software for network mapping, especially aimed at organizational applications. It presents network analysis and network visualization simultaneously and interactively, with wide graphical export options. Thus, it's possible to express changes in the network directly in terms of network measures. It features several procedure-based routines, but lacks statistical methods.

NetDraw [8] is a program for drawing networks. It's a free and standalone program and is also distributed with UCINET. It reads UCINET files natively. NetDraw uses several algorithms for displaying nodes in a two-dimensional space, using a circle layout obtained with multidimensional scaling or spring embedding. It has tools for grouping, recoloring, resizing and reshaping of nodes, links and labels. Graphs can be saved in several formats, including bitmap and JPEG files. Import and export functions to Pajek are available. It also includes some analysis procedures, such as identification of isolates, components and k-cores.

NetVis [28] is a free open source web-based tool to analyze and visualize social networks using data from CSV files, online surveys, and dispersed teams. It's available online, where data can be uploaded and analyzed, resulting in 3D graphs generation. The source code is available for

every algorithm.

3.3.5.3   Knowledge Networks

Blanche [41] is a multi-agent based computational modelling environment to specify, simulate, and analyze the evolution and co-evolution of networks. Blanche can be used to simulate a network model containing a system of actors (nodes) and multiple relations among these actors. It uses equations to describe how the strengths of relations and the attributes of the nodes change over time.

Iknow [22] is a specialized Java-based software to collect and present data on communication and knowledge networks. Nodes are actors (individuals or organizations) and the links are the knowledge or information they have about characteristics of other actors. The software can either collect interactively or automatically (from the web) information and then present it in various ways.

3.3.5.4   Statistical Testing

StOCNET [7] is an open software system for statistical analysis of social networks using advanced statistical models. It provides a platform to make a number of statistical methods and allows new routines to be easily implemented.

Analyses take place within sessions. A session consists of a cyclic process of five steps: data definition; transformation; selection; model specification and analysis; inspection of results. StOCNET doesn't contain procedures for the visualization of networks, nor procedure-based routines.

STRUCTURE [16] is a program "providing sociometric indices, cliques, structural and role equivalence, density tables, contagion, autonomy, power and equilibria in multiple network systems" [17]. It's a command-line DOS program for data management and network analysis. STRUCTURE provides unique procedures supporting five types of networks analysis: autonomy (analysis of structural holes); cohesion (detection of cliques); contagion; equivalence (analysis of structural or role equivalence and blockmodeling); power (analysis of network prominence and equilibrium).

PermNet [64] is a free academic program that provides a set of permutation tests for social network data. It provides symmetry test and transitivity test for real-valued data.

4 Problem

This chapter addresses the challenges Human Resources Management (HRM) face in their daily activities, pointing to specific areas where social network mapping and analysis can be useful in making better-informed decisions.

Four levels of information usage in HRM related to a job, to a person, to a group and to the organization as a whole were identified. For each one of these levels, questions related to social interaction within the organization were aroused, in order to inquire how to better assist decision making in HRM.

4.1 Social Networks and HRM

Networks provide access to information and knowledge. Flow of information, power and status are outcomes from social networks and the position of an individual facilitates this flow [60].

HRM activities such as recruitment and selection, training and development, performance management, employee relations and compensations can use social network information for better decision making [42].

Flows of knowledge show how human, social and intellectual capital are created within an organization. Power and status flows help HR managers to identify sources of motivation and productivity. Thus, visualization and analysis of social networks within an organization reveal critical information to HRM.

Social networks can reveal information related to a job, an employee, a group (team, department, etc) or the whole organization [63]. We now present what challenges social network analysis addresses in each one of these levels and the impact of this information on HRM functions.

4.1.1 Information Related to the Job

Social networks can be a valuable source of information for activities related to a certain job. Social interaction mapping can help managers to obtain critical information that constitutes the job description of a position, either in a formal or informal way.

Several types of job-related information can be provided by social network mapping and analysis:

- What is the level of interaction requirement of a job in relation to other jobs at the same or different organizational levels?

- Are the network contacts far apart or close together? Structural holes exist in the network?

- The centrality dimension of the position is suitable?

- What are the critical positions for maintaining harmonious relations?

The answers to these questions are a direct input to HRM functions, especially for recruitment and selection processes, development purposes and employee relations.

4.1.2 Information Related to the Person

Who does an individual interact with? With strong or weak ties? Changing through time? What types of information flow through these ties? How can the network determine performance outcomes? These are some of the questions that can be answered by social network analysis at the individual level.

If an organization can identify the individuals who occupy central positions in networks, then more targeted efforts can be applied towards these individuals in developing creativity and productivity skills.

Knowledge is usually distributed unevenly within an organization [42] because it's difficult to spread it across different individuals where pre-existing relationships are absent. To accommodate innovation, knowledge must be deliberately distributed and a network of people provides the best channel.

4.1.3 Information Related to Groups

It's recognized that groups and teamwork are essential for organizational success, although it's difficult to manage social activities within a group. Network analysis can help provide answers to questions like these:

- Is the group formal or informal?

- Do members of the group change across time?

- Are interactions frequent or occasional?

- Who occupies the central position, the group leader or somebody else socially more powerful?

- Do interactions between elements of a group persist across projects?

4.1.4 Information Related to the Organization

Organizations differ in their internal knowledge, practices and capabilities. Communication patterns inside the organization are vital information along the social culture. Does the CEO communicate with the managers and the employees? If so, what is the frequency? Can employees cross hierarchical and functional boundaries to get the work done? Is knowledge shared among employees? These are challenging organizational questions that network analysis can shed some light on.

4.2 Attended Challenges

Social network analysis deals with a multitude of information in order to assist HR managers' judgment in decision making. We now enumerate a list of information extracting challenges that we shall focus, structured by HRM functions and information level, as shown in Table 4.1.

Table 4.1: Relevant information to HRM functions grouped by level

HRM Function / Level	Job related	Employee related	Group related	Organization related
Recruitment and selection	Identify functional, cross-functional and leadership skill requirements	Match social profile for internal selection	—	Identify organizational skills demand
Training and development	—	Identify training candidates	—	Stimulate culture building
Performance management	Set normative targets for selected skills	Identify high performers Evaluate against targets	Facilitate sharing and team work	Set organizational targets
Employee relations	Identify critical positions for harmonious relations	Identify central candidates for consensus building	—	—
Compensation and benefits	Measure social component of a job	Identify motivating factors for an individual	Identify groups for similar compensation patterns	Define an architecture for compensation management

5 Proposal

In this chapter we'll present our proposal for the development of a 360º Feedback software application that can support all administrative work in order to gather aggregate feedback of a person. Next, we make a comparison of the identified SNA software packages and select the ideal solution for network visualization and analysis. Then we map 360º Feedback evaluation relations into the social network definition. In the final section it's described the information exchange process between the software entities, to achieve interoperability between the 360º Feedback application and the SNA software packages.

5.1 360º Feedback Application

The use of Web-based 360º Feedback tool consisting of a survey in a website was introduced by David Bracken [11] with the purpose of using technology to make the feedback process more effective and accurate.

The process was defined in four steps, as follows:

- **Step 1**: Taking administrative tasks involved in conducting an online 360º Feedback program, building or acquiring the website framework.

- **Step 2**: An administrator (from the HR department) within the organization should be responsible for setting up and maintaining the web-based process.

- **Step 3**: The administrator sets all parameters such as time frame, deadlines, content, e-mail wording, identification of evaluated group and provisions for anonymity such as how and to whom feedback reports will be routed.

- **Step 4**: Employees should access the website, using a browser, and login with proper authentication. Then they should create a list of evaluators and send invitation e-mail messages requesting them to complete the assessment. At the end of the time window, feedback should be collected and assembled into feedback reports.

This model remains valid and it can improve the 360º Feedback process in the following ways:

- **Logistics** - electronic communication automates distribution and collection of feedback, saving personnel resources and making the process standardized.

- **Prevented overload** - the evaluator overload can be reduced by putting a cap on a limited number of assessments.

- **Reliability** - validation steps can improve quality of provided data, preventing invalid / ambiguous inputs from being submitted.

- **Cost** - web applications are designed to handle large volumes of work and much of the administrative labour is automated. As a result, the price per participant / evaluation is low and administrative work is minimized.

5.1.1 Key Features

In order to formulate the desirable key features of a Web-based 360º Feedback application it's also vital to research, evaluate and compare existing applications. Using web searchers it's easy to find numerous applications that support the 360º Feedback process. More than 20 different applications were found on the subject, but only 8 were selected since the information available is frequently general or incomplete.

The complete report on 360º Feedback commercial applications can be found on Appendix A, focusing on the product technology, pricing, main features and also pointing some advantages and disadvantages examined. It's also presented a comparison matrix between the different applications.

After the analysis of existing applications and based on Bracken's 360º Feedback Framework it's possible to conclude that the following features are essential to a state-of-the-art Web-based 360º Feedback application:

- Fully customizable questionnaires to meet organizations' needs;

- Anonymity functionality, so people can feel comfortable giving feedback;

- Automatic reminder/notification system to promote awareness and reduce processing time;

- Comprehensive reports including overview and detailed views of data, combined and comparative results, especially in graphical terms;

- A clear and easy to navigate user interface.

5.1.2 Functional Requirements

We now detail some high-level functional requirements grouped by hypothetical types of users of the system, since they play different roles.

1. Designer Functionality (responsible for elaborating questionnaires)

    1.1 Create and modify question categories;

1.2 Create and modify question libraries;

1.3 Create different types of closed questions;

1.4 Dynamically compose questionnaires with questions picked from question libraries available.

2. Administrator Functionality (controls user management and 360º Feedback evaluation management)

2.1 Add, modify and remove users;

2.2 Assign roles to users;

2.3 Create a new 360º Feedback evaluation;

2.4 Edit, preview, start, stop and delete a 360º Feedback evaluation;

2.5 List existing 360º Feedback evaluations providing status details and statistics;

2.6 Send notifications by e-mail for evaluation events;

2.7 Generate subject reports, detailing results by category level;

2.8 Generate group reports.

3. Employee Functionality (can invite evaluators and provide feedback by answering questionnaires)

3.1 List user's 360º Feedback evaluations;

3.2 Choose evaluators and send feedback invitations;

3.3 Give feedback by answering the questionnaire associated to current evaluation.

5.1.3 Roundup

Users feel more comfortable with Web-based 360º Feedback rather than traditional paper process mainly because it's a confidential, secure medium and it alleviates administrative burdens. Thus Web-based 360º assessment seems to be a very attractive proposition for organizations familiar with technology, which nowadays are more than ever a reality.

For performance management processes, individuals can be assessed reliably against normative targets set through establish patterns. This facilitates management of performance by effective sharing of goals and by fostering efficient team work.

For compensation and benefit management processes, the profile of one individual helps managers to identify some of the factors that would motivate him/her.

5.2 SNA Package Selection

Based on the review of three well-known and general programs: UCINET, Pajek and MultiNet in chapter 3 we now make a comparison of the software packages in order to select the best one to map and analyse evaluation data.

The software packages were scored at:

1. Data manipulation;

2. Network visualization capabilities;

3. Analysis methods;

4. Availability of a manual;

5. Help functions;

6. Usability.

A $\star$ indicates that is sufficient, $\star\star$ that is good, $\star\,\star\,\star$ that is very good or strong, a $-$ that has considerable limitations. The scores are given in Table 5.1.

Table 5.1: Scores for the three main packages compared

	Data	Visualization	Analysis	Manual	Help	Usability
UCINET	$\star\,\star\,\star$	$\star\star$	$\star\,\star\,\star$	$\star\star$	$\star\star$	$\star$
Pajek	$\star\star$	$\star\,\star\,\star$	$\star\,\star\,\star$	$\star\star$	$-$	$\star\star$
MultiNet	$\star$	$\star$	$\star\star$	$\star$	$\star$	$-$

It's impossible to make a completely unbiased, fair comparison between the packages because their objectives are different, leading to distinct functionality and options.

MultiNet obtains a low score in data manipulation and visualization since it contains relatively few options. They all present good scores in analysis features distributed along descriptive, procedure-based, and statistical methods. In our opinion, UCINET's support is the best, since it combines a good manual and help functions, showing a strong aspect of this commercial package. With respect to usability, Pajek stands out, because of its interface where data, visualization and procedures are fully integrated.

As we already pointed out it remains hard to select the best package. However, in our opinion Pajek presents a good set of features, especially in network visualization capabilities, since it has several automatic procedures to find optimal network layouts. On the other hand, UCINET

stands for descriptive methods, containing a large number of network analytic routines. Using the combination of both software packages may be the optimal solution.

5.3 Network Mapping

To proceed on social network analysis of evaluation data it's necessary to map the relationships. The relationships must meaningfully reveal a group's inner workings, and they must be actionable for managers after the results are disclosed.

We will start with some basic concepts. A node is a person, namely the evaluator or the evaluated. A link between two persons on a network diagram indicates a relationship between them, in this case represents the evaluation relation. A link can have an additional attribute, representing the type of evaluation relation, for example: supervisor, direct reporter or peer. The arrowheads represent the direction of the relationship, following the direction from the evaluator to the evaluated.

Network diagrams can also assist in telling if the network is split into subgroups. When demographic information is analyzed in conjunction with the network, it's possible to tell whether the subgroup has an identifying characteristic, such as location, function, gender or age. Since these splits can be detrimental, it's important to understand them and the associated rationale. Node attributes (such geometry form or colour) can be used to assign an identifying characteristic.

5.4 Interoperability

To achieve interoperability between the 360º Feedback application and SNA software packages is necessary to exchange, convert and format data between the software entities. Our proposal it's to export 360º Feedback evaluation data (stored in relational data format) into a comprehensive file format for graphs, and then apply data transformation techniques to obtain UCINET and Pajek input file formats. Fig. 5.1 depicts the architectural modelling of the transformation process.

