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Task distribution method for projects

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Vienna, 1 November 2011

Affidavit

I, **Leonardo Garcia Medina**, hereby declare

1. that I am the sole author of the present Master's Thesis, "Task distribution method for projects", 77 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 01.11.2011

Signature

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ABSTRACT

This thesis examines a solution for some of traditional problems in project management: how to distribute tasks among team members of the project, how to evaluate the effort level required for each of those tasks and how to reward one particular team member if he or she finished correctly one assigned task? This research develops one flexible method that may answer all those questions.

The idea is simple, with a set of rules the own team will be able to self-manage those decisions. Instead of using the subjective point of view of just one person (the project manager), this method asks to the team members for what is their view of the different tasks. The team members rate the tasks of the project and using this information those tasks are democratically distributed. That information provides also the team members' estimations about each task, so there is a parameter that may be used to evaluate the effort level required for each task. Finally the team members receive a reward proportional to the effort level required, if the task is correctly performed, and a reward proportional to the level of success of the whole project.

With simulations this thesis analyses the performance of this method and the possible modification in order to adapt it to different situations.

One of the main problems for failure of self-managing teams within organizations has been the lack of clear working methodologies. Some leaders saw self-managing teams as an excuse to delegate more work and gave away many of their unwanted duties only to burden the staff with tedious responsibilities without considering the necessary training and experience. With this method, an organization has an easy to use tool. It may be a pivotal point where the organization may test and develop their self-managing team system

Human factors in task assignment during project management are very complex topics of research. The final contribution of this study is to open up research directions which explore new ways of participatory work scheduling, distribution and appraisal.

1 INTRODUCTION

1.1 Background

A relatively unknown organization is the self-managing teamwork. Self-managing teams are also referred to as ‘self-directed’, ‘self-organizing’, ‘self-regulating’, ‘empowered’, ‘autonomous’, or ‘semi-autonomous’. Essentially in all of them, the team members have considerable authority with regard to, for example, work methods, planning, and coordination with other teams. The different terms were originally developed to reflect different level of autonomy, but sometimes the borders between them seem to be not so clear and, in fact, usually those terms are completely interchangeably.

Many different companies have implemented self-management because it provides many advantages. For instance, self-managing teams are supposed to increase flexibility at the shop floor, product quality, group effectiveness, timeliness, and productivity; to improve customer service and worker attitudes; and to decrease costs, absenteeism and accident rates. Critics suggested that the implementation of self-management can also be a masked cost-cutting, intended to dispose of a management layer, and argued that self-management may result in increased individual workload, negative stress effects, and excessive social pressure among team members. However, the predominant opinion is that self-management improves both organizational effectiveness and the psychological well-being of employees

The first objective of this study is to develop a useful tool for teams assigned to a project in order to increase their self-management: a method for distributing the tasks of a project and the reward for those tasks. Also this study will analyse and evaluate the performance of that method.

1.2 Motivation

Today companies and their employees have to face completely new challenges every single day. In the last ten years, there have been few industrial sectors that have continued living untouched, but most of them have changed completely. In this age of continuing changing, should we keep using our management methods? Or is it time to use new tools to manage our resources?

Many organizational theories have very hard work crossing from the academic to the real business world. Some of them are too abstract, too inflexible or too revolutionary; self-managing concepts are not an exception.

The aims of this thesis are to provide a new simple and useful method, easy to understand and implement, helping to be more efficient and more flexible.

Both, the task assignment and the reward allocation, were chosen to be combined in this distribution method; because the correct distribution of the task within a team and the reward for the employees who finish their task correctly are key factors in the development and success of a project.

The economic challenges, the world is undergoing, require companies to find better ways to not only reward the most efficient employees, but to motivate all workers to increase performance while keeping or improving business value. Both must be done as cost-effectively as possible.

Employees not only want good salary, they also want to be valued and appreciated for their work, to be treated fairly, to do work that is important, and to have opportunities for advancement and involvement in the company.

1.3 Research objectives

This method may be used by those companies which want to create a self-managing environment for their project teams. The main areas, the thesis will cover, are two:

1. Development of the basic distribution method and evaluation.
2. Development of improvements for the basic model trying to solve the discovered problems.

1.3.1 Development of the basic distribution method and model

For the first point we are going to define our distribution method, it has to accomplish the following lists with guidelines of authority delegation (Yukl, 2002):

- Specify responsibilities clearly

- Provide adequate authority and specify limits of discretion
- Specify reporting requirements
- Ensure subordinate acceptance of responsibilities
- Inform others who need to know
- Monitor progress in appropriate ways
- Arrange for the subordinate to receive necessary information
- Provide support and assistance, but avoid reverse delegation
- Make mistakes a learning experience

After defining the distribution method we are going to make a model of that basic method. The elements of the model that we are going to define are: the utility equation of the team members and the performance measurement criteria.

1.3.2 Analysis of the simulation of the model

We want to study the limitations of the basic method and the environments where it should not be implement. For that we are going to define characteristic of the different elements of the method (members' preferences, reward, task difficulty, etc.) that are necessary for its ideal implementation. After that, we are going to study the impact of non-ideal characteristic in the performance of the method. All this information will be extracted of the study of the equations of economic model.

1.3.3 Proposals for the basic model trying to solve possible problems.

In this point, our aim is to develop more advanced methods. They will try to adapt the system to different non-ideal conditions. Those methods are so complex that it will be almost impossible to find a simple economic model for them, so the models of those complex methods are out of scope.

In summary the main primary question we want to answer here is:

How does this task distribution method work?

This method, using self-managing team, combines different aspects of project management in order to find a global solution of few engineering problems. We are going to define it under the guidelines of management delegation.

What are the results of the distribution method work under different conditions?

Unfortunately it's very hard to compare the results of the model with real-world data without a specific experiment because we are evaluating some factors we cannot measure without a precise questionnaire, for instance: preference of a task, satisfaction after performing one task, skills, etc. As consequence of that, this thesis will not use experimental data (that is completely out of scope); it will use only the output data from the economic model and the simulations. This data, provided by the simulations, will have enough scientific rigour and it will answer the question.

The secondary research question this thesis is going to answer is:

What are the plausible problems and restrictions this method may face and how may it face them?

Of course this method has to be applied in different non-ideal conditions. Different working situations and environments will need an adaptation of the method. Another problem is the strategic voting, doing that few team member may alter the normal functionality if the method. For all of them, this thesis will provide modifications for the basic method and simulations of them.

1.4 Thesis structure

Chapter 2: Literature review

In the second chapter, we present a general review of the literature in the domain of self-managing team, productivity measurement problems and reward relevance. In addition, we included extensive detail of the key definition of the concept we are going to use through this thesis.

Chapter 3: Basic distribution method

In the third chapter, we describe the basic task distribution method. In addition, we provide an example of its different stages.

Chapter 4: Research methodology

In the fourth chapter we develop a mathematical model which is going to be used in the fifth chapter to test the method under different conditions. This chapter is divided in two main sections:

The aim of first section is to find a simple and easy-to-use model to forecast the decision of the team member when they will utilize the distribution method.

The aim of the second section is to define measurement parameters in order to evaluate the performance of the method using its model.

Chapter 5: Simulations

In the fifth chapter, once the model for the basic method and the measurement parameters have been developed, the simulation of the model will start. We check the model under certain circumstances results in order to study the behaviour of the model (and the method) under those circumstances.

Chapter 6: Analysis of the simulations

In the sixth chapter, we will report the findings from the analysis derived from the description of the method and simulations of the model. These results will point to the conclusion of what are the plausible problems and restrictions this method will face under different situations. In addition this chapter will consider and suggest the responses to those problems and restrictions.

Chapter 7: Conclusion: Implications and limitations

In seventh chapter, we will summarize, integrate, and discuss the results of this dissertation study, as presented in the previous chapters of this thesis. In addition, we will discuss a number of downsides and limitations of the present study and offer suggestions as to how these might be overcome in future research. Subsequently, we will address some remaining loose ends and thoughts about research questions for the future. The chapter will conclude with the potential practical implications of the findings that were presented in this thesis.

2 LITERATURE REVIEW

Companies nowadays have to deliver quickly and flexibly new quality products and services, in order to be able to respond to greater and shifting demands from clients. Standardisation and specialisation is distinctive of traditional work organisation. However, for a continuous changing environment, this traditional work organization doesn't seem to work as well, and may lead to coordination problems and inflexibilities. Consequently, companies started to look for new forms of work organisation (European Foundation for the Improvement of Living and Working Conditions, 2007).

When a team has to start a new project, there are the two main questions for a project to face: "Who is the best member of the team for each task?" And the second but even more important: "How is productivity going to be measure for each team member?" In very well-known, groups working for many years together, and performing very well-known tasks, those questions have easy answers. Unfortunately this situation is no very common in many engineering projects.

Starting with the second question, one classical problem in management is the measurement of the productivity. The commonly used definition of productivity is: *The ratio between the amount of goods or services produced and the labor or expense that goes into producing them* (Jones, 2006).

For many years it was a good definition but now it opens to debate. The simple theory appears to be logical, but in practice we have a difficulty when we want to define the produced output. For instance, if we want to use this literal economic point of view about productivity in software industry, we will face few problems because the output is not clear.

Software metrics measure the "amount" of software produced with lines of code; because, at its most fundamental level, software is a computer program comprised of lines of code. However, lines of code, in and of themselves, are not the primary deliverables of a software project and customers often do not know how many lines of code are in the software they are buying.

Another approach that is often talked about for measuring output is Function Points (ISO/IEC 14143-1:1998). But it doesn’t count the connection among different members for the software team or the value of the software produced. In this situation, the team productivity is hard to figure out and it's even harder to measure the contribution of individuals on that team. We can get a general idea of a team's output by looking at how many features they deliver per iteration. We can get a general idea of whether a team's speeding up or if one team is more productive than another. But individual contributions are much harder to measure. While some people may be responsible for implementing features, others may play a supporting role (helping others to implement their features). Their contribution is that they are raising the whole team's productivity but it's very hard to get a sense of their individual output unless you are a developer on that team (Fowler, 2003).

After this example we can conclude that the traditional definition may work in situations where the connection between the profit for the company and the task or role carried out by one employee is clear. It is very efficient for an assembly line, for instance, but an entire disaster when they are adapted to different departments. Nowadays in many engineering fields, this straight connection is very rare to find or the relation among different tasks is very complex (Austin, 1996). Frequently managers have to use subjective and/or arbitrary parameters in order to rate other people’s work in companies with these old style productivity measurement methods.

Efficient reward programs play an important role in organizational success by helping to attract and retain high-performing employees:

- Studies by Gallup and the Corporate Leadership Council show that company appreciation of the employee’s work is highly correlated to improved employee engagement with both the employee’s work and organization.

- Increased employee engagement has an intense positive effect on rising job performance and capturing business value.

- Organizations actively seeking to improve employee engagement, including through the use of formal and informal recognition, financially outperform their competitors.

Traditional methods for keeping and motivating workers utilize compensation and benefits; but they fail frequently when they have to measure the amount of recognition they should give to one particular employee. Usually many companies have very wide-ranging reward systems. Without the correct identification of the reward, the whole system is more ineffective and expensive.

There are many cases of how a good reward system may influence the company performance. The reforms in Scotiabank, Delta Airlines and MGM Grand, for instance, illustrate how some organizations are restructuring their reward programs to connect them better with employee engagement and business strategy.

In the 2003 National Recognition Survey, sponsored by WorldatWork and the National Association for Employee Recognition (NAER), 87% of the 413 responding companies reported that they had some form of an employee reward program and 40% of the respondents indicated that they were expanding their programs. Companies hope to achieve a number of results through their recognition programs, but creating a positive work environment was the top reason cited in this survey (80%). Other goals included creating a culture of recognition (76%), motivating high performance (75%), reinforcing desired behaviours (75%), increasing employee morale (71%), supporting the organization's mission and values (66%), increasing retention/decreasing turnover (51%), encouraging loyalty (40%), supporting a culture change (24%) and other (5%).

Companies have also cited a number of additional reasons to adopt these types of programs, including the following: reducing costs; attracting and retaining key employees; increasing employee productivity, competitiveness, revenues and profitability; improving quality, safety and customer service; and lowering stress, absenteeism and turnover.

A key finding is that recognition programs need to include multiple forms of awards for instance, what is reward for one employee will not necessarily work with all of them. In addition, reward programs don't need to be expensive. In fact, many of the studies we discuss show that non-cash rewards, including simple verbal recognition, usually work best. What matters is that the reward is valuable to the worker and is awarded for behaviours linked to specific job performance goals.

Another matter to be solved is how one company may handle with a new, different, daily challenge. We are living a technology race. The required knowledge is changing continuously. Many times managers are a little bit lost without the complete understanding of their employees' work and, of course, it makes management mistakes. The best way to avoid those mistakes is to delegate the responsibility of few matters to a lower level employee who is closer to the necessary knowledge (Austin, 1996). But the questions now are: Where may someone define the hierarchy limit? Who is good enough to receive that responsibility? In a lot of situation, managers choose one member of a team in a project as "technical project leader". But we don't have any guarantee that it's a good choice. Even more, maybe the topic of the new project is so new that nobody is competent enough to carry with the management responsibility, there is no good choice. Relating now with the first question, do I really know who should do each task?