5.4.1 Graph Representation Language

Instead of making a direct and undisciplined conversion from relational data to the SNA tools input file formats it's best to accommodate social network data in a structured text language to

promote data interchange, since almost every SNA package uses their own file format.

The absence of a widely agreed-upon exchange format has led to a huge number of co-existing proprietary graph description formats and corresponding parsers, creating overhead for conversion between these formats. In recent years, a handful of formats established whose characteristics are expected to merge in GraphML as a unique core format.

GraphML is an XML-based language for the description of graphs, proposed by Brandes et al. [13]. Its development was motivated by the goals of tool interoperability, access to benchmark data sets, and data exchange. The design characteristics of GraphML are [13]:

- **Simplicity** - The format should be easy to parse and interpret for both humans and machines. As a general principle, there should not be ambiguities, thus allowing a single well-defined interpretation for each valid GraphML document;

- **Generality** - There should be no limitation with respect to the graph model (i.e: hyper-graphs, hierarchical graphs);

- **Extensibility** - It should be easy to extend the format in a well-defined way to represent additional data required by arbitrary applications or more sophisticated use;

- **Robustness** - Systems not capable of handling the full range of graph models or added information should be able to easily recognize and extract the subset they can handle.

Graph-related services are normally used as components in larger systems that associate additional data to nodes and edges in a graph. Hence, one crucial point of GraphML design is the division into two layers:

1. **Structural layer** - A set of core elements describes the graph structure and constitutes the essence of the language. It describes the structural core of the graph in terms of relations between entities.

2. **Additional data** - Applications may extend the structural layer by application-specific data labels, like layout attributes, network data or textual descriptions.

The structural layer syntax is intentionally kept simple to ease handling for parsers. See Fig. 5.2 for an illustration of the relationships between the elements.

Additional data is represented by `<data>` children of the respective node or edge. Data of the same sort is classified in `<key>` elements in the top-level `<graphml>` tag. Keys can be regarded as (possibly partial) functions that assign values to elements of the graph.

XML was found the ideal platform for such a language. Thus, GraphML can benefit from a large number of available tools for reading, parsing and processing XML-based data.
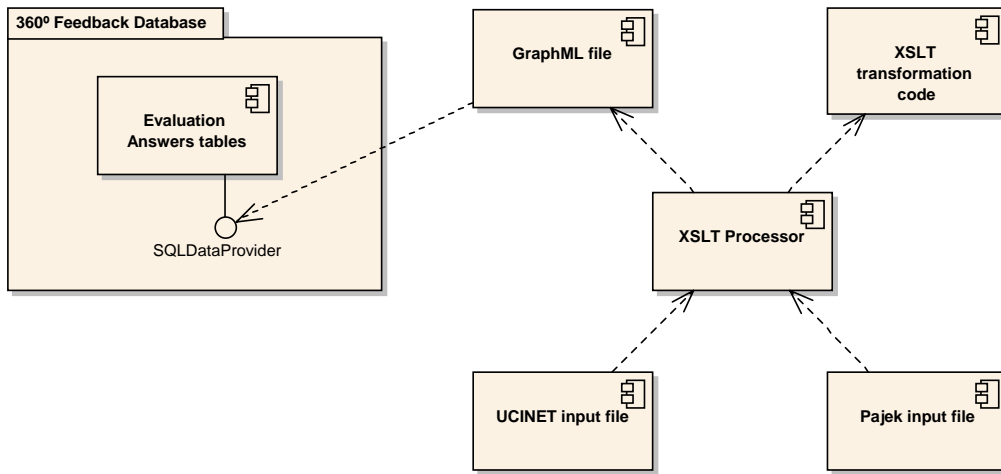
Figure 5.1: Component diagram of the data transformation process
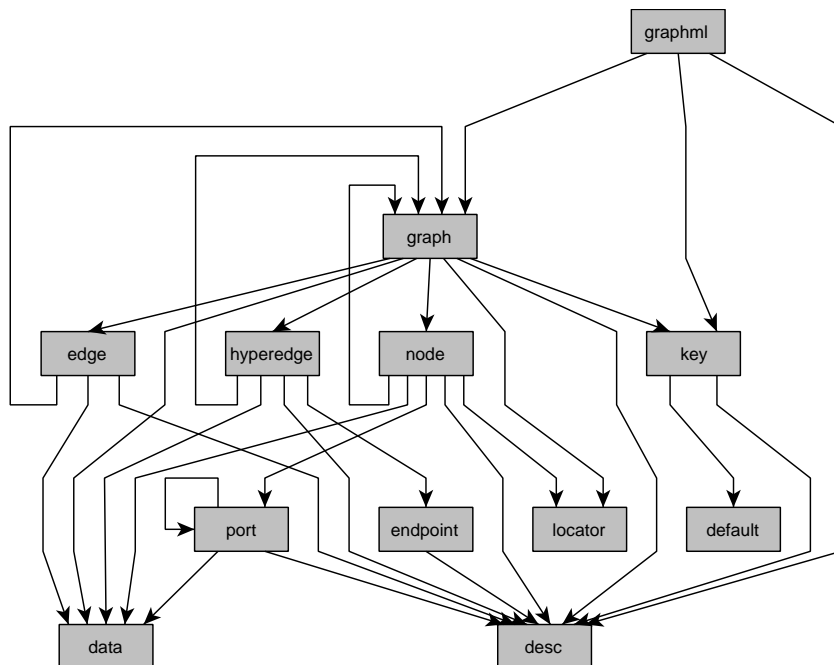
Figure 5.2: A structural view of GraphML elements [51]

5.4.2 Data Transformation

In order to convert data from a source data format into destination data it's necessary to apply data transformation. Data transformation can be divided in two steps:

1. **Data mapping** - maps data elements from the source to the destination, capturing the transformation that must occur;

2. **Code generation** - logic responsible for the creation of the actual transformation.

There are some languages available for performing data transformation, varying in their accessibility (cost) and general usefulness.

Our choice falls on XSLT (Extensible Stylesheet Language Transformations), a language for transforming XML documents into other XML documents [19]. It allows restructuring, analyzing, and evaluating XML documents. Moreover, XSLT can also be used to produce non-XML output, which is our current aim. Thus, XML is a way of structuring and storing data as plain text, and XSLT is a method of accessing and processing that data.

To obtain Pajek and UCINET's input file format, GraphML needs to be transformed to arbitrary ASCII data, preserving as much information as possible. Transformations that map one graph format to another can either be accomplished by components of translation services like GraphEx [14] or with stand-alone applications.

6 Case Study

In this chapter we present Noesis, the company where the case study took place, with a brief description of its history, their business area and a statement of embracing values. Next it's specified the adopted software development process, followed by requirements elicitation, requirements analysis and design phases. Finally the two prototypes developed are illustrated: Noesis360 and Network Converter.

6.1 Noesis Profile

Noesis currently employs about 200 dedicated and highly qualified consultants skilled in a wide range of technologies, ready to address up to the most complex IT challenges in short or long term projects.

With multidisciplinary resources, Noesis provides a full range IT services delivery in three main areas following ITIL best practices:

- **IT Infrastructure** - including system administration, database administration, operations support, helpdesk and integration services.
- **Software Engineering** - software development and maintenance (requirements, specifications, development, processes, project management and product support).
- **Quality Management Services (QMS)** - including Configuration Management (CM), Integrated Quality Management (IQM), Quality Assurance (QA) and Test Environment.

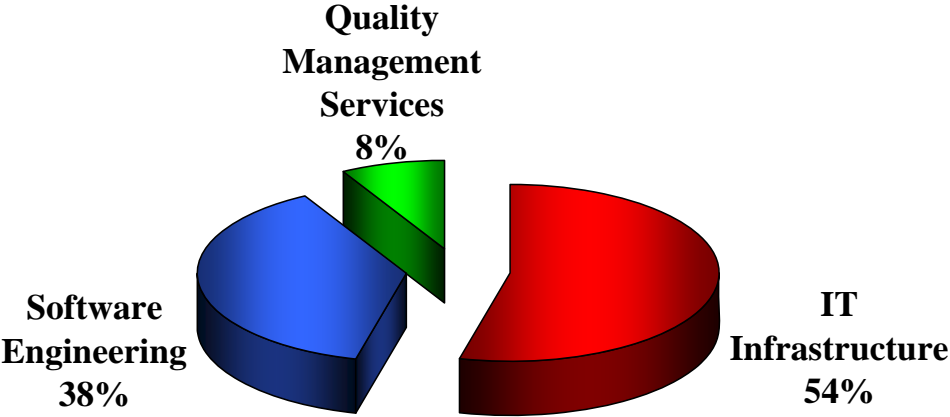Fig. 6.1 presents the revenue distribution for these areas.

Figure 6.1: Noesis IT Services distribution

This guarantee of quality and effectiveness allows Noesis's clients to focus themselves in their own business, assuring better efficiency and rationalising costs in IT area.

6.1.1 Company History

Noesis was founded in December 1995 and has made a name for itself as a company providing outsourcing services in information systems for large companies, especially in the IT Placement area.

In the second semester of 1997, due to the company's growth, its structure was enlarged through the entry of new partners. An increase in capital was promoted and, in the same year, a mainframe training services environment was created. With the offer of these services, Noesis rapidly gained the confidence of important entities in different sectors, such as banking and insurance, as well as among telecommunications and information systems consulting firms.

In 1999, Noesis diversified its services, widening its range of technological skills. As part of this development, open systems and Internet-related technologies were added, as were a series of turnkey projects using a vast set of technologies and platforms, thus complementing the services already available in the company's portfolio. In the same year Noesis reached revenues of 5 Million Euro.

During 2000, Noesis assumed its multinational vocation, opening offices in Brazil and France. In Portugal, it started intervening in the small and medium-sized enterprises, through the offer of Internet technology and SAP implementation services.

During 2002 and 2003, Noesis sold part of its capital to the TEAMLOG Group, a company listed on the Paris Stock Exchange, with a focus on computer services for industry, energy, banking, telecommunications, transports and defence.

In 2004, Noesis endowed its offer with reinforcements in the areas of outsourcing, co-sourcing, and Business Process Outsourcing (BPO) in order to provide their clients improvements in service level, benefits from industry best practices and transaction costs reduction.

6.1.2 Organizational Culture

The main pillar of values embraced by Noesis is based on a humanist culture, which has always been stimulated by their leaders, making Noesis a company in which mutual respect among collaborators prevails.

The enhancing of each element's professional skills through vocational training courses is

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one priority at Noesis. This attitude has contributed to maintaining the high degree of well-being of consultants, which itself translates into professionalism, competence and turning the team more cohesive and far-reaching as possible.

From another perspective, Noesis encourages social contact among their workers, due to its awareness of the importance of knowing each person's human qualities for the development of a company.

6.1.3 The Challenge

As consultants work on-site on several customers, it's difficult to maintain an up-to-date record of their activity, request feedback, and deal with evaluations or performance appraisals. At the same time some clients ask for explicit evaluation of outsource teams. The actual employee evaluation process is a patchwork of manual methods that are not only time consuming but also error prone.

Following organizational guidelines, Noesis sees the opportunity to build an application to get an insight about the skills and behaviours of their consultants in order to match up clients' expectations. It can also be used for performance appraisal.

6.2 Software Development Process

The first step to take in software development is to choose an adequate and effective development process, a conceptual framework for undertaking the software project.

The ICONIX process [55] was selected to guide the development of the application. The reasons were: use case driven properties, the agile approach and the small number of the team elements.

ICONIX is an agile software development process that sits somewhere in between the complexity of Rational Unified Process (RUP) and the simplicity of eXtreme programming approach (XP). The ICONIX process is use case driven, like the RUP, but without a lot of the overhead. It's also relatively small and tight, like XP, but it doesn't discard analysis and design like XP does. This process also makes streamlined use of the Unified Modeling Language (UML) while keeping a sharp focus on the traceability of requirements.

The ICONIX process is split up into four major phases: requirements analysis; analysis and preliminary design; design; and implementation. The methodology consists in producing

several artefacts that represent the dynamic and static vision of the system, built iteratively and incrementally.

Fig. 6.2 shows the global vision of the ICONIX process, which has two parts: the top part is the dynamic model, which describes behaviour, and the bottom part is the static model, which describes structure.
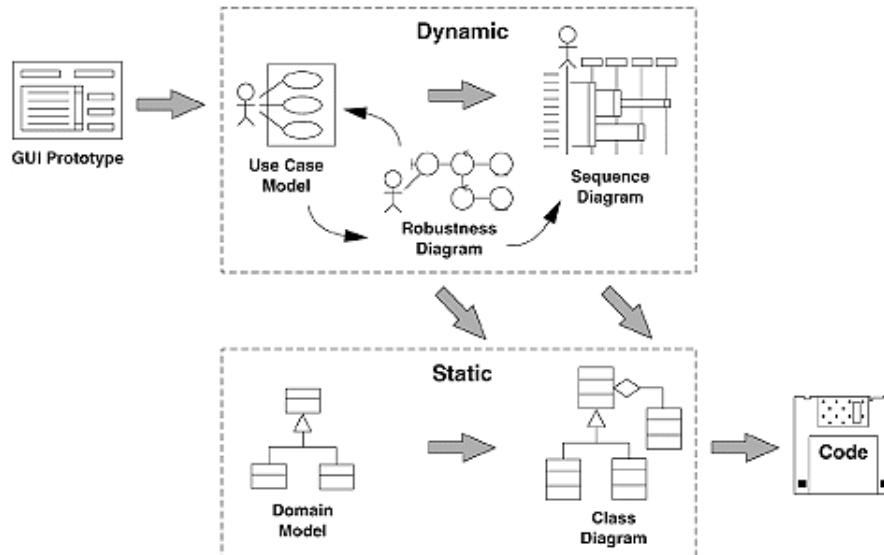
Figure 6.2: The ICONIX Process [55]

Some changes were applied to the process approach, resulting in some simplifications especially in the dynamic model. The adopted tasks for each phase were:

- Requirements analysis

  – Develop some low fidelity user interface prototypes for critical interactions;

  – Identify use cases, using use case diagrams;

  – Organize the use cases into groups, capturing this in a package diagram;

  – Identify real-word domain object and the generalization and aggregation relationships among those objects. Draw a high-level class diagram.