In the 1950, the Tavistock Institute of Human Relations in London developed a new type of work design studying coal mines. The traditional small work groups in the mines had been replaced by a large-scale and depersonalized method of coal extracting. While studying the consequences of the new method, researchers found an interesting phenomenon. Some groups of workers had reorganized their work situation in one strongly similar to the traditional small work group. And even more relevant, those groups had higher productivity, greater personal satisfaction and decreased absenteeism (Trist & Bamforth, 1951). These coalmine studies played a major role in the development the concept of self-managing teamwork (Parker, Wall & Cordery, 2001).

During many years of developing of organizational theory, we went form the classical or mechanical era to the post-modernism era (it's not a global evolution, many companies didn't evolve anything and they are still stuck with very primitive view). Now an employee is not any longer one piece more in the assembly line, human beings are something much more complex. Managers have to work with people with higher education, risen a world of democracy and freedom. They have to perform very sophisticated and creative jobs but they are completely excluded from the management process (Shanks, 2006). The Agile Manifesto includes the principle: "*The best architectures, requirements, and designs emerge from self-organizing* *teams*."

A study of more than eighty self-managing teams at an American telecommunications company (Cohen and Ledford, 1994), found that self- managing teams had significantly better job performance and higher employee job satisfaction than traditional working groups or departments. Another study (Batt, 2004) exposed that self-managed teams showed considerably higher levels of perceived discretion, employment security and satisfaction for workers and were effective in improving objective performance measures.

In a widespread European study, (Benders et al. 2001) also found a positive effect of self-managing in reducing absenteeism rates and improving organisational performance. Workers with higher control over their jobs are likely to feel more committed to their organisations and more satisfied with their jobs.

At the same time, working in self-managing teams facilitates employee learning and skill acquisition, as well as information sharing, which may be particularly important in conditions of growing economic uncertainty (Wagner et al. 1997; Wall et al. 2002; Vaskova 2007). This is particularly likely to be the case for diagnostic skills in complex systems where on-the-job learning is a prerequisite to obtaining the necessary knowledge and for the acquisition of tacit skills, where learning from others is likely to be the most effective source of skill development. For instance, research on the software development industry has shown team-based learning is crucial for engineers' knowledge acquisition (Barrett 2001).

A review of survey based research over the last decade concluded that the great majority of studies had found positive effects on operational measures of organisational performance (Delarue et al. 2007).

2.1 Key definitions

Task

In project management a task is an activity that needs to be accomplished within a defined period of time. An assignment is a task under the responsibility of an assignee which should have a start and end date defined. One or more assignments on a task put the task under execution. Completion of all assignments on a specific task should claim the task as completed. Tasks can be linked together to create dependencies.

Project

A project is a temporary endeavour with a defined beginning and end (usually time-constrained, and often constrained by funding or deliverables), (Chatfield, 2007) undertaken to meet unique goals and objectives, (Nokes, Sebastian, 2007) typically to bring about beneficial change or added value. The temporary nature of projects stands in contrast with business as usual (or operations), (Dinsmore, 2005) which are repetitive permanent, or semi-permanent functional activities to produce products or services. In practice, the management of these two systems is often quite different, and as such requires the development of distinct technical skills and management strategies.

Project team

A Project team is defined as an interdependent collection of individuals who work together towards a common goal and who share responsibility for specific outcomes of their organizations (Sundstrom, et al. 1990).

Project Teams are time-limited. They produce one-time outputs, such as a new product or service to be marketed by the company, a new information system, or a new plant (Mankin, Cohen & Bikson, 1996). For the most part, project team tasks are non-repetitive in nature and involve considerable application of knowledge, judgment, and expertise. The work that a project team performs may represent either an incremental improvement over an existing concept or a radically different new idea.

Project Management

Project management is the discipline of planning, organizing and managing resources to bring about the successful completion of specific project goals and objectives. The primary challenge of project management is to achieve all of the project goals (Nokes, Sebastian, 2007) and objectives while honouring the preconceived constraints (Dinsmore, 2005). Typical constraints are scope, time, and budget (Chatfield, 2007). The secondary (and more ambitious) challenge is to optimize the allocation and integrate the inputs necessary to meet pre-defined objectives.

Self-managing team

The main idea of the self-managed team is that the leader does not operate with positional authority. In a traditional management role, the manager is responsible for providing instruction, conducting communication, developing plans, giving orders, and disciplining and rewarding employees, and making decisions by virtue of his or her position. In this organisational model, the manager delegates specific responsibility and decision-making authority to the team itself, in the hope that the group will make better decisions than any individual. Neither a manager nor the team leader makes independent decisions in the delegated responsibility area. Decisions are typically made by consensus or by voting. The team as a whole is accountable for the outcome of its decisions and actions.

Normally, a manager acts as the team leader and is responsible for defining the goals, methods, and functioning of the team. However, inter-dependencies and conflicts between different parts of an organisation may not be best addressed by hierarchical models of control. Self-managed teams use clear boundaries to create the freedom and responsibility to accomplish tasks in an efficient manner (Blanchard, 2005)

Groups between 5 and 20 employees can form self-managed teams and in many organisations they manage complex projects involving research, design, process improvement, and even systemic issue resolution, particularly for cross-department projects involving people of similar seniority levels. While the internal leadership style in a self-managed team is distinct from traditional leadership and operates to neutralise the issues often associated with traditional leadership models, a self-managed team still needs support from senior management to operate well.

Self-managed teams may be interdependent or independent. Of course, merely calling a group of people a self-managed team does not make them either a team or self-managed.

As a self-managed team develops successfully, more and more areas of responsibility can be delegated, and the team members can come to rely on each other in a meaningful way.

In self-managed teams it is vital that the manager sets expectations for his/her employees. Expectations allow individuals to understand the manager’s evaluation process in addition to holding employees accountable to certain tasks. If it becomes routine that an employee’s tasks are unfulfilled, the manager should replace that individual immediately.

Utility

In economics, utility is a measure of relative satisfaction. In other words, it is a term referring to the total satisfaction received by a consumer from consuming a good or service. Given this measure, one may speak meaningfully of increasing or decreasing utility, and thereby explain economic behaviour in terms of attempts to increase one's utility. Utility is often modelled to be affected by consumption of various goods and services, possession of wealth and spending of leisure time (von Neumann and Morgenstern, 1944).

Economic Model

An economic model attempts to abstract from complex human behaviour in a way that sheds some insight into a particular aspect of that behaviour (von Neumann and Morgenstern, 1944). The expression of a model can be in the form of words, diagrams, or mathematical equations, depending on the audience and the point of the model.

Tactical voting

It’s a situation where voters do not vote in accordance with their true preferences, but instead vote insincerely in an attempt to influence the result. A group of voters must partially coordinate behind one in order to dislodge a disliked incumbent (Myatt, 2006).

Reward

A psychological reward is a process that reinforces behaviour — something that, when offered, causes a behaviour to increase in intensity. Reward is an operational concept for describing the positive value an individual ascribes to an object, behavioural act or an internal physical state.

SMART

SMART is a mnemonic used to set objectives, for example for project management, employee performance management and personal development. The first known uses of the term occur in the November 1981 issue of Management Review by George T. Doran (Jersak, 2011).

Specific: Goals should be straightforward and emphasize what you want to happen. Specifics help us to focus our efforts and clearly define what we are going to do.

WHAT are you going to do? Use action words such as direct, organize, develop, plan, build etc.

WHY is this important to do at this time? What do you want to ultimately accomplish?

HOW are you going to do it? (By...)

Ensure the goals you set are very specific, clear and easy. Instead of setting a goal to find job, set a specific goal to search for at least 3 job openings in a particular field by then end of this week.

Measurable: If you can't measure it, you can't manage it. Choose a goal with measurable progress, so you can see the change occur. How will you see when you reach your goal? Establish concrete criteria for measuring progress toward the attainment of each goal you set. When you measure your progress, you reach your target dates, and experience a sense of achievement.

Attainable: Goals you set which are too far out of your reach, you probably will not be able to finish. A goal needs to stretch you slightly so you feel you can do it and it will need a real commitment from you. For instance, if you aim to submit your resume to 50 job postings by the end of the day – this may seem overwhelming. However, you may be more likely to complete a goal of 10 a day for 5 days. The feeling of success which this brings helps you to remain motivated.

Realistic: This is not a synonym for "easy." Realistic, in this case, means "do-able." The goal needs to be realistic for you and where you are at the moment. A goal of completing a degree within 1 year is not realistic for most people. Pace yourself but be sure to set goals that you can attain with some effort. Too difficult and you set the stage for failure, but too low sends the message that you aren't very capable. Set the bar high enough for a satisfying achievement!

Timely: Set a timeframe for the goal: for next week, in three months, by the end of the year. Putting an end point on your goal gives you a clear target to work towards. Time must be measurable, attainable and realistic.

3 BASIC DISTRIBUTION METHOD

The method works in the following way: the company has to perform a new project. The project manager's role is to divide the project into tasks and to distribute them among the project team, from this moment on, "team members". In the ideal situation, the basic case we are going to study first, all the team members are able to perform correctly each one the tasks of the project, with higher or lower effort. In following chapters non-ideal situations will be analyzed.

First of all, the project manager defines the requirements for each task. Any criteria of good requirement could be used (for instance, they shall cover all the aspects of the SMART criteria). Even if it's not possible to define clearly each task (it's very common to find ambiguity and non-defined areas at the beginning of the many projects), the project manager shall remark those non-well defined tasks. Wherever there is a possible change in the requirements of the task should be identified, because it's an important factor to be considered by the team members.

After defining the task, the project manager may prepare a briefing with the team members about the project and the tasks. The aim of this briefing is to provide to the team member receive the necessary information to understand the difficulties the each task. Depend of the complexity of the project; more information may be delivered to the team member in form of handouts, software, digital or online documentation.

This briefing has also an important benefit besides the method itself: it encourages the whole team members to understand every single task. From the beginning the will work more coordinated because they have a complete view of the project, and also a deep understanding of the task assigned to the other team members as well as their own.

From the moment that the information is delivered, the project manager has a passive role in the distribution process. That may be very helpful if the project manager is part of the team. It is a very common situation in the engineering field that a task has to be assigned to project manager; so with this method is sure that the whole process is not going to be affected by the project manager’s preferences (even if he is not specifically part of the team it is required his support of the team during the whole project).

But a key role that an external manager has (the project manager or another one) is the surveillance and support of the whole process. That is very important role in big team were the distribution could be affected by a group of member working together in order to get maximum benefits from the method (tactical voting).

Once the team member have a clear understanding of the tasks of the project, the members of the team will rate or vote for the each task. They rate them answering this question: “Do you think this task should be assigned to you in order to have the best project’s result?” For instance, the rate number may go from 5 to 1; “5” means it’s a perfect task for my abilities and preferences; and “1” means it’s a non-capable and non-desired task. The team members know how this method works and the consequences of their choices. When they finish rating, all the rates of a task are added up, the result is called “team rate”. This term measure the subjective view of effort required for each task. This effort has an inverse relation with the team rate.

A reward is associated to the project. It may be a monetary reward, a grade in the company profile of the employee, a prize, a recognition, etc. It may be not a single type of reward but a combination of them. Anything that has a value to the employee and that can be quantified somehow. That “project reward” is established by higher hierarchy levels, and when the project manager receives the project; it should be also included the total reward for it. The project reward is divided in two parts: the total task reward and the global success reward. The global success reward is received by all the team members at the end of the project, regardless if they finished correctly or not their own task. The objective of this reward is to keep the team members working together instead of only being focused on their own tasks.

On the other hand, the total task reward will be adequately distributed to each team member only when they finish their tasks correctly. Generally, if the tasks are very disconnected between them, then the global success reward should be much smaller than the total task reward. If the tasks are very connected between them, then the global success reward should be not so small or even equal to the total task reward.

In order to distribute the total task reward adequately, those team members who performed task with higher required effort should receive more reward than those who performed easier task. So the correct finalization of every task has associated a reward: the team members, who finalized successfully their assigned tasks, will receive the reward associated to those tasks and the team members, who didn't finalize successfully their assigned task, will receive no reward or a penalization. Those "task rewards" shall have a relation with the required effort, therefore an inverse relation with the team rate.

It's not a critical matter which kind of formula is used to find a task reward, as long it keeps the inverse relation. In this thesis we are going to use a "geometrical" inverse proportionality, in other words, the proportion between any two different team rates will be exactly the inverse of the proportion between any the two different task rewards. But it's not the only valid way to find adequate rewards, for instance, they may be a set of predefined reward sort by team rate (lowest to highest).

This inverse method is chosen because it requires less set up of the model. In arithmetical we would have to define the medium level of reward (arithmetical origin), and even worse in predefined reward, where we would have to define each predefined task.

Using our inverse method, the task rewards are calculated as the sum of the inverse of each team rate multiplied by the team rate of the task, as it's described in the following formula (1).

$$Reward\ of\ task\ X = \frac{Total\ task\ reward}{Team\ rate\ of\ task\ X} * \left(\frac{1}{Team\ rate\ task\ 1} + \frac{1}{Team\ rate\ task\ 2} + \cdots\right) \quad (1)$$

Example: there is a typical software project. The project manager divides the project into 5 tasks. They are different functions of one software application. All the team members can perform every task but they don't require the same effort level. There also are 5 team members (including the project manager). They will rate the tasks from 1 to 5. Also the software department manager has decided that the reward for this project is 535: 335 is for total task reward and 200 is for global success reward (40 for each team member if they have 100% of success). The voting result for this example is:

Table 1 Example of the rating of the tasks.