- Analysis and preliminary design

  – Write small descriptions for use cases;

  – Perform robustness analysis. For each use case, identify a first cut of objects that accomplish the stated scenario, updating the domain-model class diagram with new classes and related attributes;

  – Finish updating the class diagram.

- Design

  – Allocate behaviour. For each critical use case, identify the messages that need to be passed between objects and associated methods to be invoked, drawing a sequence diagram;

  – Verify if the design satisfies all the requirements identified;

  – Plan the software architecture, detailing software entities and its interfaces.

- Implementation

  – Produce a deployment diagram;

  – Write/generate the code;

  – Perform unit testing;

  – Perform user-acceptance testing.

6.3 Requirements Elicitation

Requirements engineering is often a key problem in the development of software systems [15]: "The hardest single part of building a software system is deciding what to build. (...) No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later.".

Many requirements errors are passed undetected to the later phases of the life cycle, and correcting these errors during or after implementation has been found to be extremely costly [49].

Prior to ICONIX, it was necessary to elicit requirements from individual sources, ensuring that the needs of users are consistent and feasible.

6.3.1 Methodology

The methodology used is based on Elicitation Methodology Framework [18] following five major phases which were adapted and simplified to the current project.

I. Fact-finding

   In this step is determined what the problem to be addressed is and who needs to be involved. Some initial interviews with the stakeholders of the system were performed resulting in the formulation of:

   - A statement of the problem context;

- The overall objectives of the target system;

- Application and environment context.

II. Requirements Gathering

This phase consists basically in getting a wish list for each stakeholder. Information was gathered through interviews directly with end users, and with the capture of features from similar systems (see Appendix A). Wish lists were confronted with functional, non-functional, environment and design constraints.

III. Rationalization

In this stage risk assessment was performed addressing technical concerns, questions about the necessity of several features were analyzed and the rationale was captured to support future requirements evolution.

IV. Prioritization

The requirements were prioritized, so high priority needs are addressed first. Essentially this step made possible to incrementally design and implement the system, resulting in several functional prototypes.

V. Early validation

Finally requirements were checked for agreement with originally stated goals, resolving conflicts with consistency checking.

The final output for requirements elicitation is the requirements document which consists in a formal artefact. The 360° Feedback requirements document can be found in Appendix B.

6.4 Requirements Analysis

Requirements analysis includes low-fidelity user interface prototyping, package and use case diagrams and domain modelling.

6.4.1 Low-Fidelity Prototyping

Low-fidelity GUI prototyping was used in this project as a way to quickly reach a common understanding of the critical requirements. It's a cheap way of providing prototypes used in participatory design sessions, giving a lot of feedback about the interaction between the user and the interface.

Two methods were applied: paper and pencil to quickly mock-up early interface screens;

and some wireframes to provide basic visual guide and placement of fundamental design elements in website pages. A wireframe example is shown in Fig. 6.3.
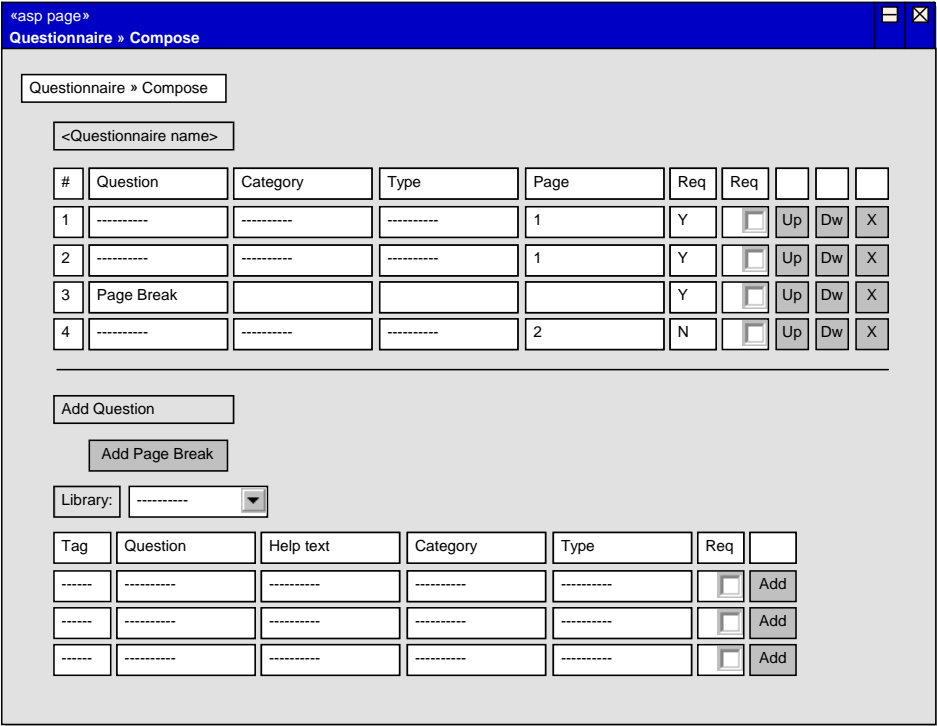
Figure 6.3: Wireframe for 'Compose Questionnaire' page

6.4.2 Package Diagram

The package diagram depicts how the system is split up into logical groups and the actors involved, giving a good logical hierarchical decomposition of the system. Fig. 6.4 shows two major packets: package "360º Feedback Managing Portal", containing all the use cases for administration and management purpose; and package "360º Feedback Evaluation Portal", which deals with users' evaluation process. Note that "UNoesis" is an abstract actor representing a set of responsibilities common to other concrete actors. In package "360º Feedback Managing Portal" is represented the actor "System" responsible for automatic procedures such as sending e-mail notifications.

6.4.3 Use Case Diagrams

Use case diagrams were extracted from functional requirements description, overviewing the functionality of the system per actor. Fig. 6.5 present the use cases for Employee and Person.
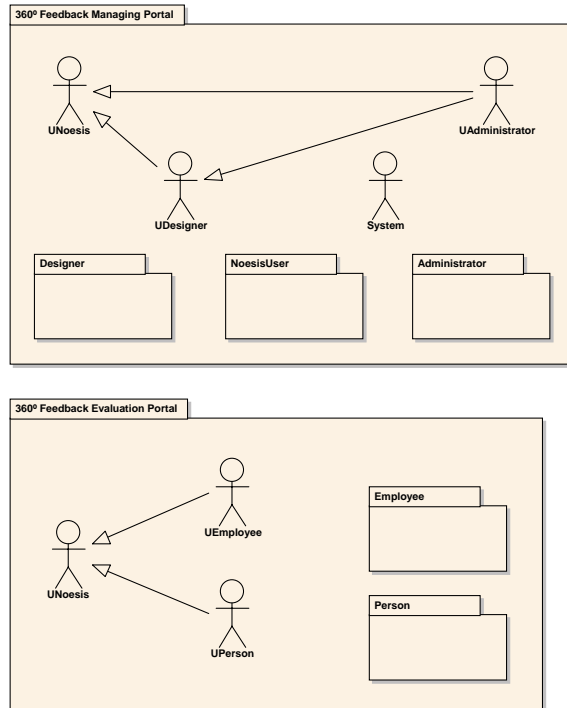
Figure 6.4: Use case package diagram
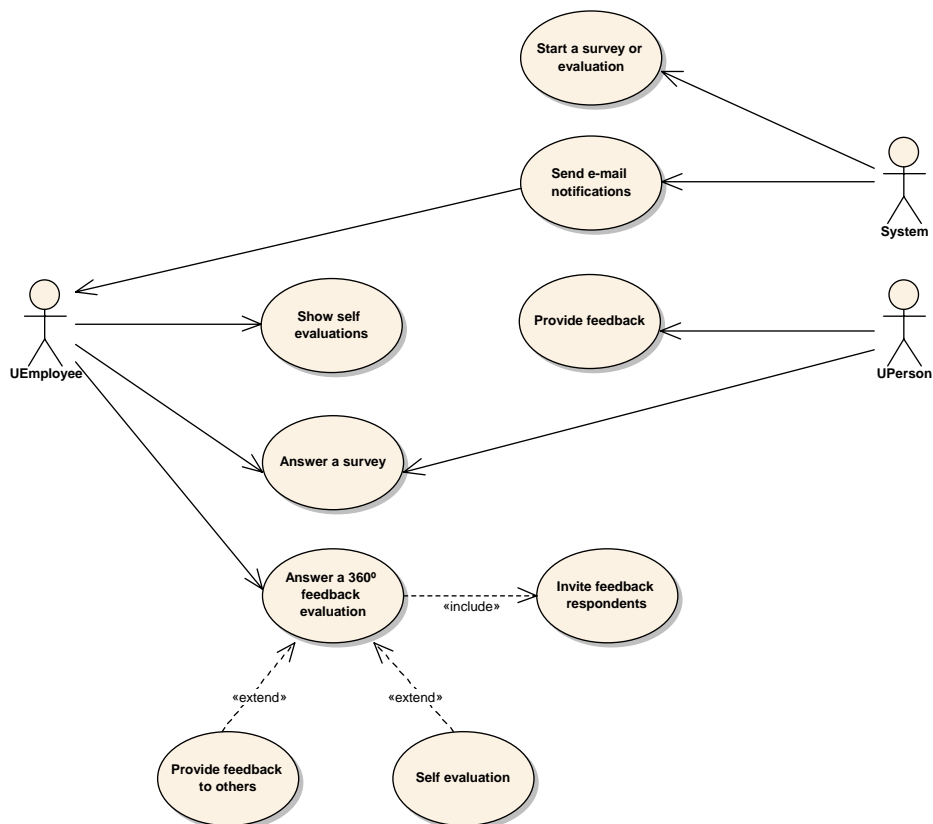
Figure 6.5: Use case diagram for Employee and Person users

6.4.4 Domain Model

This activity consists on identifying real-world domain entities and their relationships, in order to understand the key concept of the system and to familiarize with the vocabulary. The result is the corresponding high-level class diagram illustrated in Fig. 6.6. In other to obtain the model it was necessary to inspect and interpret the functional requirements.

6.5 Analysis and Design

Analysis and design phases include use case goals description, robustness analysis, class diagram and the definition of the software architecture.

6.5.1 Use Case Descriptions

A summarized description of use case goals for both prototypes is listed on Tables 6.1 and 6.2.

6.5.2 Robustness Analysis

Robustness analysis is one of the most important activities in ICONIX because it's the major link from the analysis phase ("what") to design phase ("how"). This analysis allowed running completeness tests, validating if all courses of execution were identified through use cases, and new entity discovering not found during domain modelling activity. Fig. 6.7 presents the robustness diagram for the use case 'Compose questionnaire'.

6.5.3 Class Diagram

Based on high-level class diagram it's presented the final class diagram in Fig. 6.8 and 6.9. This diagram contains all attributes for each class and details the relationships between classes, including its multiplicity. Note that all classes have no behaviour (methods) because they will be directly translated to SQL tables and business logic is handled by stored procedures and Business Logic Layer, as described ahead in subsection 6.5.4.

6.5.4 Software Architecture

Software architecture is the main representation of a software system, ensuring discipline for effectively implementing the design. Three-tier architecture was elected as one that best fits

Figure 6.6: High-level class diagram

Figure 6.7: Robustness diagram for use case 'Compose questionnaire'

Figure 6.8: Rich class diagram (Part 1)