Task	Member 1	Member 2	Member 3	Member 4	Member 5	Team rate	**Reward**
A	2	3	3	1	4	16	**45**
B	1	1	2	2	3	9	**80**
C	2	2	1	5	1	10	**72**
D	1	1	4	1	1	8	**90**
E	4	4	1	3	2	15	**48**

Now the team members will be assigned to a task. Starting with task with the lowest team rate, the unassigned member with the highest number will receive that task. When a member receives one task, that member cannot be assigned to another task. The next task for assignation will be the task with the second lowest team rate and the process is repeated. In case of a tie between two or more team members, this task is not assigned in that moment. This task will be assigned when there is only one of the team members of the tie still unassigned. The flowchart of the assignations is the follow:

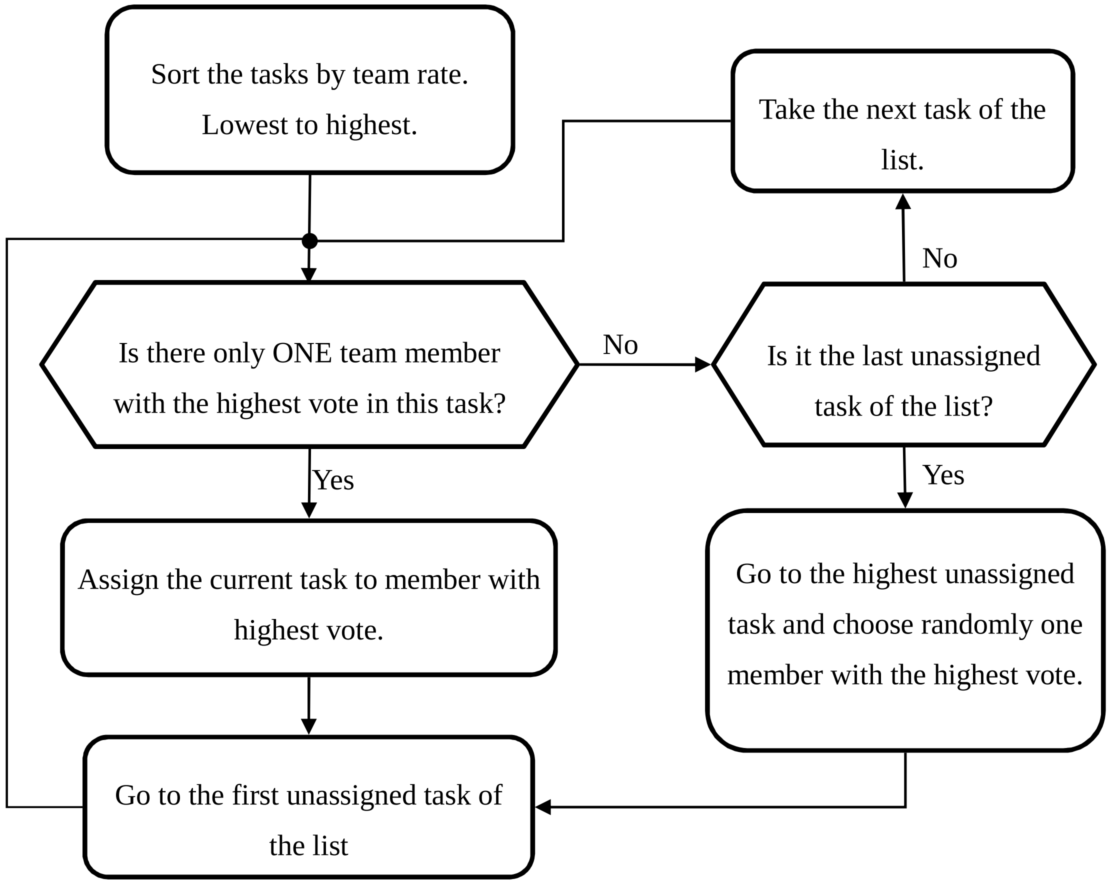

Fig. 1. Flowchart of the assignation process of the distribution method.

Example: continuing with the previous software project, the task with the lowest team rate is the Task D, so the assignation process is going to start with it. The team member with the highest vote in that task is the Member 3, so he will receive the Task D. Then the assignation process continues with the Task B which is assigned to the Member 5 and the Task C which is assigned to Member 4. Then the next task should be Task E but this task must be skipped because there is a tie between Member 1 and Member 2. When the tie was solved, this task would be the next one in the process. Following the order, the Task A is assigned to Member 2, breaking the tie, so immediately the next (and last) task is Task E and it is assigned to Member 1. With this last task the assignation process is finished.

Table 2 Example of the preferences of a team.

Member	Task Assigned	Success?	Task Reward	Global Success Reward	Total Reward
1	E	Yes	48	80% global success (8 out of 10) Global Success Reward = **32** (out of 40)	**90**
2	A	Yes	45		**78**
3	D	Yes	90		**122**
4	C	No	72		**32**
5	B	Yes	80		**112**

In the example the team member 4 didn't finalize the assigned task and, because of that, he is not going to receive any task reward, but as a member of the team he will receive a part of the global success reward. That member was working with his colleges and, even if he couldn't deliver this work before the deadline or with the required quality, maybe part of his work was used for his colleges to perform their own tasks.

This distribution method fulfills the task preferences of the team members in combination with the rewards connected with the effort required by the task. As this method mainly only depends on the team members' decisions, they take responsibility of the correct performance of the project. As we explained before, the distribution method is very fast and flexible. The company is not going to waste employees' time: only 5 minutes for making the decision of the different votes and for writing it on a piece of paper or in an online application. With such little time, the company would receive very valuable information about their employees. For instance, the company is able measure the productivity within the team, even if the tasks are very heterogeneous (tasks managerial, coordination, development, etc.).

It is very important that the people (specially the team members) involved in this process understand the implications of the method they have and how it works. Because essentially, the team members are taking a lot of responsibility in the task and reward assignation, and the managers are delegating their power. Both must be aware of it and they must agree to take the possible consequences.

Of course, this basic method may be combined with another reward system (there is not any incompatibility). For instance, this method doesn't provide a measure that the project is performed under certain requirements. If the company wants to measure also the quality or the quantity of the output beyond the minimum required level, then the company may combine this with another reward system focus on that.

Also there is another possibility, during the thesis different more complex method will be developed. Those complex methods will try to solve some problems of the basic method and to adapt it to specific situations just as the described before.

4 RESEARCH METHODOLOGY

Once the method has been explained, in the first part of this chapter we are going to develop a mathematical model which is going to be used in the next chapter to test the method under different conditions. The aim of the next section is to find a simple and easy-to-use model to forecast the decision of the team member when they would utilize the distribution method. We are going neither to try to evaluate every possible variable in the decision process nor to make an extreme complex model.

After defining the model we are going to use in simulation, we are going to define measurement parameters in order to evaluate the performance of the method using its model.

4.1 Model of the basic method

Consider N team members and N tasks. Each team member has one skill S_i with $i=\{1,2,\ldots N\}$ and each task has a difficulty D_j with $j=\{1,2,\ldots N\}$. The difficulty gives us the effort required if a member has only one point of skill. Every team member has also a preference for the each task P_{ij}, it represents how much the team member i wants to be assigned to a specific task j and because of that the effort level for that task is increased or reduced. In other words, D_j represents the rational view of the effort that one task requires, it's the same of all the team members because it's the actual effort they would take if they are assigned to that task. On the contrary, P_{ij} represents each team member's personal (irrational somehow) view of the effort that one task requires, it's different for each team member because it's related with his personal "feeling" about each task. The members might "feel" that an easy task it's harder because they hate it, or that a hard task it's easier because they love it.

The team members don't know their own values exactly. There is a "subjectivity distortion". The skill value they perceive is S_i' with normal distribution with mean equal to the actual value S_i and with a standard deviation of σ_m.

As it was commented before, all the team members are able to perform any task. In other words, there is no minimum level of ability for the tasks; the only different is that the task will be harder for one member with low ability than for other with higher ability. This scenario is not unrealistic, for instance, in the field of software engineering: one big application has to be divided into few parts, one per functionality. Every team member is able to code every part; they prefer one easy task because they will be very relaxed and one hard task will make them feel under pressure. In other words, every task has a specific "cost" for each team member. This "cost" is defined (Lazear, 2001) as the following cost function (2):

$$C_{ij} = k\frac{D_j - P_{ij}}{S_i'}$$

(2)

The parameter *k* is a constant that converts one "unit of effort" into one monetary unit. It helps when this cost shall be related to a wage or income, as we are going to do later on. But in this model we will set up the different factor in order to have a common normalized value, so for the moment *k*=1.

R is the total reward for the tasks of the whole project and V_{ij} the votes of each team member *i* for each task *j*. The votes may have any possible value between 1 and 10. Continuous votes may be not very realistic but discrete votes make the formulas of the model much harder to understand and the system much more complex. Moreover, once continuous votes are found the change to discrete ones is not so difficult.

As it was mentioned before, the system this method will use to divide the reward among the team member must have an inverse proportion with the team rate for a task (the sum of every vote of every member for that task). For the moment the global success reward will be ignored for making the model clearer but it is going to be included at the end of this chapter. So I_j is the income that any team member will receive if the task *j* is assigned to him. The function of that income is:

$$I_j = \frac{R}{(\sum_{h=1}^{N} V_{hj})(\sum_{t=1}^{N} \frac{1}{\sum_{h=1}^{N} V_{ht}})}$$

(3)

Finally the utility function for the voting process is:

$$U_{ij} = I_j - C_{ij}$$

(4)

The team members are not going to know the skills of the other team members. Instead of that they know the skill average $\bar{S}$ of the whole team and they will deduce the "average vote" of the "average member". Expected Income of the "average member" for the task *j* is:

$$\bar{I}_j = \frac{R}{N\bar{V}_j \sum_{j=1}^{N} \frac{1}{N\bar{\bar{V}}_j}}$$

(5)

The "average member" will vote in order to have the same utility in all the tasks:

$$\bar{U}_1 = \bar{U}_2 = \bar{U}_3 = \cdots = \bar{U}_N$$

$$\frac{R}{\bar{V}_1 \sum_{t=1}^{N} \frac{1}{\bar{\bar{V}}_t}} - \frac{D_1}{\bar{S}} = \frac{R}{\bar{V}_2 \sum_{t=1}^{N} \frac{1}{\bar{\bar{V}}_t}} - \frac{D_2}{\bar{S}} = \frac{R}{\bar{V}_3 \sum_{t=1}^{N} \frac{1}{\bar{\bar{V}}_t}} - \frac{D_3}{\bar{S}} = \cdots = \frac{R}{\bar{V}_N \sum_{t=1}^{N} \frac{1}{\bar{\bar{V}}_t}} - \frac{D_N}{\bar{S}}$$

(6)

Solving this equivalence leaving $\bar{V}_1$ as a free variable:

$$\bar{V}_2 = \bar{V}_1 \frac{ND_1 + R\bar{S} - \sum_{t=1}^{N} D_t}{ND_2 + R\bar{S} - \sum_{t=1}^{N} D_t}$$

$$\bar{V}_3 = \bar{V}_1 \frac{ND_1 + R\bar{S} - \sum_{t=1}^{N} D_t}{ND_3 + R\bar{S} - \sum_{t=1}^{N} D_t}$$

$$\vdots$$

$$\bar{V}_N = \bar{V}_1 \frac{ND_1 + R\bar{S} - \sum_{t=1}^{N} D_t}{ND_N + R\bar{S} - \sum_{t=1}^{N} D_t}$$

$$\sum_{t=1}^{N} \frac{1}{\bar{V}_t} = \frac{NR\bar{S}}{\bar{V}_1 (ND_1 + R\bar{S} - \sum_{t=1}^{N} D_t)}$$

(7)

Now instead of using $\bar{V}_1$as free variable, the equivalence (7) is solved using any other average vote $\bar{V}_x$:

$$\bar{V}_j = \bar{V}_x \frac{ND_x + R\bar{S} - \sum_{t=1}^{N} D_t}{ND_j + R\bar{S} - \sum_{t=1}^{N} D_t}$$

$$\sum_{t=1}^{N} \frac{1}{\bar{V}_t} = \frac{NR\bar{S}}{\bar{V}_x (ND_x + R\bar{S} - \sum_{t=1}^{N} D_t)}$$

One condition of the voting system is that all votes will be positive so:

$$D_j + R\bar{S} - \sum_{t=1}^{N} D_t > 0 \ \forall \ j = 1,2,3 \ldots N$$

$$R > \frac{1}{\bar{S}} \sum_{t=1}^{N} D_t$$

(8)

This equation provides a degree of freedom, so we have to find another condition. The lowest $\bar{V}_j$ will be assigned for the minimum possible value for a vote. This value is 1. The task that has the highest D_j is that lowest $\overline{V}_j$. So this degree will be used for setting the model up in the following way (9):

$$Min\ (\overline{V}_j) = 1;\ \forall\ j = 1,2 \ldots N$$

$$T = \sum_{t=1}^{N} \frac{1}{N\overline{V}_t} = \frac{R\bar{S}}{ND_{max} + R\bar{S} - \sum_{t=1}^{N} D_t}$$

$$\overline{V}_j = \frac{D_{max} + R\bar{S} - \sum_{t=1}^{N} D_t}{D_j + R\bar{S} - \sum_{t=1}^{N} D_t}$$

(9)

Solving the system of equations, we have $\overline{V}_J$ for all the different tasks. They are going to be used by the team member to make an approximation of the expected income of a particular task.