Table 6.1: 360º Feedback use case goals description
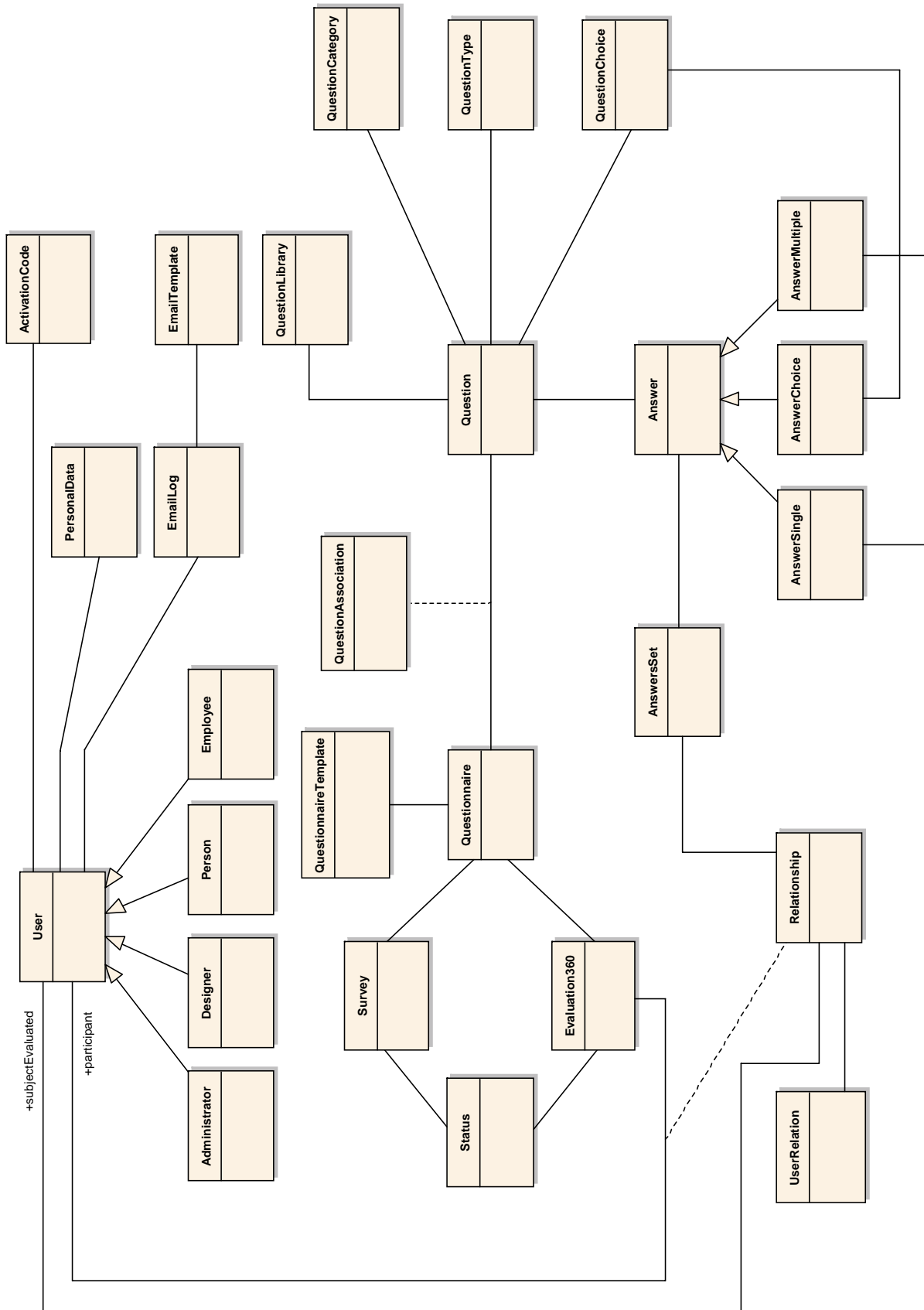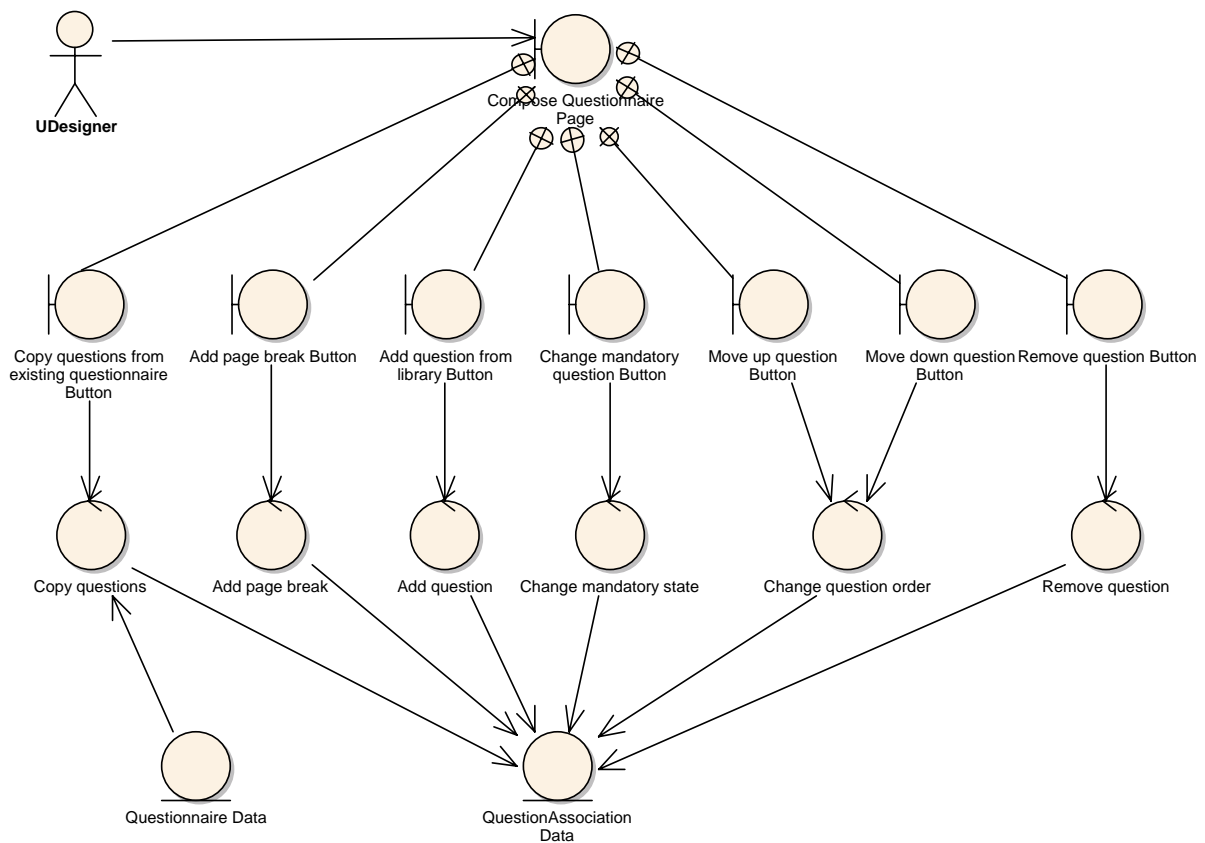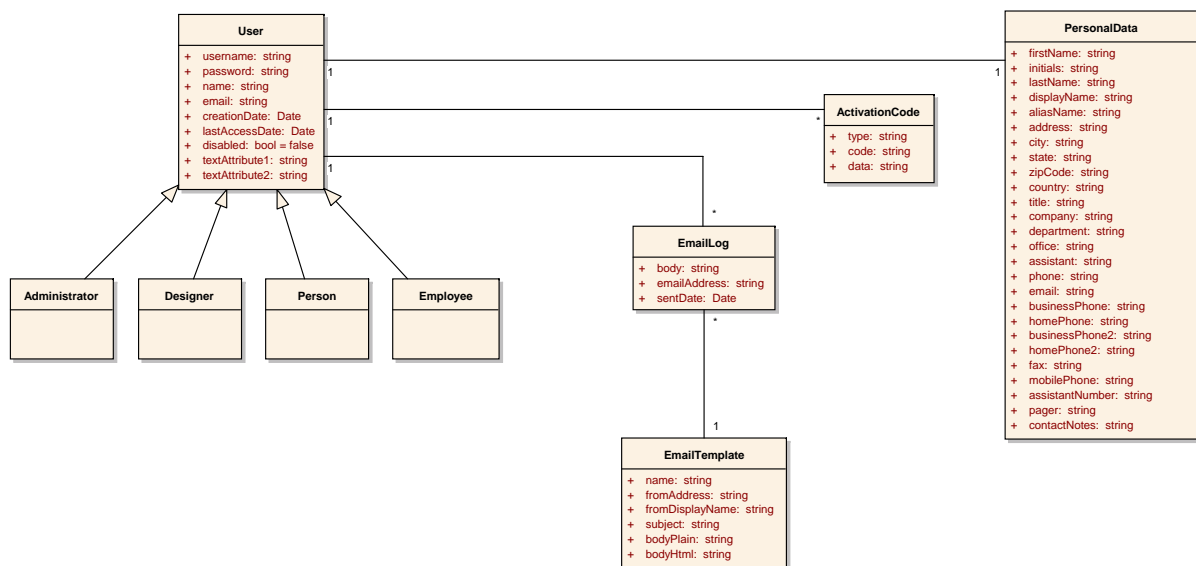
Group	Name	Goal
Designer	Create new question	The user adds a new question defining its attributes
	Show question catalog by library	List and preview all questions of a library
	Delete an existing question	The user deletes an existing question
	Manage question category	The user applies CRUD operations to question categories
	Manage question library	The user applies CRUD operations to question libraries
	Manage questionnaire	The user applies CRUD operations to questionnaires
	Compose questionnaire	The user compose a new or existing questionnaire, modifying its questions
	Preview questionnaire	The user previews the questionnaire
Administrator	List users	List of all available users
	Login As user	Authentication as one user of the system
	Manage users	The user applies CRUD operations to users
	Manage user roles	The user applies CRUD operations to user roles
	Edit personal user data	The user updates users' data attributes
	Create a new 360º feedback evaluation	The user adds a new 360º feedback evaluation defining its attributes
	View existing surveys and evaluations	List general details about existing surveys and evaluations
	Show participation statistics	Present a complete report on participation statistics
	Manage a 360º feedback evaluation	The user starts, ends, edits or deletes a 360º feedback evaluation
	Generate and view reports	The user generates and views reports from evaluation answers
	Subject reports	The user generates and views subject reports
	Group reports	The user generates and views group reports
System	Send e-mail notifications	E-mail notifications are sent by the system
Person	Provide feedback	The user answers the questionnaire associated to the evaluation
Employee	Show self evaluations	List evaluations submitted to the user
	Answer a 360º feedback evaluation	The user answers a 360º feedback evaluation
	Invite feedback respondents	The user invites respondents for his/her evaluation
Noesis	Edit personal data	The user updates personal data such as e-mail address
	Change password	The user changes the password
	Recover Password	The user recovers the forgotten password, providing the e-mail address

the implementation of an enterprise web application, since tiers can be deployed on physically separated environments. These three tiers are:

- **Presentation Tier** - web browser front-end;

- **Middle Tier** - middleware logic;

- **Data Tier** - DBMS backend.

Inside the Middle Tier it was applied the layered style, which reflects a division of the software into units, promoting good properties of modifiability and portability. Layers can be seen as virtual machines that provide a cohesive set of services through a public interface [20].

We can distinguish three logical layers:

- **Database Access Layer (DAL)**: refers to the component that provides an interface to the database. ADO.NET and stored procedures are considered part of this layer.

Table 6.2: Network Converter use case goals description

	Name	Goal
Basic functionality	Create new GML file	The user creates a new GraphML file to hold a network definition
	Open an existing GML file	The user opens an existing GraphML file
	Save a GML file	The user saves a GraphML file previously created or opened
	Open network in Pajek	The user opens the current Pajek file externally
	Open data in UCINET	The user opens the current UCINET file externally
Database import	Configure database connection	The user configures the database connection properties (including authentication)
	Import data	The user imports data from the views defined in the selected database
Data conversion	Convert to Pajek networks	The user converts from GraphML input file to Pajek NET file
	Convert to Pajek matrices	The user converts from GraphML input file to Pajek MAT file
	Convert to UCINET text files	The user converts from GraphML input file to UCINET DL text file

- **Business Logical Layer (BLL)**: component that encapsulates business logic of the application, especially report generation logic. It's considered an extra layer but increases code transparency and maintainability.

- **Presentation Layer (PL)**: refers to the web application pages implemented in ASP.NET.

Fig. 6.10 shows an overlay that combines the three-tier architecture and layered style.

6.6   360º Feedback Prototype

The web application (named Noesis360) that supports the 360º Feedback evaluations was successfully implemented.

We now present some screenshots of the resulting product, focusing on the user interface since is a main issue for user acceptance.

6.6.1   Questionnaire Design

After inputting individual questions into the system it's possible to aggregate them into questionnaires, through compose questionnaire page, as shown in Fig. 6.11. Questions can be added from different libraries, choosing its mandatory answering. They are sorted by select order, but can be rearranged through move up / move down buttons. Note that the insertion of page breaks automatically divides questions in different pages.

It's also possible to preview the questionnaire, similar to the respondents interface, except for save and submit buttons. Adjacent questions are grouped automatically by category.
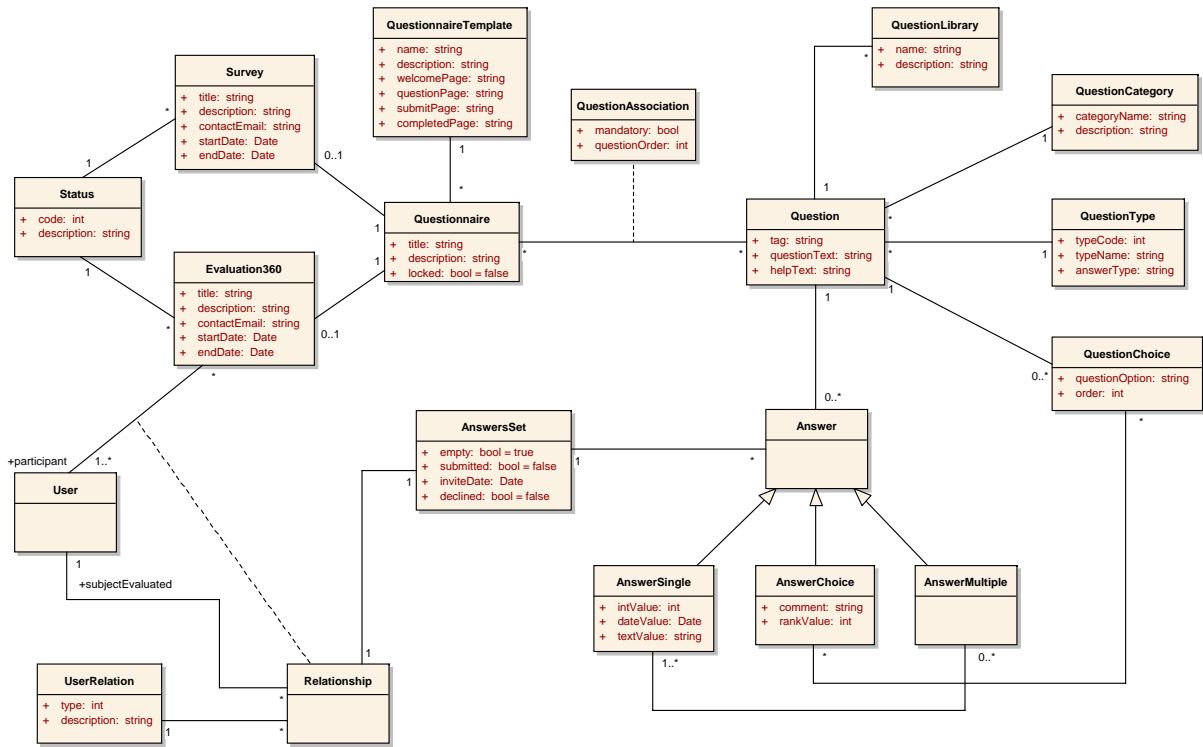
Figure 6.9: Rich class diagram (Part 2)
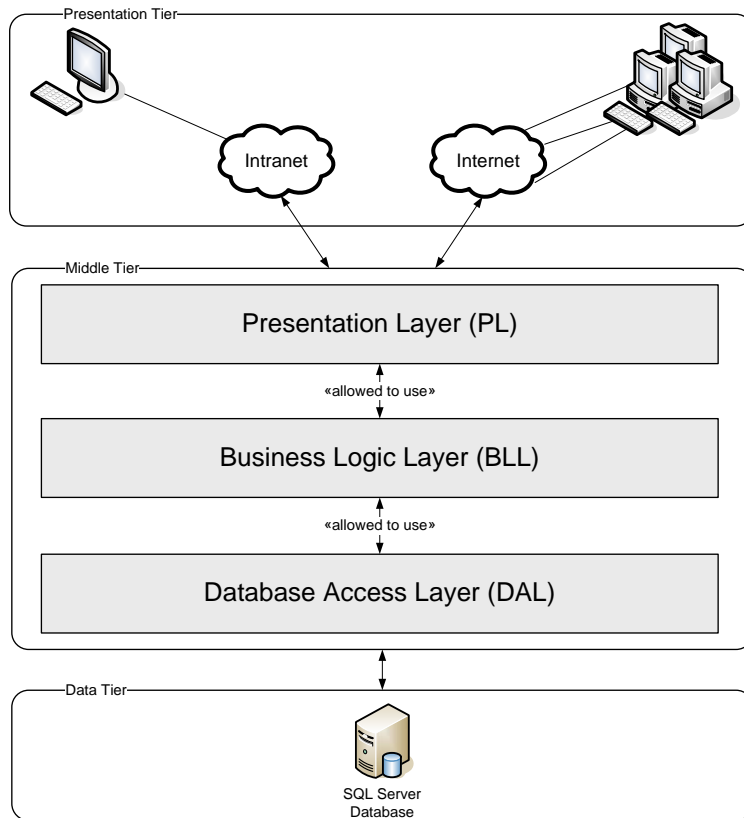
Figure 6.10: Software architecture overlay view