Now we are able to find the value of the team members' votes. We start with the team members' utility:

$$U_{ij} = \frac{R}{(\sum_{h=1}^{N} V_{ht})(\sum_{t=1}^{N} \frac{1}{\sum_{h=1}^{N} V_{ht}})} - \frac{D_j - P_{ij}}{S_i}$$

(10)

As in the previous part, they are going to follow the strategy of having the same utility of all the tasks because it's very hard for them to predict with task are going to receive:

$$U_{i1} = U_{i2} = U_{i3} = \cdots = U_{iN}$$

Simplifying with the following approximation:

$$\sum_{t=1}^{N} \frac{1}{\sum_{h=1}^{N} V_{ht}} \approx T$$

$$\sum_{h=1}^{N} V_{ih} \approx V_{ij} + (N-1)\bar{V}_j$$

$$U_{ij} = \frac{R/T}{V_{ij} + (N-1)\bar{V}_j} - \frac{D_j - P_{ij}}{S_i'}$$

This equation doesn't have any dependence of the votes of the other team members, only with the "average member" and we already know those votes. For instance for the team member 1, the equation to solve is:

$$\frac{R/T}{V_{11} + (N-1)\bar{V}_1} - \frac{D_1 - P_{11}}{S_1'} = \frac{R/T}{V_{11} + (N-1)\bar{V}_1} - \frac{D_2 - P_{12}}{S_1'} = \cdots$$
$$= \frac{R/T}{V_{1N} + (N-1)\bar{V}_N} - \frac{D_N - P_{1N}}{S_1'}$$

Solving the equivalence again:

$$V_{12} = \frac{RS_1'(V_{11} + (N-1)\bar{V}_1)}{RS_1' + (V_{11} + (N-1)\bar{V}_1)T(P_{11} - D_1 + D_2 - P_{12})} - (N-1)\bar{V}_2$$

$$V_{13} = \frac{RS_1'(V_{11} + (N-1)\bar{V}_1)}{RS_1' + (V_{11} + (N-1)\bar{V}_1)T(P_{11} - D_1 + D_3 - P_{13})} - (N-1)\bar{V}_3$$

$$\vdots$$

$$V_{1N} = \frac{RS_1'(V_{11} + (N-1)\bar{V}_1)}{RS_i' + (V_{11} + (N-1)\bar{V}_1)T(P_{11} - D_1 + D_N - P_{1N})} - (N-1)\bar{V}_N$$

Now instead of using V_{11} as free variable and of solving a particular case, a general solution V_{ij} for any task *j* and any team member *i* may be found. In this case V_{ix} is used as a free variable:

$$V_{ij} = \frac{RS_i'(V_{ix} + (N-1)\bar{V}_x)}{RS_i' + (V_{ix} + (N-1)\bar{V}_x)T\left(P_{ix} - D_x + D_j - P_{ij}\right)} - (N-1)\bar{V}_j$$

The vote has to fulfill the following conditions:

$$V_{ix} > \frac{(N-1)\overline{V_j}\,(RS_i' + (N-1)\overline{V_\iota}T\big(P_{ix} - D_x + D_j - P_{ij}\big)) - RS_1'(N-1)\overline{V_x}}{\big(RS_1' - T\big(P_{ix} - D_x + D_j - P_{ij}\big)(N-1)\overline{V_j}\big)}$$

$$\big(RS_1'(1 + (N-1)\overline{V_1}) - T\big(P_{11} - D_1 + D_j - P_{1j}\big)(N-1)\overline{V_j}\,\big) > 0$$

$$RS_1' + (V_{11} + (N-1)\overline{V_1})T\big(P_{11} - D_1 + D_j - P_{1j}\big) > 0$$

Again we find a degree of freedom; in this case we want to maximize the utility. In order to do that we have to maximize the utility of the lowest $D_j - P_{ij}$

$$Min\,[D_j - P_{ij}] = \widetilde{D} - \tilde{P}_i$$

$$\widetilde{U}_i = \frac{R}{\tilde{V}_i \sum_{t=1}^{N} \frac{1}{N\overline{V_t}}} - \frac{\widetilde{D} - \tilde{P}_i}{S_i}$$

$$\frac{\partial \widetilde{U}_i}{\partial \tilde{V}_i} = 0 \to \frac{\partial \widetilde{U}_i}{\partial \tilde{V}_i} = \frac{-RT}{\tilde{V}_i T}$$

But the minimum possible value for one vote is $\frac{RS_y}{T(D_j - D_y + P_{xy} - P_{xj})} \forall\, j = 1,2,3 \ldots N$ so:

$$V_{xy} > \frac{RS_y}{T(D_j - D_y + P_{xy} - P_{xj})} \forall\, j = 1,2,3 \ldots N$$

$$\widetilde{U}_i = \frac{R}{T} - \frac{\widetilde{D} - \tilde{P}_i}{S_i}$$

$$U_{i1} = U_{i2} = U_{i3} = \cdots = U_{iN} = \widetilde{U}_i$$

$$\frac{R}{V_{11}T} - \frac{D_1 - P_{11}}{S_1} = \frac{R}{V_{12}T} - \frac{D_2 - P_{12}}{S_1} = \cdots = \frac{R}{V_{1N}T} - \frac{D_N - P_{1N}}{S_1} = \frac{R}{T} - \frac{\widetilde{D} - \tilde{P}_1}{S_1}$$

$$V_{ij} = \frac{R}{T(\widetilde{U}_i + \frac{D_j - P_{ij}}{S_i})}$$

Finally the global success reward will be included in the equations. The Income formula is now:

$$I_j = \frac{R}{(\sum_{h=1}^{N} V_{hj})(\sum_{t=1}^{N} \frac{1}{\sum_{h=1}^{N} V_{ht}})} + G_{ij}$$

The factor G_{ij} is the reward for the global success of the project. This parameter depends of which task will finally receive a specific member. Assuming that the difficult of the project is well-balanced, if one member finally receives a task much harder than his ability then there is a small chance of finalizing that task without the required quality. From the point of view of one single team member, if he receives a very easy task compared with his skill and the average, it means that another team member will receive a very hard task. So he knows that the probability of finishing the project is lower. The expected value of the global success reward G_{ij} is:

$$G_{ij} = \frac{R}{2N}(1 - \alpha \left| D_j - \frac{\overline{D} S_i}{\overline{S}} \right|)$$

(11)

The global success reward (11) has a constant α $(0 < \alpha < 1)$ which defines the influence of the effort in the chances of successful finalization of the tasks. It's an empirical value, in this case is we are going to assume that is a constant with value 0'01.

Also in order to simplify the complexity of the system and reduce the number of variables the global success reward will exactly the half of the total task reward R.

The new vote equivalence is:

$$V_{ij} = \frac{RS_i'(V_{ix} + (N-1)\overline{V_x})}{RS_i' + (V_{ix} + (N-1)\overline{V_i})T\left(P_{ix} - D_x + D_j - P_{ij} + S_i' G_{ix} - S_i' G_{ij}\right)} - (N-1)\overline{V_j}$$

4.2 Model for performance measurement

Finally we are going to define the performance of the team, in order to compare different situations and distribution systems. There are two main factors we want to measure in order to find the performance of team: global level of success and satisfaction of the team members.

The satisfaction of the team member is measured as the square of expected value divided by the received value. The satisfaction cannot be bigger than 1 so in case of receiving more income that was expected, the satisfaction is only 1.

$$Satisfaction = \begin{cases} 1 & when\ Expected\ < Received\ Income \\ \left(\dfrac{Received\ Income}{Expected\ Income}\right)^2 & when\ Expected > Received\ Income \end{cases}$$

The expected income (E_{ij}) is proportional to the difficulty of the task to perform modified by the preference of the member *i* for that particular task *j*. R is the total task reward, D_j is the difficulty for that task and P_{ij} the preference.

$$E_{ij} = \frac{R(D_j - P_{ij})}{\sum_{t=1}^{N} D_t}$$

As it was mentioned before, every team member is able to perform any task, but that doesn't mean that there isn't any change of failures when a member is performing a task which requires a lot of effort (working with a lot of pressure drives errors). In case of performing a task without a lot of required effort, then they success of that task is secure.

The success of the whole project is the average of the different task successes. For one particular team member *i* and one particular task *j*:

$$Task\ success = \begin{cases} 1 & when\ \dfrac{\bar{D}S_i'}{\bar{S}} > D_j \\ 1 - \alpha\left(D_j - \dfrac{\bar{D}S_i'}{\bar{S}}\right) & when\ \dfrac{\bar{D}S_i'}{\bar{S}} < D_j \end{cases}$$

The task success has a constant α $(0 < \alpha < 1)$. As in the situation of the global task reward (11), α defines the influence of the effort in the chances of successful finalization of the tasks. It's an empirical value, in this case is we are going to assume that is a constant with value 0'1.

5 SIMULATIONS

Once the model for the basic method has been developed, the simulation of the model will start. First we are going to check the parameters of the model in order to study the behavior of the model (and the method) under certain circumstances. They will give us a better understanding of the method how to configure it in order to adapt it to our office workflow.

5.1 Study of the impact of the total task reward

Essentially this method wants to distribute an amount of money among a group of people. Logically one of the parameters of the model with the highest importance is that one which represents money we wants to distribute: the total task reward. It will drive a lot the behavior of the team member because, as we studied before in the developing of the model, it affects to all the stages of the decision making process of the team members.

We are going to compare the difficulty of the task (D_j) that each team member receives with individual task reward associated to that task (I_j). The expected result, without too much influence of the team members' preferences, is that every task reward will have approximately the same fraction of the total task reward than the difficulty associated to that task of the sum of all difficulties. In the next figures, we are going to express those fractions as a percentage.

$$Dificulty\,\% = \frac{D_j}{\sum_{t=1}^{N} D_t} 100$$

$$Task\ reward\,\% = \frac{I_j}{\sum_{t=1}^{N} I_t} 100$$

At the beginning, we want to simulate this parameter with a model as simple as possible: the "subjective parameters" of the team member will be zero (preference and σ_s), and also the global success reward. We are going to introduce them step by step.

The difficulties and the skill will be defined as a random variable between 1 and 10 and there will be 5 team members and tasks.

The total task reward will have the following values: 10, 30, 40, 60, 80 and 100. All of those values fulfill the condition for the total task reward we have established developing the model (for the chosen skills and difficulties distributions, the minimum total task reward is 10).

For each of those values for the total task reward, there will be 5 simulations (and for each simulation the value of the 5 team members). In the abscissa of the next figures there will be two numbers (X.Y); the first one (X) represents the simulation number of the series; and the second one (Y) represents the task number.

Characteristics of the next simulations:

Number of members: 5

Total task reward: 10/30/40/60/80/100

Global success reward: 0

Skill: Randomly distributed [1,10], $\sigma_s = 0$

Difficulty: Randomly distributed [1,10]

Preference: 0

X.Y represents: X for the simulation number in the series and Y for the task number.