Figure 6.11: Noesis360 Compose questionnaire page

6.6.2 360º Feedback Management

After a questionnaire is assembled it's possible to create new 360º Feedback evaluations, choosing the participants, associated questionnaire and other evaluation attributes. Various options are provided to evaluation management, as represented on Fig. 6.12, including participation statistics which enumerate all evaluators and their chosen relations with current answering status.

Two major types of reports are available: subject reports and group reports. Subject reports are generated for each participant, if a minimum value of answered questionnaires is met. At least one is necessary for stats calculation, but three is recommend for anonymity reasons.

6.6.3 360º Feedback Evaluation

Fig. 6.13 shows the page for requested feedback. It's possible to save all the answers, resume a questionnaire and submit it later.

6.7 Network Converter Prototype

To achieve interoperability between the 360º Feedback application and SNA software packages a prototype has been implemented. We now expose some screenshots of the final product.

Figure 6.12: Noesis360 Manage 360º Feedback evaluations page

Figure 6.13: Noesis360 Provide feedback page

In Fig. 6.14 we can see all the main menus, along with its functions, which we expect to be self explanatory. The user interface is divided into three tabs, containing the input format (GraphML) and the two output formats (for Pajek and UCINET). We call attention to the options for opening the converted networks in the respective software packages.
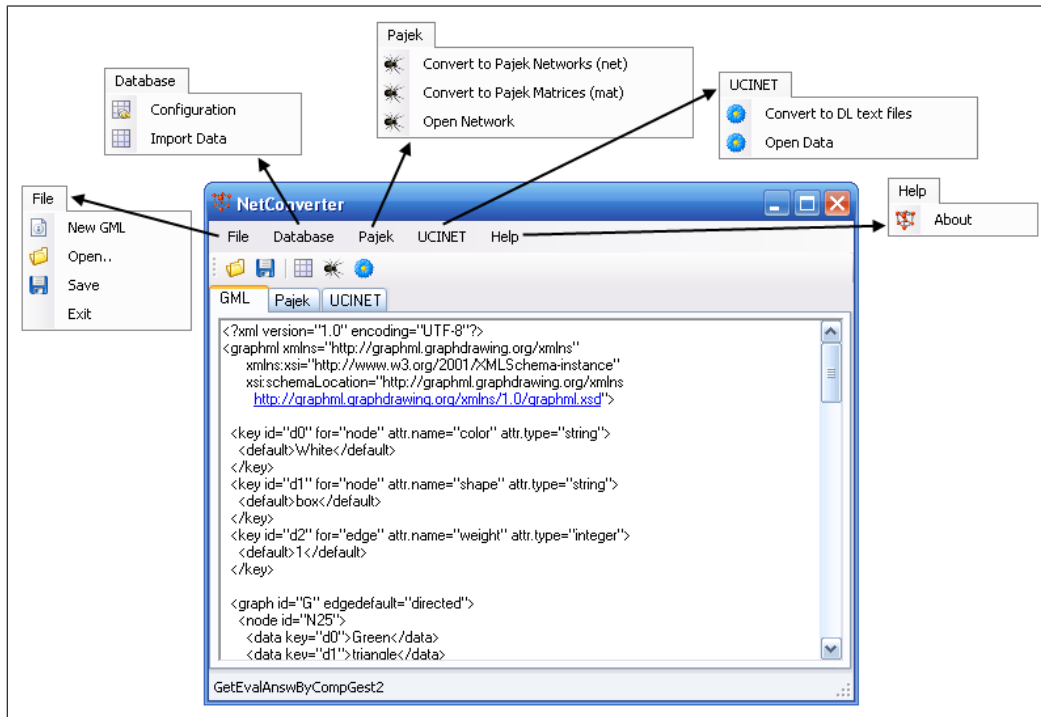
Figure 6.14: NetConverter main menus and functions

In order to import data from 360º Feedback evaluation data first it's necessary to configure the database connection. The user can select the database from the available ones and then access the intended view containing the network data (relations and attributes), as shown in Fig. 6.15.

After the network data is available in the GraphML format (either by importation or direct input) it's possible to convert to Pajek and UCINET file formats. As mentioned before, the user is able to immediately visualize and analyse the networks with a simple click, opening the external applications, as depicted in Fig. 6.16.
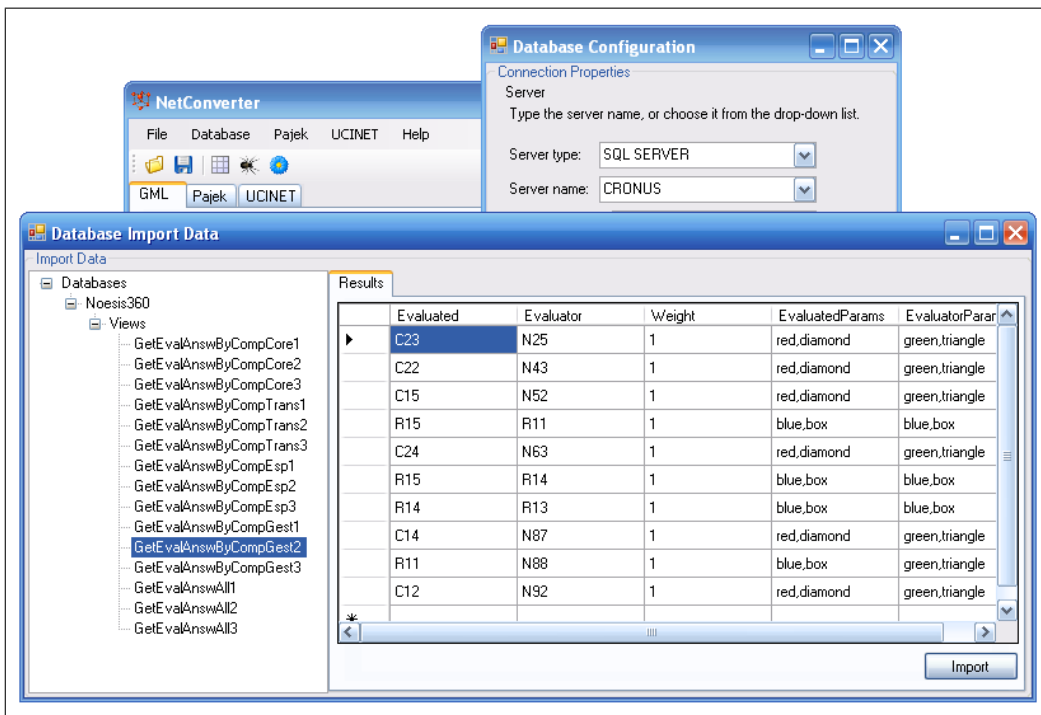
Figure 6.15: NetConverter database configuration and data import
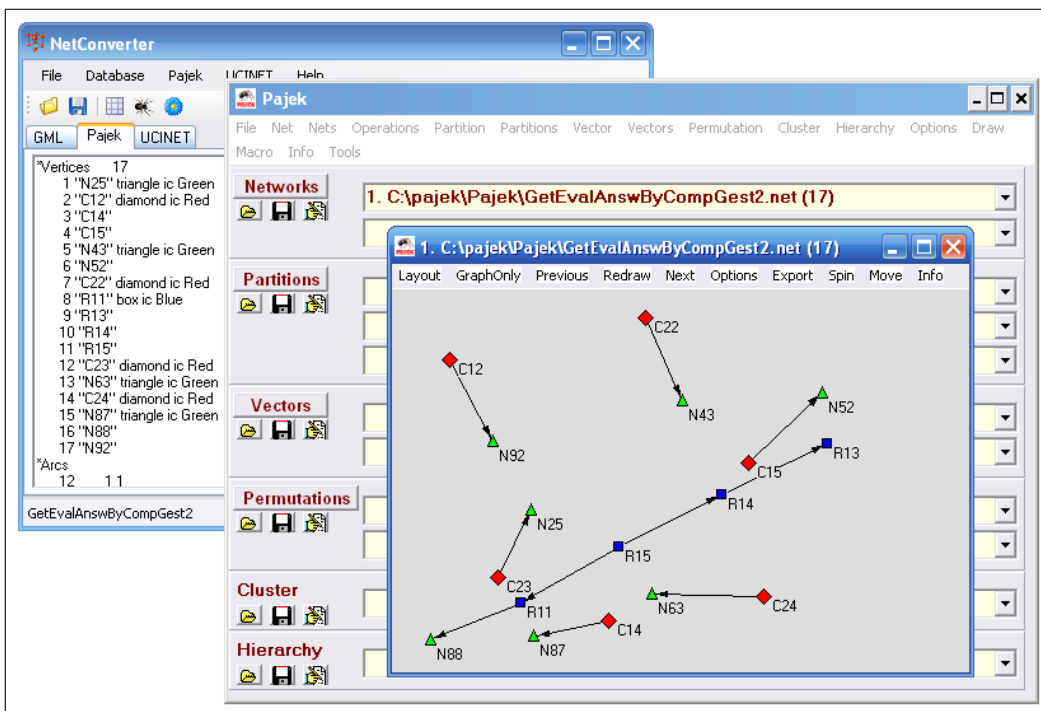
Figure 6.16: NetConverter showing a network in Pajek

7 Evaluation

This chapter describes the obtained results and evaluates the presented case study. It describes the participants and the associated questionnaire which evaluates several relevant skills. Next, it's presented data visualizations using networks representations and formulated a discussion of the overall results including data analysis. Finally we show software validation results and make a roundup discussion of SNA applied to 360º Feedback evaluations.

7.1 Case Study Evaluation

At the end of the software development life cycle, a periodic evaluation was conducted at Noesis, with the participation of all collaborators. Noesis consultants were evaluated by their nominated superiors in several skills by the behaviours shown during the last year of work.

7.1.1 Participants

The population reached almost 300 individuals, from Noesis outsourcing consultants (the evaluated population) to middle and upper management belonging to Noesis and their clients. Noesis collaborators include consultants (normally assigned to a project at client site) and HQ residents (management, commercial, HR, accountancy and internal projects).

7.1.2 Questionnaire

A questionnaire was used to provide both quantitative and qualitative feedback regarding a set of skills that should be scored by manifested behaviours in the last year. Additionally, participants were asked to identify improvement areas in an open-ended manner.

The questionnaire was developed based on a series of best practices [27] for effective questionnaire design. A key guideline that allows evaluation completion in 20 minutes or less was used, also defining the scope of the instrument. Questions queried observable behaviour rather than thoughts, suppositions or motives.

The sections of the questionnaire were designed to contain a similar number of items to provide the highest probability of obtaining compatible responses across all the questions.

A response scale was created to provide regularly intervals, asking respondents to estimate a frequency and offering an odd number of options. The possible answers for each question related to the skill group are:

- No answer;

- "Can't evaluate";

- "Rarely" (less than 20%);

- "Sometimes" (between 20% and 60%);

- "Regularly" (between 60% and 75%);

- "Almost all the time" (between 75% and 90%);

- "Role model" (between 90% and 100%).

7.1.3 Evaluated Skills

Collaborators were evaluated in 4 major skill categories:

1. **Core skills**: common to all collaborators, these skills translate the organization culture in its daily performance and behaviours.

2. **Transversal skills**: shared by all professional functions and development areas, interpreted specifically in each context.

3. **Specific skills**: technical, functional and business skills required by sector, technological area or functional activity. These skills reflect the specialization degree and know-how demands.

4. **Management skills**: required in functions where leadership and management abilities are required. They are applied to middle and top management positions, as well as team leaders.

In Table 7.1 is enumerated the list of skills for each skill category.

7.1.4 Participation Statistics

The data shown in Table 7.2 was gathered from 360º Feedback application. Some conclusions can be drawn:

- Almost all of Noesis collaborators answered the self-evaluation, reaching more than 90% of participation;

- Most of unanswered evaluations belong to a small group of evaluators;

- The value of approximately 78% in total completed evaluations is satisfactory.

Table 7.1: Complete list of evaluated skills

Skill Category	Skill	Skill Category	Skill
Core skills	Sense of cooperation	Specific skills	Commercial aptitude
	Client orientation		Collaborator identification and attraction
	Change orientation		Functional knowledge
	Stress resilience		Delivery management
	Learning motivation		Technological tendencies
	Availability		Technical skills
Transversal skills	Knowledge and information sharing	Management skills	Planning
	Work interest		Team motivation
	Work initiative		Delegation
	Time management		Decision-making
	Problem solving		Self-discipline
	Effective communication		Results orientation
	Strategic thought		Results control

Table 7.2: Case study participation statistics

Number of collaborators	174
Scheduled evaluations	349
Evaluations unanswered	69
Evaluations in progress (not completed)	8
Evaluations submitted by collaborators	158
Evaluations submitted by evaluators	114
Evaluations submitted	272
Percent of completed evaluations	77,9%

7.1.5 Evaluation Network

The evaluation relationship network is depicted visually in Fig. 7.1 as the baseline layout. All participants are represented by nodes masked by a code label for privacy matters. The node legend should be read as follows:

- Blue square - HQ resident;

- Green triangles - Noesis consultant;

- Red losange - Client (tipically a supervisor exterior to Noesis).

The direction of the connection represents the evaluation hierarchy, from source (evaluator) to destination (evaluated). The most notorious network contains HQ residents, since consultants are dispersed working on-site in different clients or even in other departments, resulting in several isolate pairs in the network.
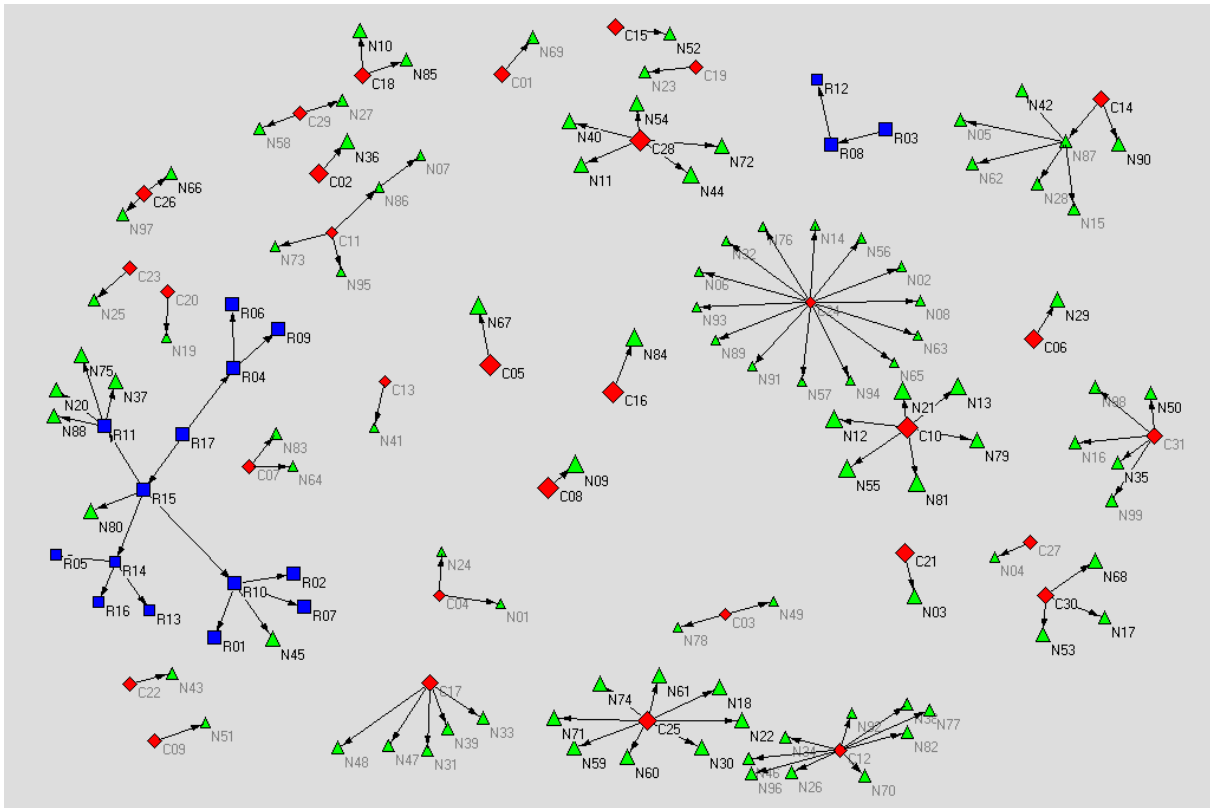
Figure 7.1: Evaluation baseline network layout

The cluster coefficient provides the average probability that collaborators are working together as a clique or cluster, in this case the cluster coefficient is low (less than 5%), indicating that the evaluation network has low cohesion.

The resulting graph representation uses the Kamada-Kawai spring embedded algorithm which disperses infrequent or non-existing interactive nodes and clusters of frequent interactive nodes.

7.1.6 Data Normalization and Analysis

For each answer in the skill group the values were normalized: "Can't evaluate" and "No Answer" were given value 0 and the rest of the scale was increasingly numerated from 1 to 5. Then the arithmetic mean was calculated for all answers in the group, and a percent value was obtained. If a certain skill group had less than half of answers the score was not considered.

Table 7.3 shows some statistics for the normalized evaluation data. Next, for each skill group the population was aggregated in three samples, following a Gaussian distribution:

- Lower quartile (Q_1);
- Median (Q_2) and Upper quartile (Q_3)

- Max value

Table 7.3: Case study evaluation statistics

	Core skills	Transversal skills	Specific skills	Management skills	Overall
Number of answers	114	114	106	92	114
Arithmetic mean	79%	75%	75%	70%	75%
Statistical dispersion	0,14	0,14	0,15	0,14	0,13
Max value	100%	100%	100%	100%	100%
Min value	26%	20%	27%	20%	23%
Percent difference	74%	80%	73%	80%	77%

7.1.7 Network Analysis

Since core skills are common to all Noesis collaborators and express the organization's culture in daily behaviour and performance, we are only interested in low scores, the population of the lower quartile.

Fig. 7.2 provides a network representation of evaluations with low scoring on core skills category. It shows that node C25 from the 8 evaluations he made, 6 of them got low scores. Could mean that he's very rough evaluating his subordinates or maybe the team is unhappy or unmotivated.

Nodes N13, N20, N80 got low scores from their evaluators, but were the only ones in the evaluation group, revealing some problems in work quality and availability. Half of the subordinates of C12, C28 and C31 have low scores too.

Nodes N24, N64, N85 are isolates with low scores, but nothing can be concluded since they are weak linked with the rest of the network structure.

In the HQ residents subnetwork the middle management (nodes R10, R11, R14, R15) evaluated some elements with low scores, including 3 consultants not currently assigned to any project in the client.

The network representation of evaluations with high scores (max value) on management skills is shown in Fig. 7.3. There are 12 nodes with good leadership and management abilities that should be investigated further for reviewing their actual position.

Nodes C04, C26 and C30 gave excellent scores to all of their subordinates in management skills which most probably isn't the best assessment. Management should take a measured,
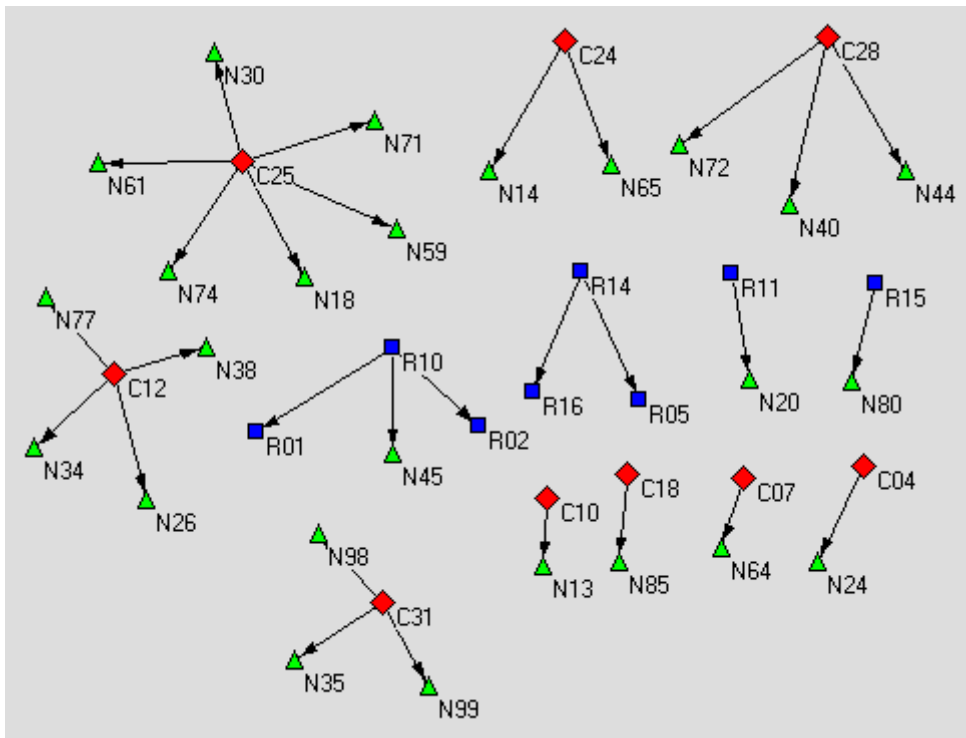
Figure 7.2: Network representation of low scores on core skills
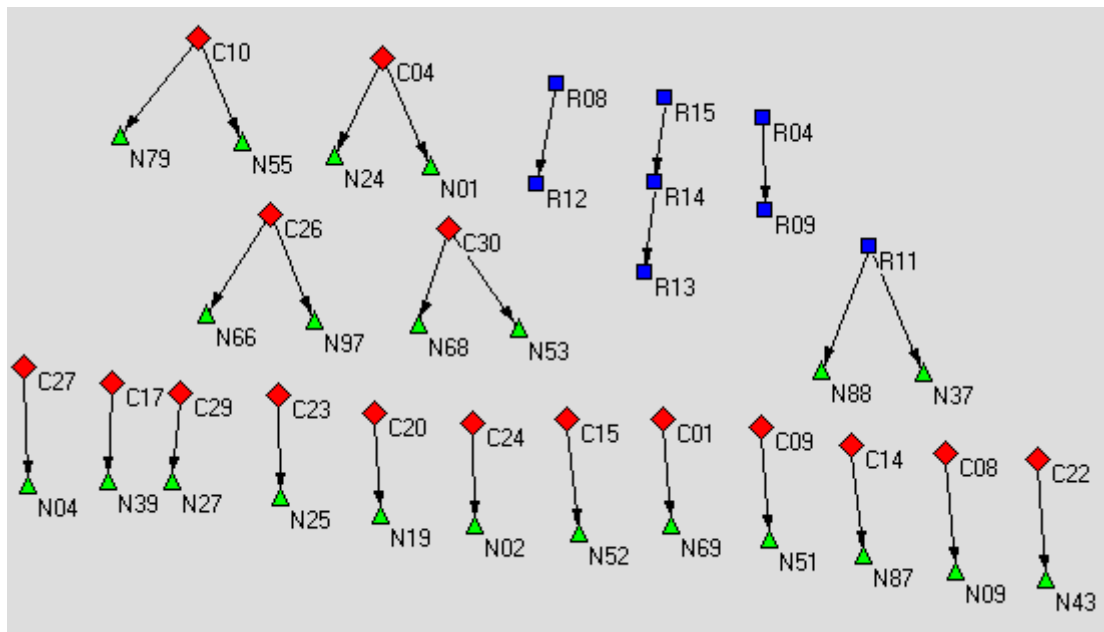
Figure 7.3: Network representation of high scores on management skills

threefold and quantitative approach to evaluations. The lack of distinction in evaluating judgment can reveal problems in own management basic skills.

Relating to the HQ residents subnetwork the only 2-path connection with good scores in management skills is between nodes R15, R14 and R13. None of the evaluations made by upper management (R03 and R17) to middle management denotes excellent results.

Finally we visually analyze the network of overall evaluation scores belonging to the first quartile (see Fig. 7.4), revealing the elements with considerable problems that require immediate attention. The outliers such as node N13, N14, N23, N64, N83 and N85 may represent underutilized resources with skills, expertise not leveraged effectively. The overall results of evaluations made by nodes C12, C25, C28 and C31 follow the low scores on core skills category, as expected.
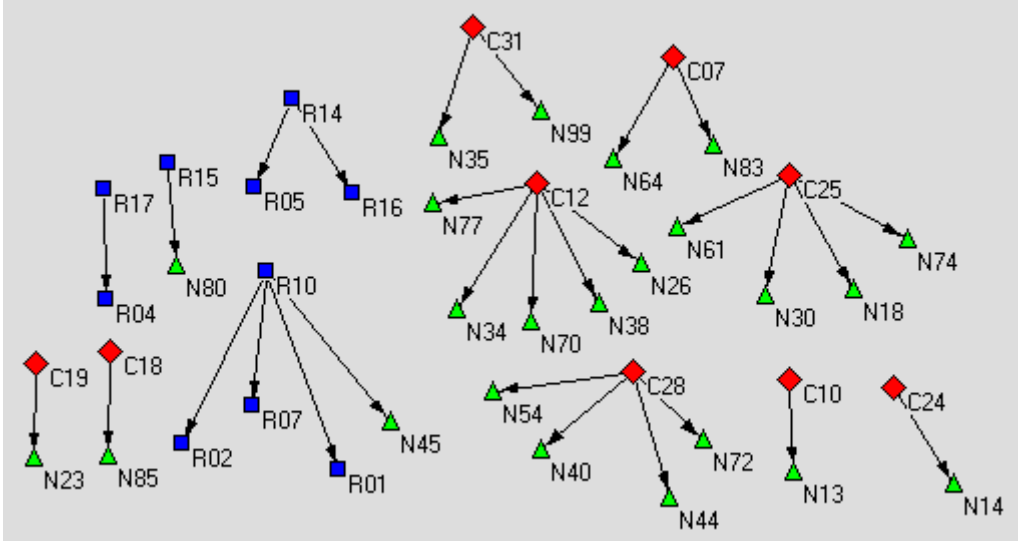
Figure 7.4: Network representation of low evaluation overall scores

In the HQ residents subnetwork node R04 (belonging to middle management) receives a bad evaluation from R17 (upper management). Nodes N80 and N45 (outsourcing consultants not assigned to any project for at least 6 months) also got bad evaluations from Noesis management. Node R10 scores all subordinates with low scores following the scores on the core skills category.