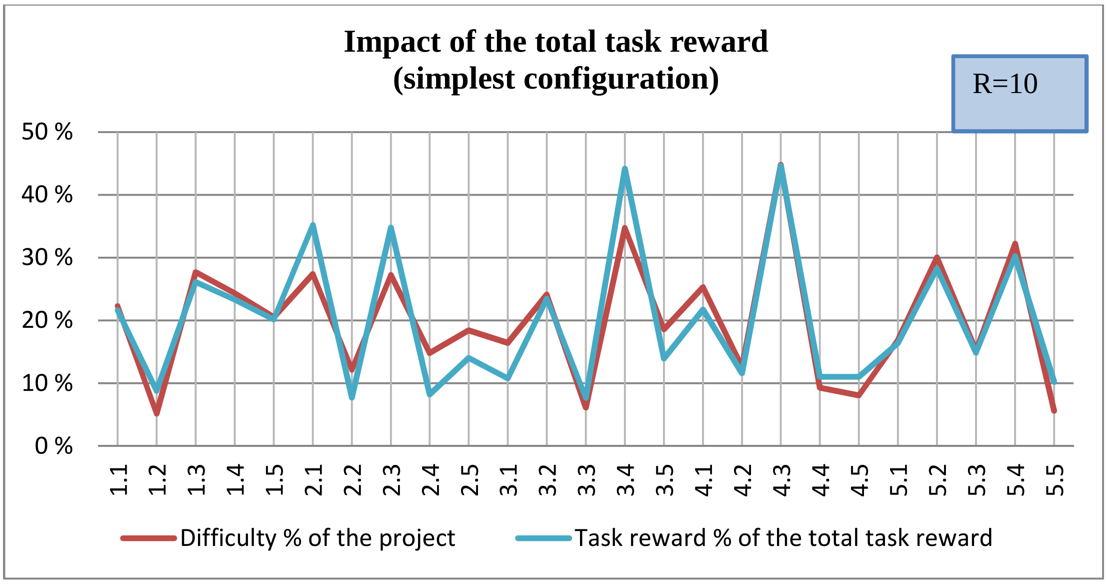

Fig. 2. Impact of the total task reward (simplest configuration) R=10

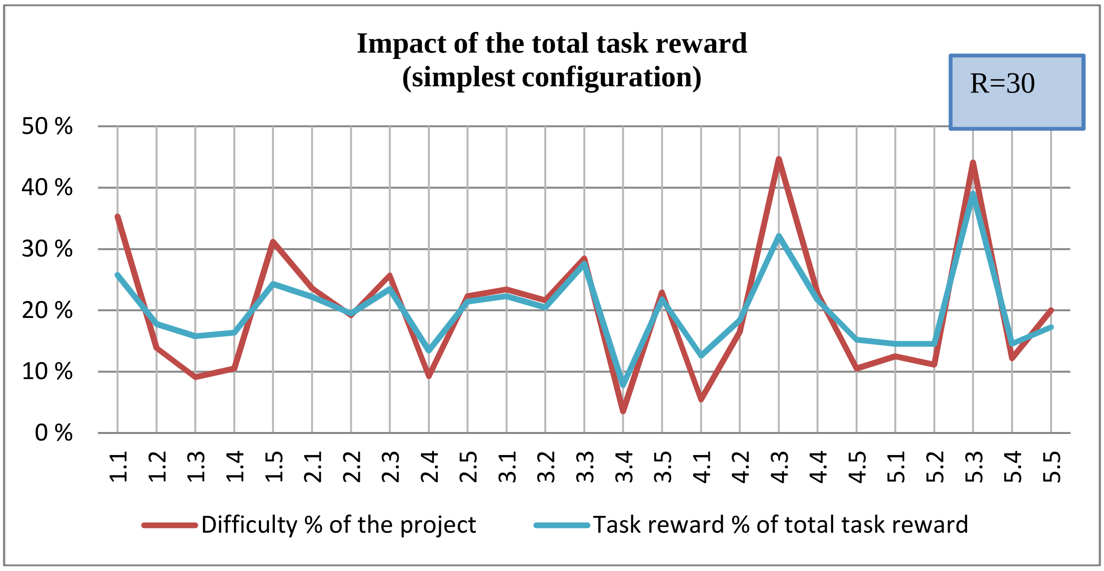

Fig. 3. Impact of the total task reward (simplest configuration) R=30

In these two figures (figures 2 and 3), the final distribution of the reward of the tasks is clearly correlated with their difficulties.

The average difference in the simulation with R = 10 (figure 2) is less than 3.13% with a maximum value of 9.4%. In this case the team member clearly overacted to the difficulties. The reason is simple: there is not too much reward to distribute, so they prefer to choose an easy option because the chances of getting a hard task with low reward are really high. They are “risk adverse” due to that high difficulty/low reward relation; and a task with lower votes will receive lower task reward and vice versa.

In the second case (figure 3), the simulation with R=30, the average difference is 3.7% and the maximum value is 12.5%. In this case, the team members start to lose their "risk adverse" behavior. They vote to hard task because they expect a high reward choosing them and they don't vote to easy task because they expect a low reward. Those votes produce the errors we may see in the figure 3.Those errors are mainly in the "extreme difficulties", tasks with the highest and lowest values. It has much sense from a psychological point of view: if the team members know that one task is going to provide a lot of reward (high-difficulty tasks), they have predisposition to vote for that task, even if it is the hardest task (otherwise everybody votes the minimum possible vote for the hardest task). And the other way around, if they know that one task is going to provide little amount of reward, they don't have any predisposition to vote for that task. For these low-difficulty tasks the effect is more important because they have a small percentage of the total difficulty of the project and the distortion is more perceptible there.

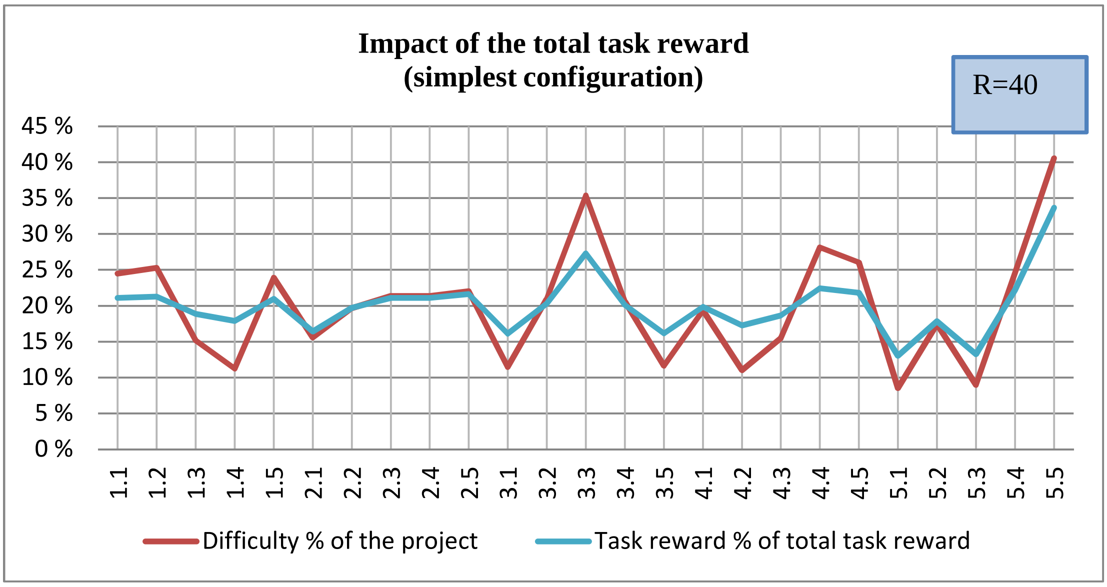

Fig. 4. Impact of the total task reward (simplest configuration) R=40

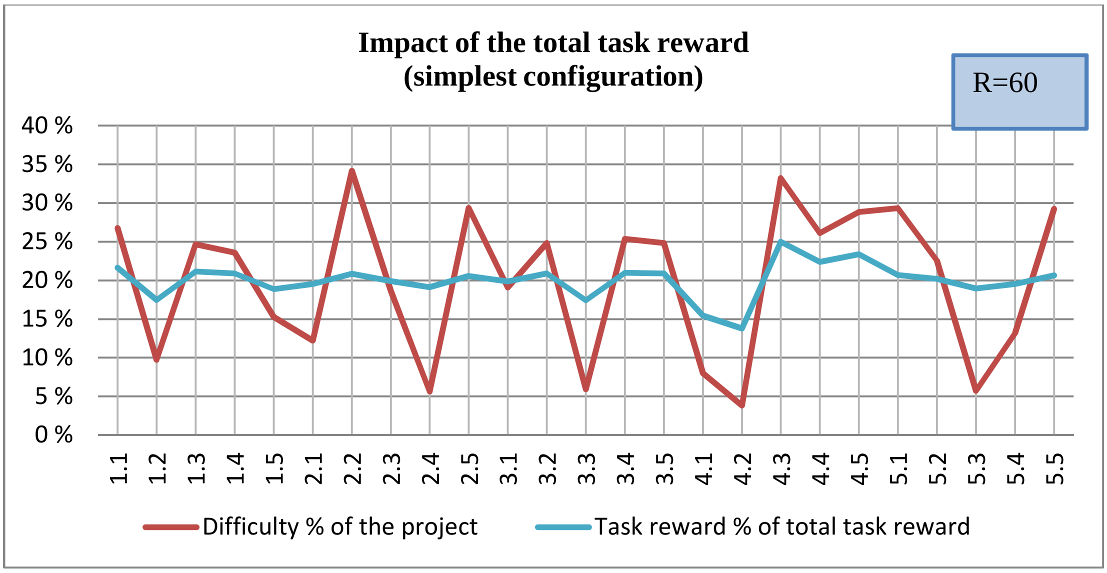

Fig. 5. Impact of the total task reward (simplest configuration) R=60

In these two figures (figures 4 and 5), we may observe the change in the results. The team members are becoming more and more “risk lovers”, so even if they don’t have a good skill, they try to get harder but more profitable tasks.

The average difference in the simulation with R = 40 (figure 4) is 3.17% with a maximum value of 8.07%. This numbers and the previous ones are pretty similar. But in the second case (figure 5), the simulation with R=60, the average difference is 6.7% and the maximum value is 13.5%. Here we may observe a huge change in the average difference and the shape of the task rewards on the figure 5, even if it still has little relation with the difficulty of the shape, is much flattener, almost useless.

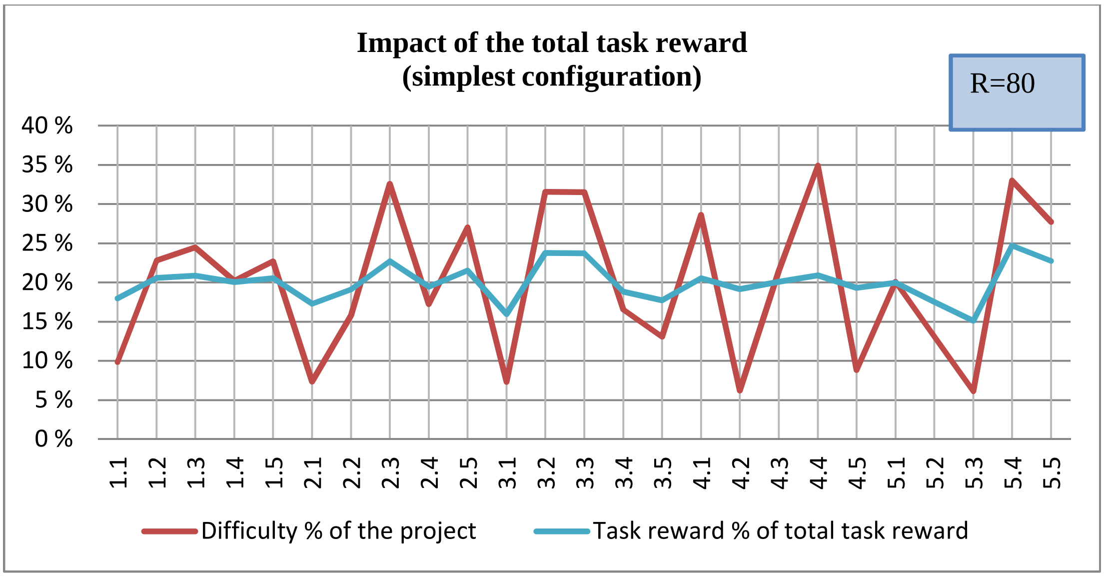

Fig. 6. Impact of the total task reward (simplest configuration) R=80

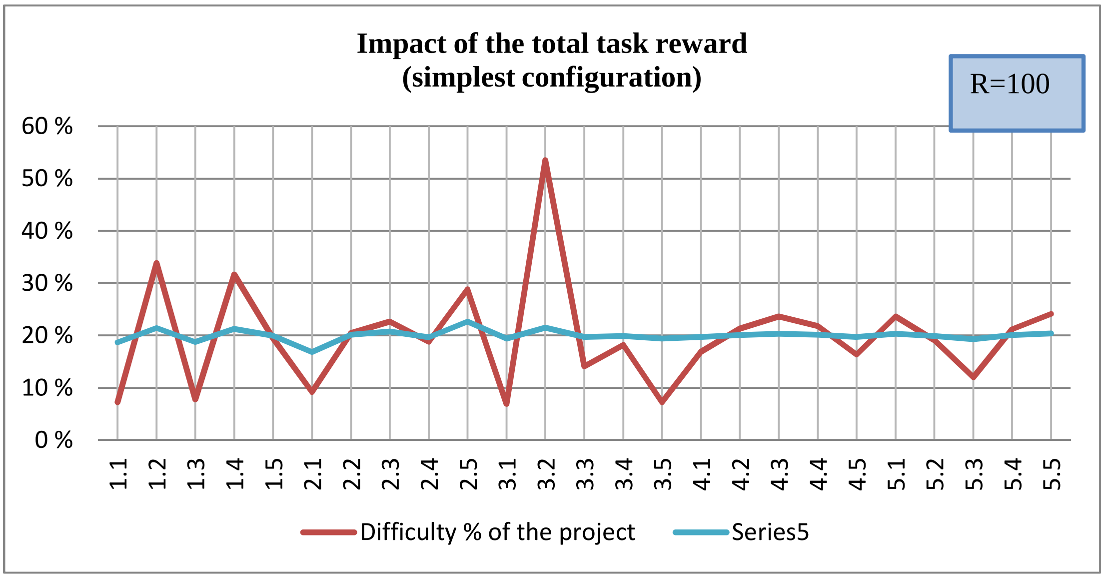

Fig. 7. Impact of the total task reward (simplest configuration) R=100

These last two simulations show us that the trend of voting for hard tasks continues growing. The average difference is in both cases more than 6% and the maximum difference around 14% with R = 80 and more than 30% with R = 100 (almost completely flat). In these cases the team members don't care about the task rewards because they are going to receive so big reward that the transfer of votes form easy task to hard task is complete.

The conclusion of these simulations is that we have to adjust the total task reward to the project difficulty if we don't want to feed the risk behavior of the team members.

Anyway this problem has is already solved in the model. The easy solution is to use the global success reward. It will reduce the "greediness" of the team members. It objective is that they don't have to work only for themselves but for the common good of the team members and the project.

So in this group of simulations, we are going to take one more step: now the global success reward is included. As we commented before, α is 0.1 and the global success reward amount in the 100% success case is half of the total task reward.

The "subjective parameters" of the team member will continue being zero (preference and σ_s). All other parameters will be defined as in the previous simulations. We are going to simulate only total task reward values of 100 and 80 (extreme flat cases) in order to see how the new parameter affects the model, and also we are going to include 10 to check if the modify the behavior with more adjusted total task rewards.

Characteristics of the next simulations:

Number of members: 5

Total task reward: 80/100/10

Global success reward: $\alpha = 0.1$, 40/50/5

Skill: Randomly distributed [1,10], $\sigma_s = 0$

Difficulty: Randomly distributed [1,10]

Preference: 0

X.Y represents: X for the simulation number in the series and Y for the task number.

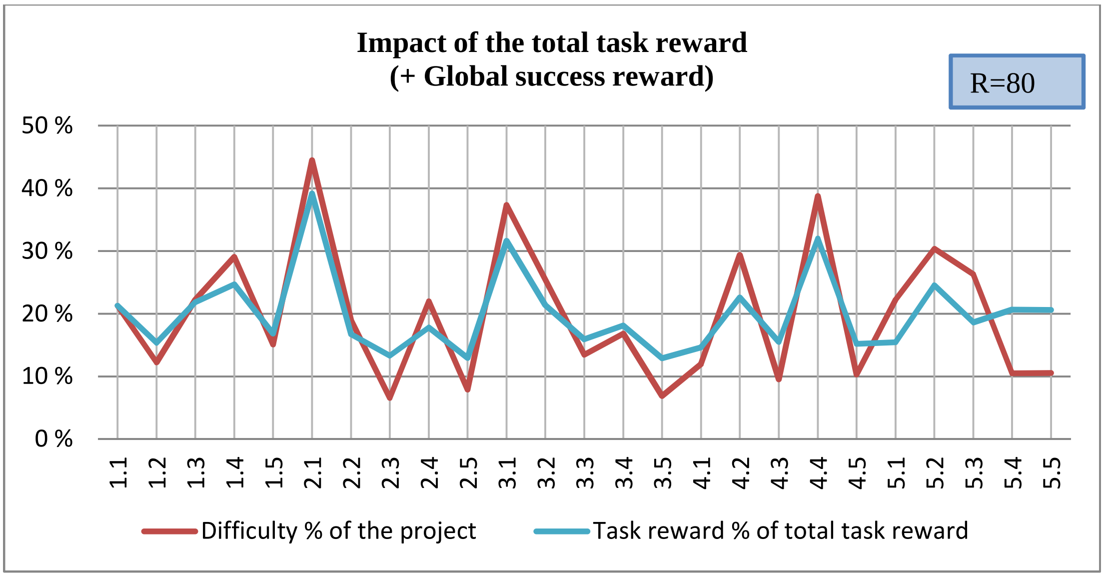

Fig. 8. Impact of the total task reward (+ global success reward) R=80

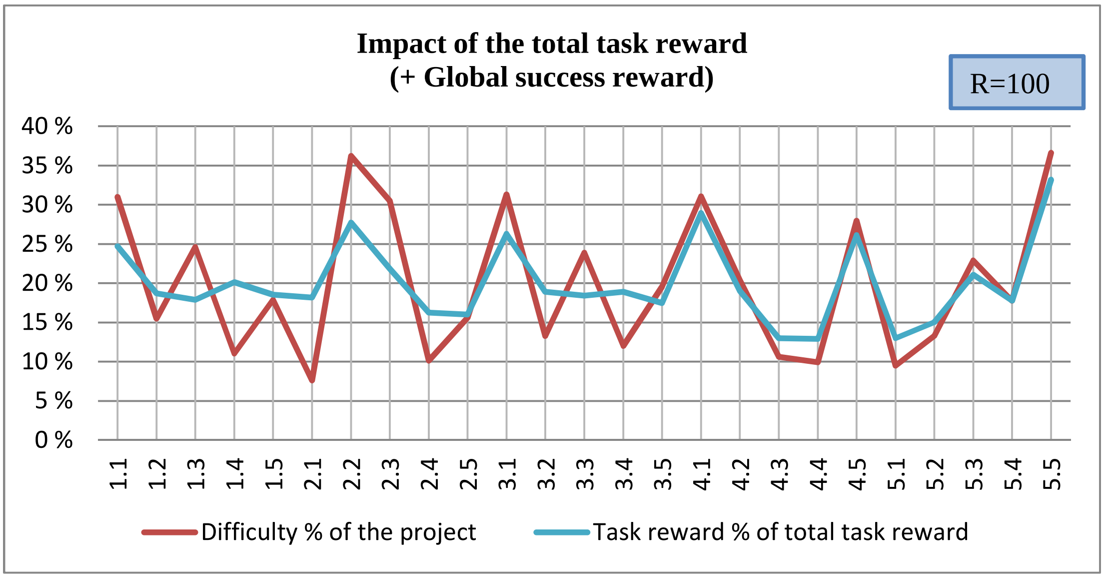

Fig. 9. Impact of the total task reward (+ global success reward) R=100

The comparison of the previous figures with global success reward (figures 8 and 9) and their equivalences without global success reward shows us that the differences between task rewards and their task difficulties has decreased a lot.

In the first case (R = 80), the average difference is 4.8 and the maximum one is 10.1 with global success reward; and without it 6% and 14% respectively. We can appreciate a great improvement here but it's not very impressive if we compare with the improvement of the second case (R = 100): average difference 4.2% and maximum difference 10.52% with global task reward, in contrast to 6.2% and 32.1% without global task reward respectively.

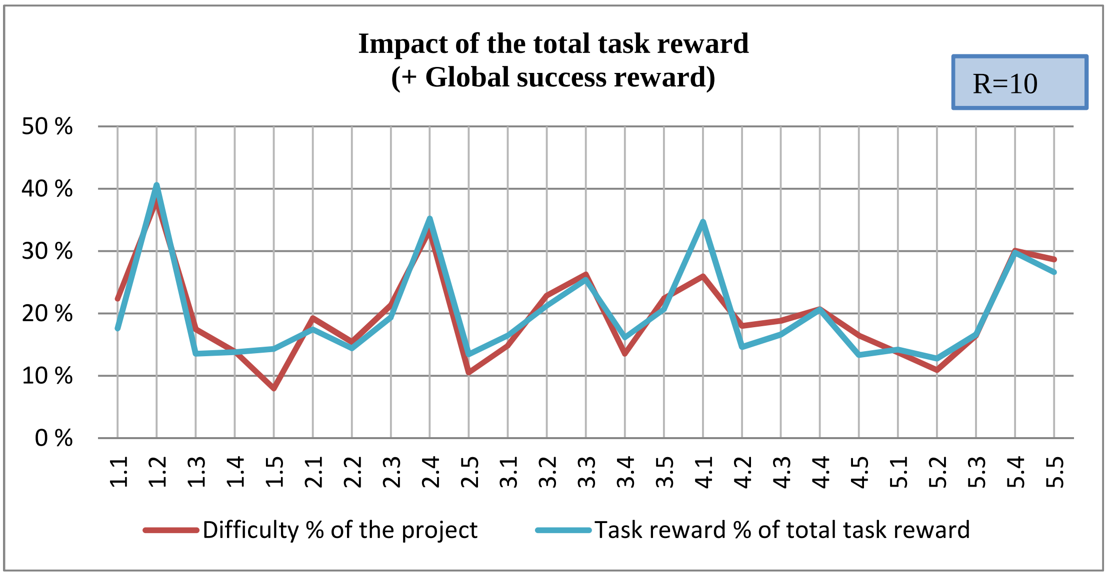

Fig. 10. Impact of the total task reward (+ global success reward) R=10

Briefly we may observe that with the lowest reward possible the numbers are similar: 2.3% average difference and 8% maximum difference with global task reward and 3.1% and 9.4% respectively without global task reward. There is a small improvement as in the other cases.

Besides those particular improvements, the global task reward reduces considerably the risk behavior of the team member, it doesn't matter the value of the total task reward.

Anyway, from now on, we are going to choose the both rewards as small as possible. The reason is simple: in a real situation, any company doesn't want to pay to the team of a project more money (or any other type of reward) than the project deserves. So generally we are going to use adjusted rewards in the next simulations, as it is described in the next equation:

$$R = 3\frac{N(D_L + 2\sigma_p)}{S_L}$$

Where D_L and S_L are the maximum value of the possible values of the difficulties of the tasks and the skills of the team member respectively (for instance if the difficulties are randomly distributed between 1 and 10, D_L = 10 or if the skills are randomly distributed between 1 and 20, S_L = 20). The σ_p, even if it was not studied until now, should be included because that factor will influence the maximum difficulty in extreme cases.

5.2 Study of the impact of the preferences and difficulties values

Now we are focus our attention in the impact of the team members' preference values in the distribution. Continuing with the study we started previously, we are going to compare the task reward's fraction of the total and the fraction of the difficulty associated to that task of project total difficulty.

In these simulations we are going to include one parameter that we didn't use in the previous ones, the team members' preferences (σ_s will remain zero). The skill and the difficulty will remain a random variable between 1 and 10 and there will continue being 5 team members and tasks.

The standard deviation of the preference (σ_p) will have the following values: 0.5, 1, 1.5, 2, 2.5 and 3.5. As in the previous simulations, there will be 5 simulations for each of those values for the total task reward (and for each simulation the value of the 5 team members). In the abscissa of the next figures there will be two numbers (X.Y); the first one (X) represents the simulation number of the series; and the second one (Y) represents the task number.

Characteristics of the next simulations:

Simulation Name: Influence of team members' preferences

Number of members: 5

Total task reward: 16.5 / 18 / 19.5 / 21 / 22.5 /

Global success reward: α =0.1; Maximum 10

Skill: Randomly distributed [1,10]

Difficulty: Randomly distributed [1,10]

Preferences: Normal distribution, media $\mu = 0$, standard deviation σ_p = 0.5/1/1.5/2.5/3.5.

X.Y represents: X for the simulation number in the series and Y for the task number.

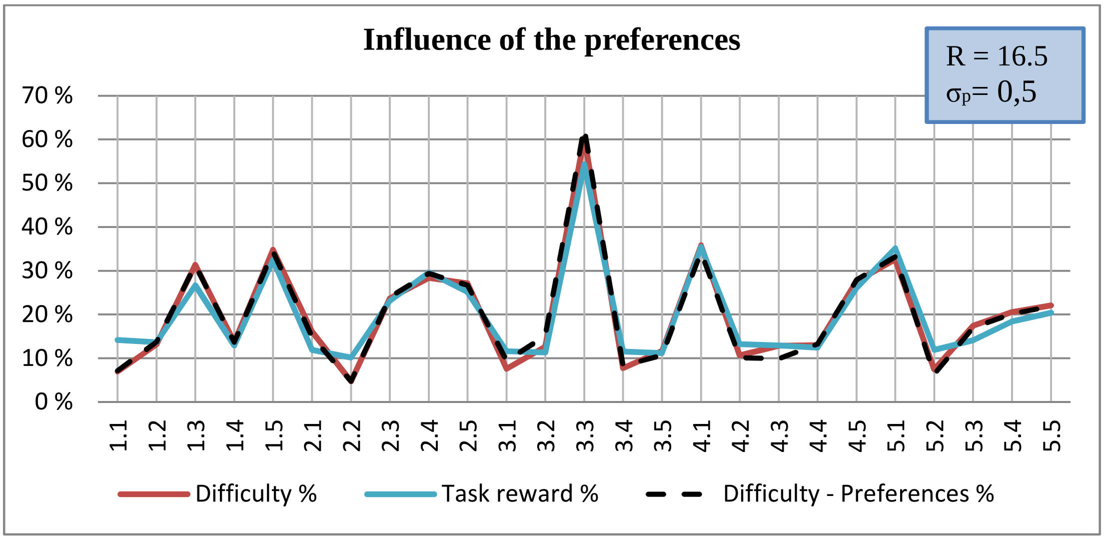

Fig. 11. Influence of preferences. (R=16.5; σ_p= 0.5)

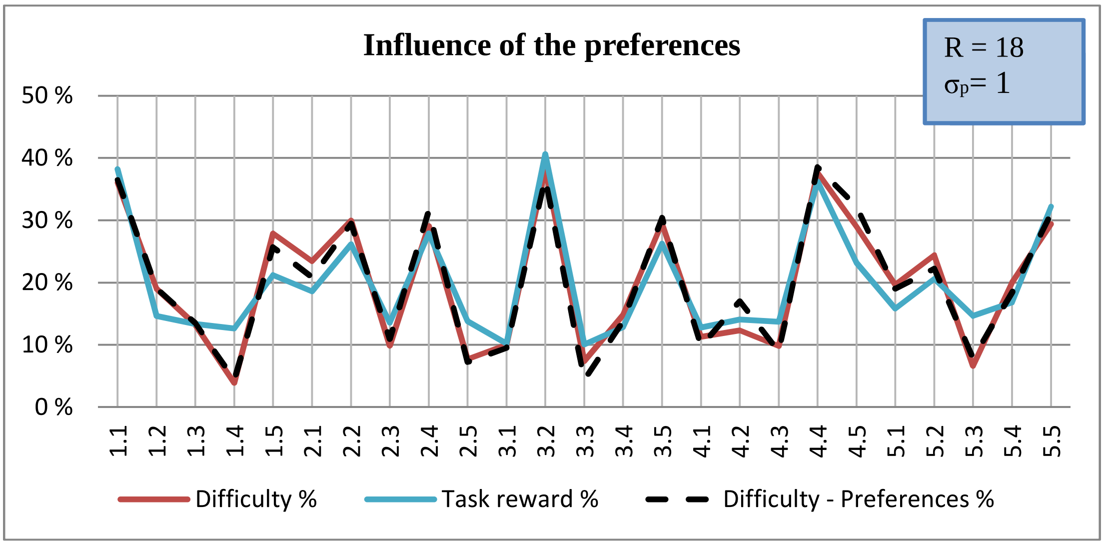

Fig. 12. Influence of preferences. (R=18; σ_p= 1)

As it may be observed in the figures 11 and 12, with a σ_p lower than 1, the task rewards assigned to each task and the task difficulties have approximately the same proportion. This is because the influence of the preference parameter is very small, almost zero (the dotted line is nearly identical to the red line).