We came up with insights about individuals just by analyzing different network perspectives. It's important to multi-focus on subgroups to get an accurate view of the network. However, as diagrams become more complex, patterns can be based on false beliefs as opposed to what the information network reveals, and therefore misinterpret important points.

7.1.8 Post Analysis

Although network analysis is an extremely useful way to understand the relationships between people in a particular group, it doesn't provide effective answers. To get a better understanding of network and evaluations results, interviews with both the subject and the evaluators should be conducted. Network analysis should determine which people to interview.

Reporting methods can vary from a written document to workshops with all participants. It should focus on what can be done to improve effectiveness of the individual and the group. These sessions should tend to get an agreement on important issues to address and next steps to take. Workshops are diagnostic and a first step in a change management program.

7.2 Software Validation

After the execution of the case study evaluation, it's pertinent to show final validation results and its impact on functional requirements. Table 7.4 describes the requirements which suffered changes, including the option of not implementing it, justifying the choice or its context. Any other non-mentioned requirements were fully implemented, tested and validated. Table 7.5 lists the new requirements discovered during the iterative process of development, also with the proper justification for its appearance.

Table 7.4: Changes in initially defined requirements

Requirement(s)	Status	Justification
R107 (question types)	Incomplete implementation	Not all types of questions are required for the time being
R205 and R206 (working associations)	Not implemented	Outside of the scope of the project, another project will handle it
R218 (subject reports)	Incomplete implementation	Privacy and relevance matters excluded reports with question granularity
R222 (export to CSV/Excel)	Not implemented	Not necessary at the moment
R302 (curriculum vitae)	Not implemented	Outside of the scope of the project, another project will handle it

Table 7.5: New requirements discovered during development stage

Id	Group	Requirement	Justification
ER01	Miscellaneous Functionality	The application should redirect to the requested page upon successful user login.	Enhance usability
ER02	Person Functionality	The user should be allowed to deny a feedback invitation, stating the reason.	Unconsidered option
ER03	User Functionality	The GUI should allow all users to edit personal information (e-mail address).	Reformulation / generalization
ER04	Miscellaneous Functionality	The password recovery should resist to bogus attempts, confirming the request with a verification code.	Unconsidered option

7.3 Discussion

SNA was able to provide insight into a large set of skills of Noesis consultants, even if an overall lack of cohesion exists within the evaluation network. SNA offers a framework to help drive organizational networks toward optimum performance by highlighting major areas and skills.

The duo 360º Feedback and SNA provided strong indications of areas for improvement that otherwise would not have been quantified or easily acknowledge.

Some of the key limitations observed in the case study include:

- There are no standards from which SNA networks can be compared making it difficult to assess its advantages;

- The qualitative judgment by the respondents regarding skill evaluation justifications could affect data quality and variance;

- All participants were identified, introducing some limitations into the objectivity of the respondents' data.

In our opinion, the management must address these limitations by validating feedback provided by multiple sources and by coaching and participate with employees on providing and giving feedback.

Finally it's expected that some feedback results can influence the performance appraisal and the corresponding bonus award and compensation adjustments.

8 Conclusion

The success of any organization depends upon how the performance of employee is evaluated. Different appraisal methods can be used depending on the nature of the job, HR philosophy adopted and in the number and type of employees working in the organization. The 360º Feedback is an effective management tool for employee motivation and development, chosen at Noesis in order to improve productivity and quality of work life. Combined with SNA it provides an ability to address and drive organizational change related to issues that impede performance.

In order to fully implement a 360º Feedback evaluation process in Noesis a software platform was mandatory, since the workforce size is considerable and is working in dispersed locations. To analyze evaluation data in SNA software packages a conversion application was necessary to exchange, convert and format network data. Both applications have been successfully implemented, tested and validated meeting the proposed users' necessities.

But the software system isn't enough alone to make the evaluation process successful. Despite its proven abilities, sometimes it fails from different reasons. Its introduction must be properly and carefully executed. The objectives of the organization and participants must be clear and the evaluation has to be applied to all key employees, not only to employees with visible problems. Each participator has also the responsibility to make an action plan with the help of the supervisor or HR specialist. The assessment method should be an ongoing development process ensuring efforts to improve employee's performance.

8.1 Main Contributions

We now present the main contributions of this thesis both in the software development aspect and the organizational impact.

8.1.1 Software Application

The result of this project is an application that actively supports the 360º Feedback process, but also has good extensibility properties. Since the composition of questionnaires is completely abstracted it's possible to use the questionnaires for other types of structured information gathering. Survey support is already built-in in the system, since after all a survey is a subset of 360º Feedback evaluations.

The system effectively helps HR people. The burden of gathering and processing an enormous stack of paper assessment forms was unthinkable. Even to assure confidentiality by paper/manual methods it was necessary too many physical resources. With this system the outcome is a less bureaucratic and time-saving process.

Professional services also benefit from SNA, since they focus on developing and maintaining rich relationships with clients. Evaluation results are much easier to analyze in the selected software packages, providing instant access to information and insights across sub networks, uncovering substantial biases from an individual or an evaluation group.

8.1.2 Organizational Impact

Despite the importance of performance feedback, managers often fail to provide enough of it on an often basis. They feel too busy, assume that employees are already aware of their performance level, or may be reluctant of sharing critics because of expected negative reactions. Another reason is the inexistence of valid and concrete information in order to get conclusive feedback. 360º Feedback overcome this problem since it systematically gathers data on person's skills, abilities and behaviours from a variety of sources. The results can also be compared across time to see if improvements have been made.

The implication of this thesis is that SNA provides an ability to apply network analysis and management concepts to the organization environment. Coupled with directed open-ended responses and sessions of debriefing, management-driven improvements can be identified, measured and compared to a baseline. SNA can also be expanded to include larger scale activities to drive optimum performance.

As a result of the evaluation analysis, the feedback sessions and a prior commitment to improve collaboration, the organization made some changes.

The figure of Team Supporter was introduced. The Team Supporter should offer to each assigned collaborator a specialized support in:

- Client team integration - presenting the team elements, team culture, organization methods and main areas of actuation;

- Facilitate and orient contacts with Noesis;

- Follow day's work events - problems, achievements, identification of possible conflicts and tensions with colleagues and others;

- Follow and guarantee the correct application of evaluations and performance appraisals;

- Identify new commercial leads;

- Improve professional motivation and self-motivation of collaborators.

At the same time, Noesis developed a self-service Intranet portal that includes forums and knowledge bases aggregated by competences, facilitating sharing and the breaking down of barriers. This signalled a move to a more participatory organization model.

Organization change is in progress. More than ever a meaningful connection between performance standards and organization vision is necessary. It's going to be possible to distinguish effective performers from the ineffective ones. The main challenge now is to turn the evaluation method acceptable to all participants and easy to understand by both managers and employees.

8.1.3 Measuring ROI

Although 360º Feedback together with SNA can lead to improved results, it's difficult to calculate and define an accurate ROI. Metrics and measurements are hard to tie directly and even if change occurs it's a fuzzy correlation.

Three important facts must be taken in account when dealing with ROI on 360º Feedback and SNA:

- 360º Feedback is a continuous measurement activity and not a singular event;

- Networks are highly revealing, but judgment plays a role each time an analysis is conducted;

- Feedback doesn't directly translate in behaviour change, it's the afterwards action plan that generates the ROI.

So using the assessment information the employee can take different initiatives, which range from training, development opportunities, job reassignment, etc. The ROI comes from what is done after feedback results.

8.2 Future Work

There are still some features that were not developed because the effort was too high, the impact on system operation was low and by time and resources constraints. A list of application-centred features is enumerated without any order in particular:

- Full support of survey questionnaires and reports;

- Improve group reports, drilling down till category level;

- Enable the comparison of evaluation results across time or between consecutive evaluations of the same subject;

- Integrate with authentication and identity systems, such as Microsoft Active Directory;

- Fully integrate networks representations and SNA results into the evaluation application, using automated functional GUI tools.

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A 360º Feedback Commercial Applications

In the following pages it's presented a report on 360º Feedback commercial applications, focusing on the product technology, pricing, main features and also pointing some advantages and disadvantages examined.

In Table A.1 is shown a comparison matrix between the different applications, regarding the main aspects and key features of a 360º Feedback application.

Table A.1: 360º Feedback applications comparison matrix

	Technology	Price	Application Service Provider	Customer hosting	Graphical reports	Custom questionnaires	Rating scales	Notifications / Reminders	Spell checking	Overall score (1-3)
Halogen e360	Web	Med	●	●	●	●	–	●	●	★ ★ ★
Action Knowledge 360	Web	Med	●	–	●	●	–	●	–	★ ★ ★
Cognology 360º Feedback	Web	N/A	●	–	?	●	●	●	–	★ ★
Leadership Intelligence 360	Web	N/A	●	–	●	?	–	–	–	★ ★
TrakStar Multi-Rater	Web	Low	●	●	●	–	?	●	?	★ ★
ManagerView/360	Win	Med	–	●	●	–	–	–	–	★
eAS 360º Feedback	Web	N/A	●	●	●	●	●	●	?	★ ★ ★
Visual 360	Web	N/A	●	?	●	–	–	●	●	★ ★

A.1 Halogen e360

Company: Halogen Software

Website: `http://www.halogensoftware.com/products/e360open.php`

Technology: Web application, Java, MS SQL Server or Oracle.

Pricing: The license fee is a one-time charge per subject number. Prices range from $7,500 (50 licenses) to $82,500 (1500 licenses).

Features:

- HR Administrators

  - Automatic personalized reminders - decreases time spent following up by automating evaluator notifications, approval notices, and so on;

  - Report center - offers real-time status monitoring on all subjects as well as completion statistics. Archives evaluations for future reference;

  - Implementation variations - includes optional pre-establishment of managers by HR, subject selection of evaluators, manager approval of selected subjects, and so on;

  - Spell check - avoids potentially embarrassing mistakes and significantly reducing admin time to check all reviews.

- Evaluators

  - Automatic step-by-step reminders;

  - Save-and-resume functionality - offers the option to fill out evaluations a few questions at a time;

  - Web-based framework - offers the freedom to write reviews outside the office environment.

- Organizations

  - Anonymity functionality;

  - Web-based framework - provides universal access 24/7;

  - Password-level security - safeguards against inappropriate access.

Advantages	Disadvantages
Extensive set of features (reminders, spell check)	Price model and value
Subject and group reports / comparative reports	
Graphical and text value data	
Complete status report	

A.2 Action Knowledge 360

Company: Action Knowledge

Website: `http://www.actionknowledge.com/Default.aspx?tabid=83`

Technology: Web application.

Pricing: $150 per assessment.

Features:

- Hosted application - application is hosted on Action Knowledge's server;

- Online PDF report delivery - when the assessment is closed, the system generates reports automatically and notifies you that the reports are ready electronically;

- Quick status panel shows you the number of invitations you have created and the number of responses provided;

- Email notifications on progress;

- Comprehensive, easy to understand reports including an overview and a detailed graphic report per area and per item;

- Mandatory or optional questions;

- Standard or custom questionnaire - you can use the standard leadership questionnaire, or you can create your own;

- Aggregate feedback with minimum report requirements - reports are provided with aggregated information. A minimum number of respondents can be specified in order to generate the report.

Advantages	Disadvantages
E-mail notifications on progress	Invite system with tokens only
Includes several pre-made questionnaires	Price model
Detailed reports (summary graphs, area and question details)	

A.3   Cognology 360º Feedback

Company: Cognology

Website: `http://www.cognology.com.au/360_degree_feedback.htm`

Technology: Web application.

Pricing: Not available.

Features:

- Highly cost effective - by eliminating the need to buy software, a server or upgrades;

- Web based - made to be easy for employees and managers;

- No software needs to be installed;

- Adaptable to your needs - you can configure questionnaires, rating scales and more;

- Customizable questionnaires;

- Rating scales - configurable;

- Open-ended questions - give people the opportunity to make more valuable feedback;

- Reports - help people understand their strengths and improvement opportunities;

- Security - people can feel comfortable giving feedback.

Advantages	Disadvantages
Rating scales	Not enough information available

A.4   Leadership Intelligence 360

Company: DecisionWise

Website: `http://www.decwise.com/360-degree-feedback.html`

Technology: Web application.

Pricing: Not available.

Features:

- *Rater Selection* - The feedback for the 360 degree survey is collected from multiple sources. HR administrators can email a list of participants or complete an online form. Participants and managers select their raters. An email with a link to the Rater Selection Page is sent to each participant and/or manager;

- *Participation Reports* - Participation rate is tracked by the project manager. Raters and participants receive reminder emails to ensure a sufficient response rate per participants, and the client will receive a Participation Report throughout the survey administration period;

- *Participant and Group Reports* - Participants receive their individual 360 Degree Feedback Report, which provides the combined feedback on performance dimensions critical to effectiveness from all raters. Group reports present the composite scores of all the participants across each performance dimension;

- *Content* - The 360 Degree Feedback Report highlights the participant's strengths and areas for improvement. It provides both numerical and qualitative feedback, highest and lowest scores are highlighted, and the gaps between rater groups are presented.

Advantages	Disadvantages
Structured reports	Not enough information available

A.5 TrakStar Multi-Rater

Company: Promantek

Website: `http://www.promantek.com/products.jsp`

Technology: Web application.

Pricing: From $795 to $20,000.

Features:

- Reports - The reports provided breaks down respondent input from a variety of angles and visually displays the data for clear communication of the results;

- Email notifications - Automatic email notifications keeps the manager and respondents informed of their status in real-time;

- Get relevant feedback - Request feedback from peers, subordinates and anyone else that can provide insight into an employee's performance;

- Web Based - Available anytime from anywhere without software to install.

Advantages	Disadvantages
Promantek hosting vs. customer hosting Component of TrakStar Performance Evaluation Software	Not enough information available

A.6 ManagerView/360

Company: Organizational Performance Dimensions

Website: `http://www.360feedback.org/ps-p-mv360.html`

Technology: Windows application.

Pricing: $105 per individual.

Features: Manager View/360 is suitable for executive and management coaching, supervisory training, management/leadership development, training needs assessment, career development, and training evaluation. Use the OPD Scoring Bureau service for your complete 360-degree feedback administration needs or the Manager View/360 software (Windows Version) for complete in-house scoring and report generation.

Advantages	Disadvantages
Other applications (PerformanceView, EmotionalIntelligenceView)	Desktop solution (not web-based)
	Outdated interface

A.7   eAS 360º Feedback

Company: ARTI

Website: `http://www.360eas.com/`

Technology: Web application.

Pricing: Prices models:

- Price per profile based on annual volume

- Price per seat or license

- Hosting fee + flat rate per profile

Features:

- Completely web-based;

- Fully customizable to meet your organization's needs and can be readily tailored to any individual requirements;

- Highly scalable - maintains an unlimited number of questions and related scores;

- Generates an unlimited number of reports and graphics in easy-to-read high quality multimedia formats;

- A clear and easy to navigate user interface for both users and administrators.

Advantages	Disadvantages
Scalability concerns	Not enough information available

A.8   Visual 360

Company: Mindsolve

Website: `http://www.mindsolve.com/site/products/360_Feedback.aspx`

Technology: Web application.

Pricing: Not available.

Features:

- Industry-leading efficiency and accuracy;

- Drag-and-drop ratings for ease of use and accuracy;

- Integrated suite of development tools;

- Multi-source Performance Logging;

- Online real-time status reports;

- Easy training and user support;

- Automatic e-mail action prompts and reminders;

- Online individual and departmental reports;

- Spell check, Comment Assist, and comment editing.

Advantages	Disadvantages
Visual feedback Spell check and other text analysis	Not enough information available

B 360º Feedback Requirements

B.1   Document Purpose

This document constitutes a formal concretization of requirement process, assuring that it matches users' expectations and it's aligned with organization plan and business model.

The document will be used as a direct input to the design phase, and at a later point in the validation phase to check if the prototype satisfies agreed requirements.

B.2   Product Key Features

The "Noesis360" main purpose is simplifying the 360º feedback process benefiting evaluators and entire organization as tool of awareness. It provides a web-based framework with anonymity functionality ensuring honest feedback.

The "Noesis360" application provides the following key features:

- *Web-based user database* - containing personal and contact data, working relations and curriculum vitae.
- *Design and creation of questionnaires* - for use both in surveys and 360º feedback evaluations.
- *Managing 360º feedback process* - sending feedback invitations, gathering information from all participants and publishing evaluations.
- *Report generation* - offers status monitoring on all subjects and completion statistics.

B.3   Application Context

The use of "Noesis360" will require that HR administrators initialize a 360º feedback process, designing a specific questionnaire to target subjects. After collecting all data electronically is necessary to analyse reports and plan the best way to deliver evaluation results to participants.

B.4   Functional Requirements

B.4.1   Designer Functionality

R101: All designers have to be verified using a login (username and password) that is issued by an Administrator.

R102: Every question always belongs to only one "Category", for example "Emotional intelligence", "Cultural intelligence", "Social Intelligence", "Leadership Capability", "Management Capability", etc.

R103: The GUI should allow the designer to create new question categories, retrieve and edit existing ones and delete them. If a category already exists, the GUI should prompt the designer accordingly.

R104: The GUI should allow the designer to create new question libraries, retrieve and edit existing ones and delete them. If a library already exists, the GUI should prompt designer accordingly. Question libraries are the equivalent to one-depth folders to organize questions.

R105: The application should allow the designer to create new questions and associate them with an existing question library.

R106: The designer should be able to delete an existing question. Before deleting it, the application should confirm that the question wasn't used in any questionnaire.

R107: The following question types should be available:

- *Instruction*: Instruction free text;
- *2 point choice*: Allow a simple Yes / No option;
- *3 point choice*: Allow the responses Yes / No / Uncertain;
- *5 point choice*: Allow a single rating of between 1 and 5 for the question at hand;
- *6 point choice*: The same as above, only with 6 instead of 5;
- *List*: Allow to add a series of possible answers/options from which the participant may choose only one;
- *List with comment*: Same as last but includes an area to explain the choice;
- *Multiple options*: The participant may choose any that apply (none, one or more);
- *Multiple options with comment*: Same as last but includes an area to explain the choice(s);
- *Multiple short texts*: Allow multiple short text answers to match a series of pre-defined titles (e.g.: name three things);
- *Ranking*: rank in order of preference;
- *Date*: Enter a date (DD/MM/YYYY);
- *Numerical input*: Require an answer that contains only digits;
- *Short free text*: Support open answers;

- *Long free text*: Support open answers.

R108: The question includes:

- Unique tag. Every question must have a unique tag/label by which it can be easily identified.
- Question text. The question text itself.
- Help text associated.
- Question type. Every question must be of one of the types defined earlier.
- Question choices: If the question is of type *List*, *List with comment*, *Multiple options*, *Multiple options with comment* or *Ranking* is necessary to add various options associated to the question.
- Question category: as stated in R102.

R109: The GUI should allow the designer to compose questionnaires, which consists in grouping different questions in a particular order. The questions are picked from the question libraries available.

R110: When composing questionnaires it should be possible to add a "special" question - a page break, to divide groups of questions in different pages.

R111: A questionnaire template consists in a group of pre-defined screens (e.g.: "Welcome page", "Question page", "Submit page") in which the designer can edit the HTML code of the screen leaving some special tags to allow navigation through pages.

R112: The application should allow the designer to create new questionnaire templates by making a copy of an existing one.

R113: The application should allow the designer to assign a template to a questionnaire.

B.4.2 Administrator Functionality

R201: An administrator should be able to perform all operations of a designer user.

R202: All administrators have to be verified using a login (username and password) that is pre-defined manually.

User management

R203: The GUI should allow the administrator to add new users, retrieve and edit existing ones and delete them. It should allow assign roles (e.g.: designer) to users too.

R204: The personal information associated to users should be coincident with the current data stored in Noesis Microsoft Office Outlook virtual business cards (vCards).

R205: The GUI should allow the administrator to associate a company to a user, being the company a client of Noesis.

R206: The "working" association includes:

- Start date;
- End date (if applicable);
- Brief description of the job assignment.

Surveys and 360º Feedback evaluations

R207: There are two distinct types of uses to a questionnaire:

- Survey - standard one-way survey to collect information from a variable number of respondents (in this case users registered in the system);
- 360º Feedback evaluation - the questionnaire responses come from subordinates, peers and supervisors in the organizational hierarchy, as well as a self-assessment.

R208: The GUI should present to the administrator a complete list of existing surveys and 360º Feedback evaluations providing status details and general information such as title, start date, end date, total number of responses.

R209: The GUI should allow the administrator to retrieve all surveys and 360º Feedback evaluations sorted alphabetically by title or sorted by status.

R210: The administrator should be allowed to create a new survey / 360º Feedback evaluation providing the following information:

- Title - small description that also identifies the survey;
- Long description;
- Contact e-mail;
- Start date;
- End date;

- Associated questionnaire;
- List of respondents.

R211: The GUI should allow the administrator to edit, preview, start (on demand) and delete a survey or 360º Feedback evaluation.

R212: The application should present to the administrator a report focusing on the status of a survey / 360º Feedback evaluation including statistics about scheduled evaluations, completed evaluations and complete percentages.

Notifications

R213: The GUI should allow the administrator to create and edit notifications to be sent by e-mail to the participants of the survey / evaluation. A notification contains a subject and a message text.

R214: The notifications can be sent right away or scheduled to an exact date, or relatively to the start or end date.

Surveys reports

R215: The administrator should be allowed to view reports about each survey, drilling down into each category till the question level, providing simple statistics (like mean) on the answers delivered by participants.

R216: The administrator should be allowed to view complete reports about individual answers provided by a specific participant on a survey.

360º Feedback evaluation reports

R217: The administrator should be allowed to view subject and group reports on a 360º Feedback evaluation.

R218: A *subject report* should include:

- Category reports that break down into average scores from participant groups (self, supervisor, direct report, colleagues, others);
- Specific category detailed reports that analyse answers of participant groups question by question;

- Some general statistics on group answers, showing strengths and weaknesses with reports that sort scores from best to worst or vice versa (top 3 questions / under 3 questions).

R219: A *group report* should include some cumulative results and statistics presenting trends or improvements by looking at comparative reports across target individuals on a group evaluation.

R220: When the number of participants of a group is low (less than 3) relationship information should be hidden to preserve anonymity.

Reports

R221: The administrator should be allowed to access partial reports for in progress surveys or evaluations, as soon as a single response is entered into the system.

R222: The administrator should be allowed to export raw data from questionnaires to CSV / Excel format.

R223: The administrator should be allowed to publish the mentioned reports to PDF format enabling easy distribution, archiving and printing facilities.

B.4.3 Employee Functionality

R301: All employees have to be verified using a login (username and password) that is issued by an Administrator.

R302: The GUI should allow the employee to edit some personal information (such as contacts) and update Europass Curriculum Vitae information.

R303: The GUI should allow an employee to retrieve all surveys sorted by status and deadline dates.

R304: An employee should be able to answer proposed surveys.

R305: Regarding 360º Feedback evaluations, the GUI should present a list of self evaluations and a list of feedback they need to provide. The results returned should be sorted by status and deadline dates.

R306: An employee should be allowed to choose the participants of the 360º Feedback evaluation by sending feedback invitations to existing users of the system or external users that need

to register for the desired effect.

R307: An employee must set for each respondent a type of relationship. The following types should be available:

- Supervisor;
- Direct report;
- Colleague / Peer;
- Others.

R308: An employee should be allowed to download a report after assessment closes and an administrator approves its availability.

R309: The application should present to the employee a quick report on status of a 360° Feedback evaluation including deadline, sent invitations per group and number of feedback received per group.

R310: All the answers can be saved during participant taking survey or evaluation, so that user can resume any incomplete questionnaire at a later point.

B.4.4 Person Functionality

R401: All persons have to be verified using a login (username and password) that is issued by an administrator or by employee invitation.

R402: The GUI should allow the person to edit some personal information, such as contacts.

R403: The GUI should allow a person to retrieve all surveys and evaluations sorted by status and deadline dates.

R404: A person should be able to answer proposed surveys and feedback evaluations.

B.4.5 Miscellaneous Functionality

R501: The application should support language internationalization, starting with English and Portuguese translations.

R502: The application should have a "Help" function on every screen that allows users to search for help on a variety of topics, as well as localized help tips on complex forms.

R503: A global timer should exist so it can start automatically surveys or evaluations and send scheduled notifications by e-mail.

B.5 Environment Requirements

Since the application is expected to be accessed from different platforms, it should be able to run on well known browsers, such as Microsoft Internet Explorer 6+, Mozilla 1+, Opera 7+, Netscape Navigator 6+ and Safari 1+, using XHTML and CSS for greater compatibility and transformability.

The web application will be implemented using Microsoft .NET in ASP.NET with C# language, using ADO.NET as data-access component and SQL Server 2000 as database management system.

Regarding unit testing two frameworks will be used:

- NUnit - unit-testing framework for business logic layer;
- NUnitAsp - an extension to NUnit for automatically testing ASP.NET web pages.

ASP.NET provides a vast set of features for developing web applications. It delivers an easy programming model based on server controls that enable an HTML-like style of declarative programming. The .NET framework also offers considerable amount of classes that encapsulate rich functionality.

B.6 Software Qualities (Non-Functional Requirements)

- **User-friendliness** - since users of the application are diversified, it's essential to be user-friendly as possible.
- **Correctness** - because the application works with sensitive and personal data it's imperative that performs correctly.
- **Reliability** - not critical but important quality. The application should not crash more than once per month.
- **Performance** - the application should run smoothly and efficiently, with single page request not taking more than one second in CPU time.
- **Extensibility** - over time the system can be enhanced adding small features, therefore the application should be extensible.
- **Robustness** - it is expected that application does not crash with wrong inputs or data.

- **Verifiability** - the system should be verified with extensive software testing and use of prototypes.

- **Maintainability** - maintenance is necessary from time to time, specially managing users.

- **Security** - it is important to prevent access from outside users of the system and preserve personal and sensitive data from illegal usage.

- **Confidentiality** - data from evaluations should be confidential.

- **Portability** - portability is not a current concern.

- **Understandability** - all aspects of application (design, code and test cases) should be documented and understandable to future developers.

- **Interoperability** - since the application does not have to interoperate explicitly with any other software, interoperability is not main concern for now.

B.7 Potential Risks

- **Difficult to use** - Since the application addresses various types of users it is possible that some users might find it difficult to use.

- **Limited flexibility** - The composing of questionnaires is somewhat limited to pre-defined types of questions and organization through question categories, so it can be a limitation and a plausible reason not to use the system.

B.8 References

- The Europass Curriculum Vitae (CV), `http://europass.cedefop.eu.int/`
- NUnit, `http://www.nunit.org/`
- NUnitAsp, `http://nunitasp.sourceforge.net/`