The average difference in the simulation with σ_p= 0.5 (figure 11) is less than 2.6% with a maximum value of 7.23% and a correlation of 0.97 in both cases (if we compare the reward with the difficulty only or with the difficulty modified by the preferences).

In the second case (figure 12), the simulation with σ_p= 1, the average difference between the percentage of the difficulty of a task in the whole project and the task reward of that task in the total task reward is 3.53%, the maximum value of that difference is 8.72% and the correlation between the rewards and the difficulties (modified and unmodified) is 0.92 also in both cases.

In these cases the result is the expected: the distribution has a strong relation with the difficulty and even better with the difficulty modified by the team members' preferences.

The errors are mainly concentrated in the "extreme difficulties", tasks with the highest and lowest values. Also, in the low-difficulty tasks the errors are more important due to their small percentage in the total difficulty of the project.

When we are in this type of distribution of parameters, this model is able to analyze the difficulty if every task. That may be very useful when one company has the similar set of task many times. After using the method certain number of times the company will be able to form better adjusted project teams, to assign them better to different projects and also it will be able to create more equilibrated tasks.

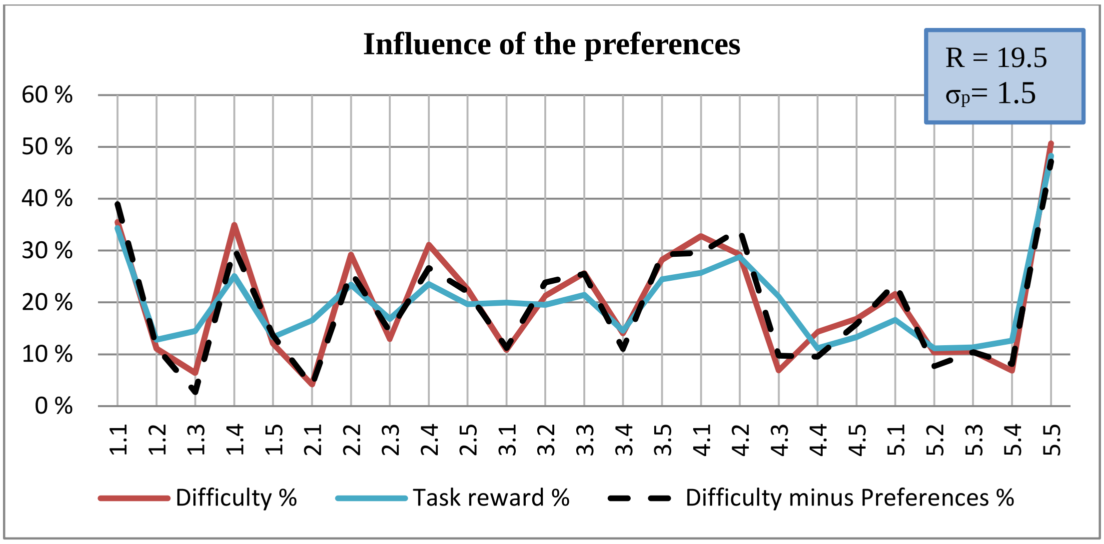

Fig. 13. Influence of the preferences. (R = 19.5; σ_p= 1.5)

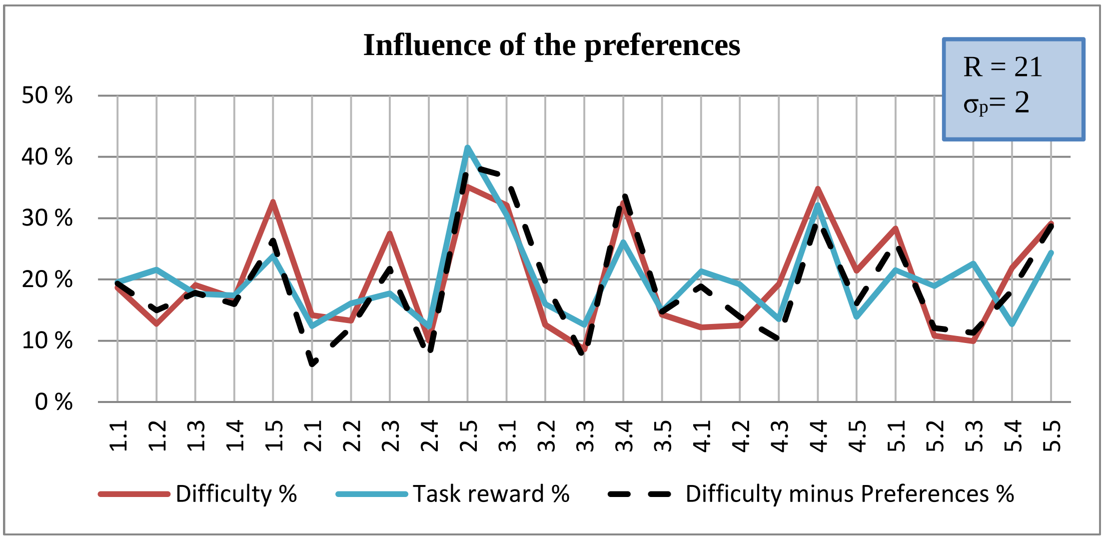

Fig. 14. Influence of the preferences. (R = 21; σ_p= 2)

Now it may be observed in the figures 13 and 14, with a σ_p of 1.5 and 2, the task rewards assigned to each task and the task difficulties starts to have the different proportions. In the simulation number 3 of the figure 13 and the number 1 and 5 of the figure 5, the shapes of the rewards and the difficulties don't correspond to each other.

The average difference in the simulations with σ_p= 1.5 (figure 13) is less than 4.69% with a maximum value of 14.24%. The correlation values are 0.865 (compared with difficulty, red line) and 0.88 (compared with difficulty mines preferences, dotted line).

In the second case (figure 14), the simulation with σ_p= 2, the average difference between the percentage of the difficulty of a task in the whole project and the task reward of that task in the total task reward is 5.31% and the maximum value is 12.65%. In this case the correlation continues with its reduction: 0.698 if we compare the reward with the difficulty only or 0.845 with the difficulty modified by the preferences.

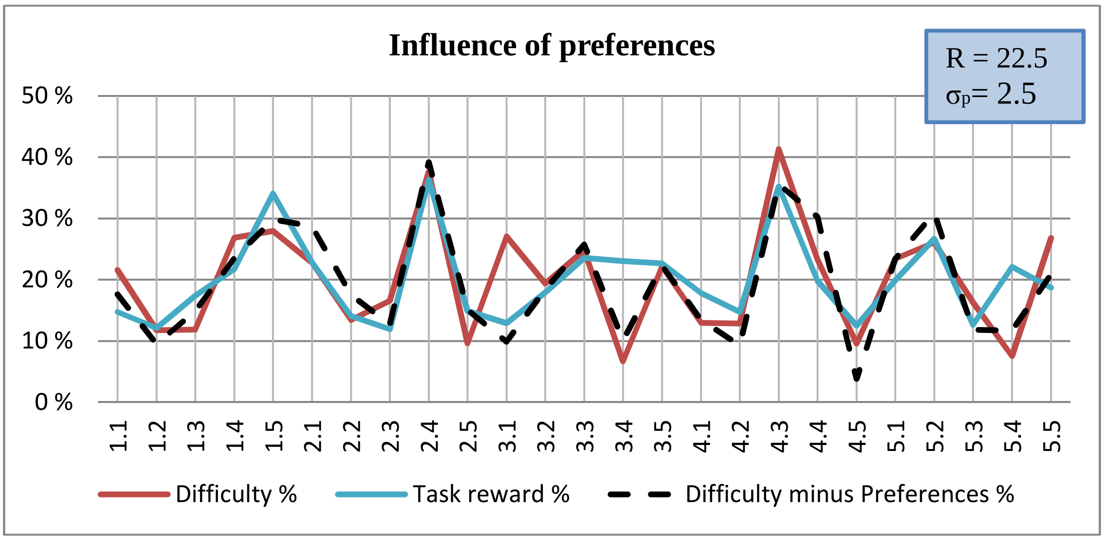

Fig. 15. Influence of the preferences. (R= 22.5; σ_p= 2.5)

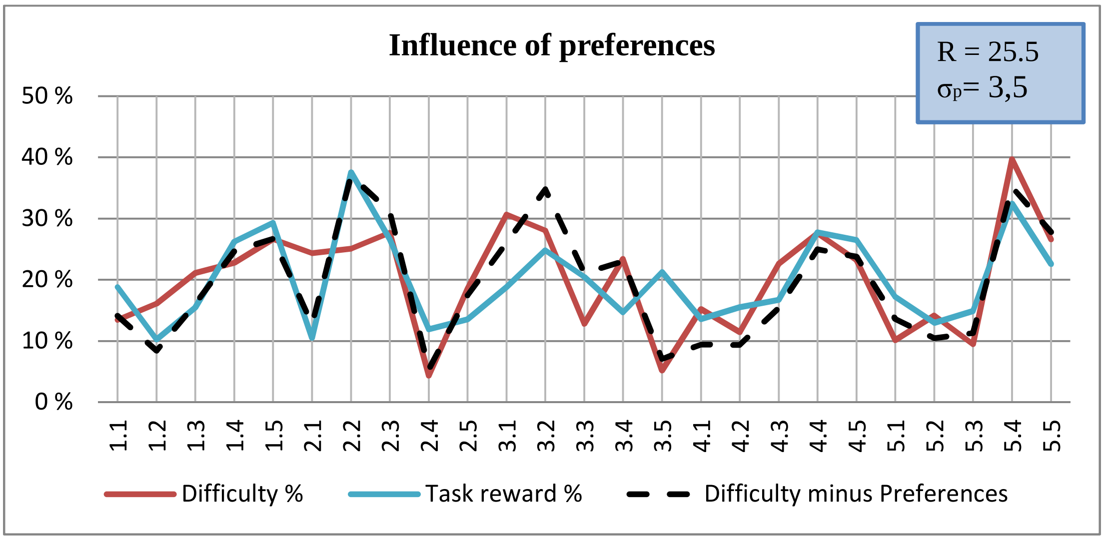

Fig. 16. Influence of the preferences. (R= 25.5; σ_p= 3.5)

Finally it may be observed in the figures 15 and 16, with a σ_p of 2.5 and 3.5, the task rewards assigned to each task and the unmodified difficulties don't have any similar proportions but there is still a relation with the difficulties modified by the preferences. The correlations are: for the first case (figure 15) 0.681 and for the second case (figure 16) 0.578 (compared both with red line, difficulty alone). The correlation with the modified difficulties (compared with dotted line) is 0.83 in both cases.

The average difference in the simulations with σ_p= 2.5 (figure 6) is 4.78% with a maximum value of 16.34%.

In the second case (figure 16), the simulation with σ_p= 3.5, the average difference between the percentage of the difficulty of a task in the whole project and the task reward of that task in the total task reward is 6.02% and the maximum value of that difference is 16.12%.

Even if there is a huge difference between both values, that doesn't mean an error in the method, it's just limitation. When preference is big enough (compared to the distances between different difficulties), the ruling parameter of the model is not the difficult, it's the preference, a much more random parameter.

In other simulations (not right now) we are going to compare the performance of the method and compare it with a classical distribution. There will be able to see if even with this limitation this distribution method is an improvement over the classical distribution.

Now we are going to continue studying the influence of different range of difficulty. We expect that the influence of the preference parameter will be reduced; but there will be also other side effects to have in consideration (for instance, if difficulty range is increased, the total task reward should be increased too).

Characteristics of the next simulation:

Simulation Name: Influence of task difficulty range

Number of members: 5

Reward: 20.25 / 27.75 / 35.25 / 50.25 / 65.25 / 80.25

Skill: Randomly distributed [1,10]

Preferences: Normal distribution, media $\mu = 0$, standard deviation σ_p= 3.5

X.Y represents: X for the simulation number in the series and Y for the task number.

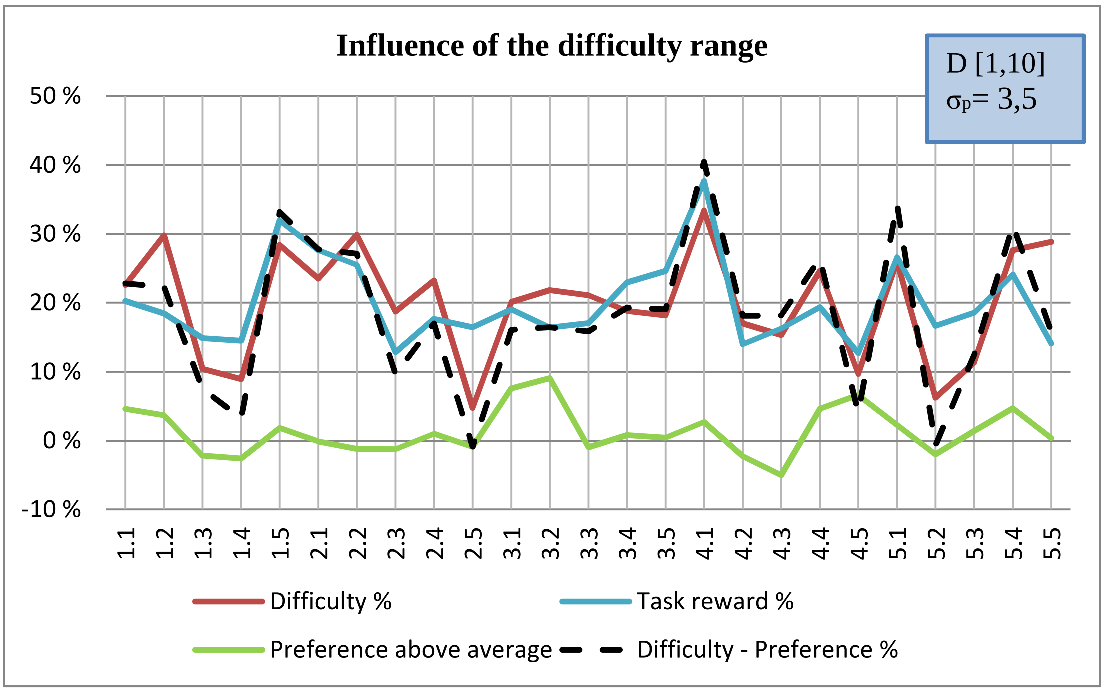

Fig. 17. Influence of the difficulty range. (Difficulty range [1, 10], σ_p= 0.5)

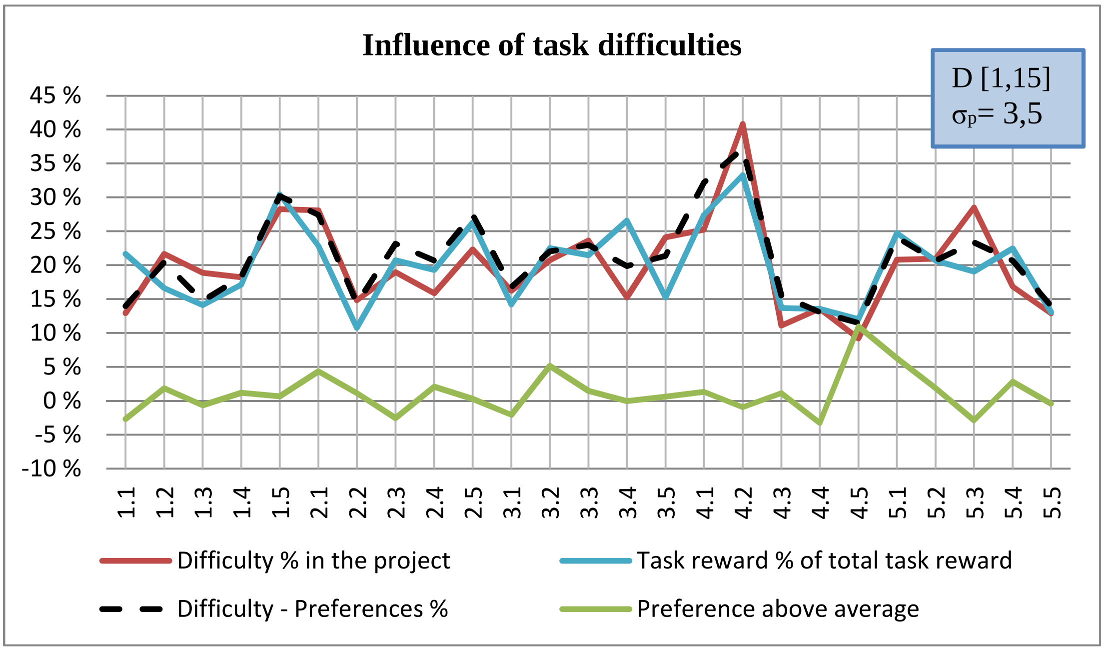

Fig. 18. Influence of the difficulty range. (Difficulty range [1, 15], σ_p= 3.5)

The figure 17, with a σ_p of 3.5 and a difficulty range from 1 to 10, has a result similar to the figure 16. That was expected because they have the same simulation values. In the case of figure 18, there is only a small increase of the difficulty range so any significant improvement may be observed.

The correlations are 0.613 (figure 17) and 0.69 (figure 18) if we compare the reward with the difficulty only but, if we compare it with the difficulty modified by the preferences, the correlations are 0.815 and 0.867 (figure 17 and 18 respectively). These difference between modified and unmodified difficulties are caused because the influence of the preference parameter is still too important compared to the difficulties values.

The average difference in the simulations with rage 1-10 (figure 13) is less than 4.03% with a maximum value of 11.30%. The sum of all the preference values gives us 27.78 above the average.

In the second case (figure 14), the simulation with range 1-15, the average difference between the percentage of the difficulty of a task in the whole project and the task reward of that task in the total task reward is 3.484% and the maximum value is 11.02%. In this case the value of preferences above the average is 31.88.

In these cases the result is the expected: the distribution has a weak relation with the difficulty but a strong one with the difficulty modified by the team members' preferences.

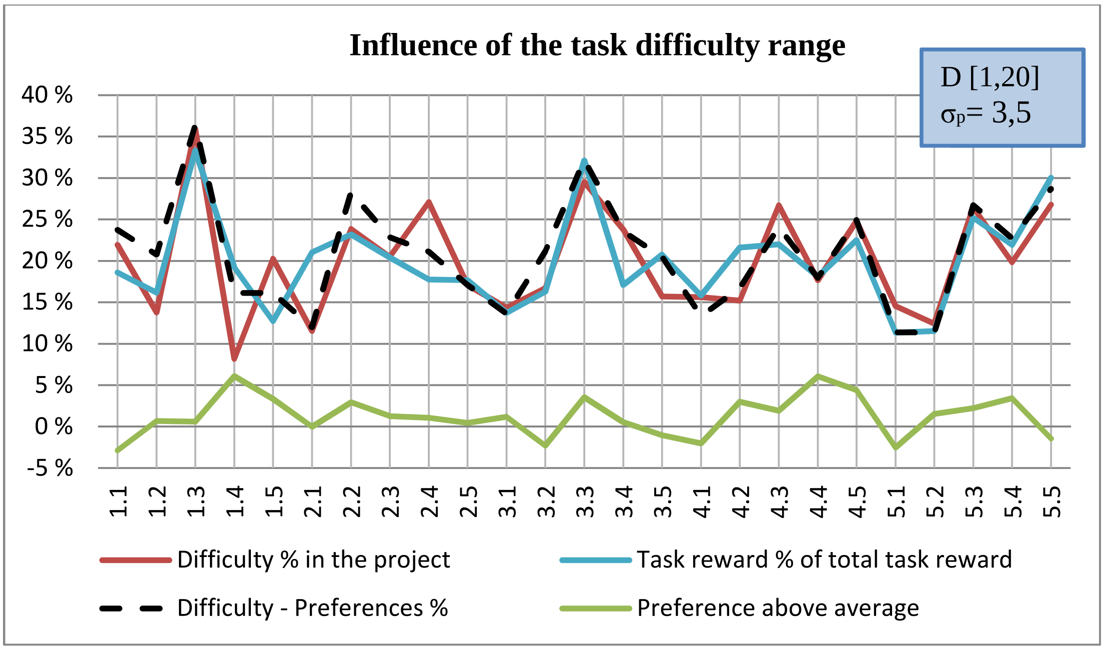

Fig. 19. Influence of the difficulty range. (Difficulty range [1, 20], σ_p= 3.5)

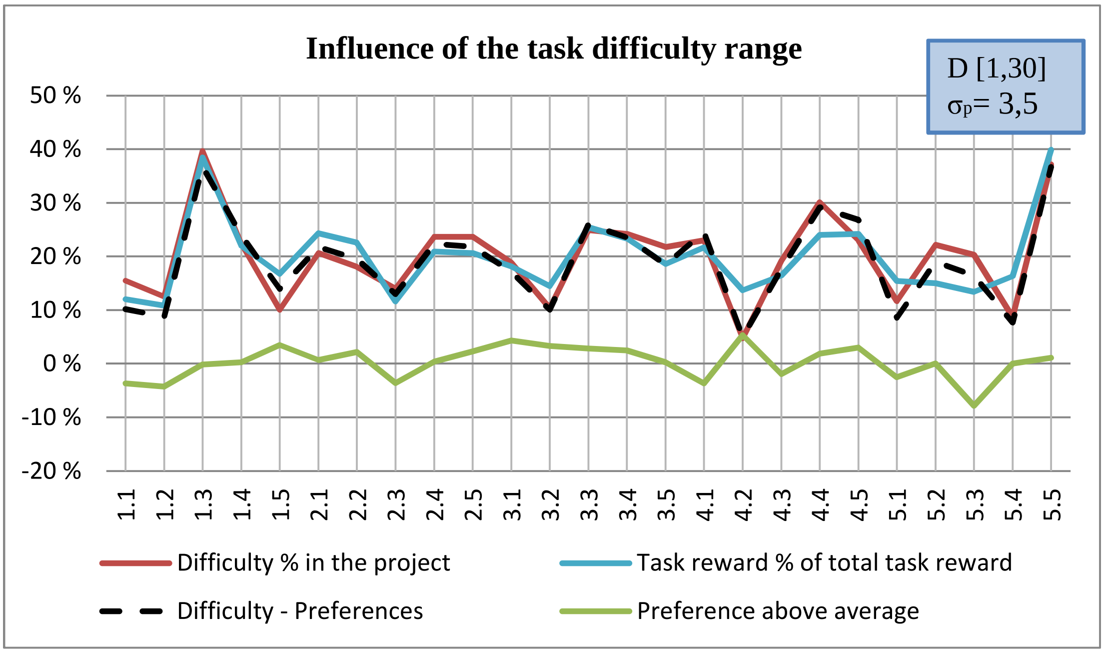

Fig. 20. Influence of the difficulty range. (Difficulty range [1, 30], σ_p= 3.5)

Now it may be observed in the figures 19 and 20, ranges of 1-20 and 1-30, shapes of the task rewards similar to each task and the unmodified difficulties. Now the difficulty factor is strong enough to have high correlation factors: 0.7 and 0.85 (figures 19 and 20). But correlation with the modified difficulty is higher: 0.846 and 0.9.

The average difference in the simulations with range 1-20 (figure 19) is 3.48% and maximum value of that difference is 11.02%.

In the second case (figure 20), the simulation, with range 1-30, the average difference between the percentage of the difficulty of a task in the whole project and the task reward of that task in the total task reward is 3.51% and the maximum value of that difference is 8.94%.

The preferences above the average are 3.811 and 6.31 for the figure 19 and 20 respectively.

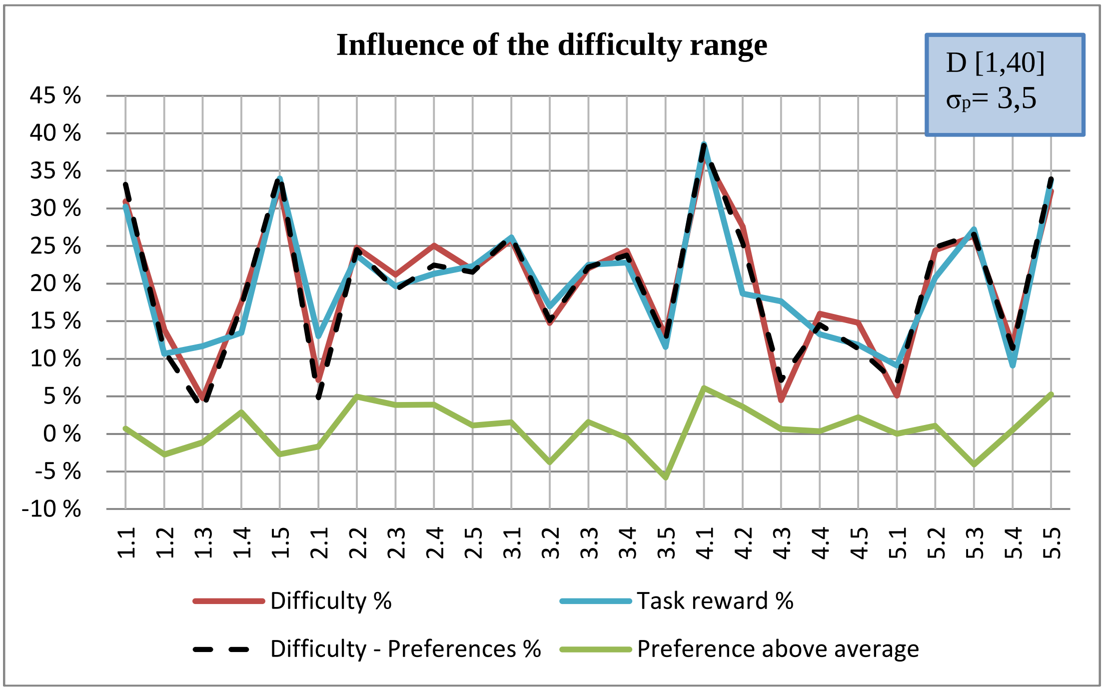

Fig. 21. Influence of the difficulty range. (Difficulty range [1, 40], σ_p= 3.5)

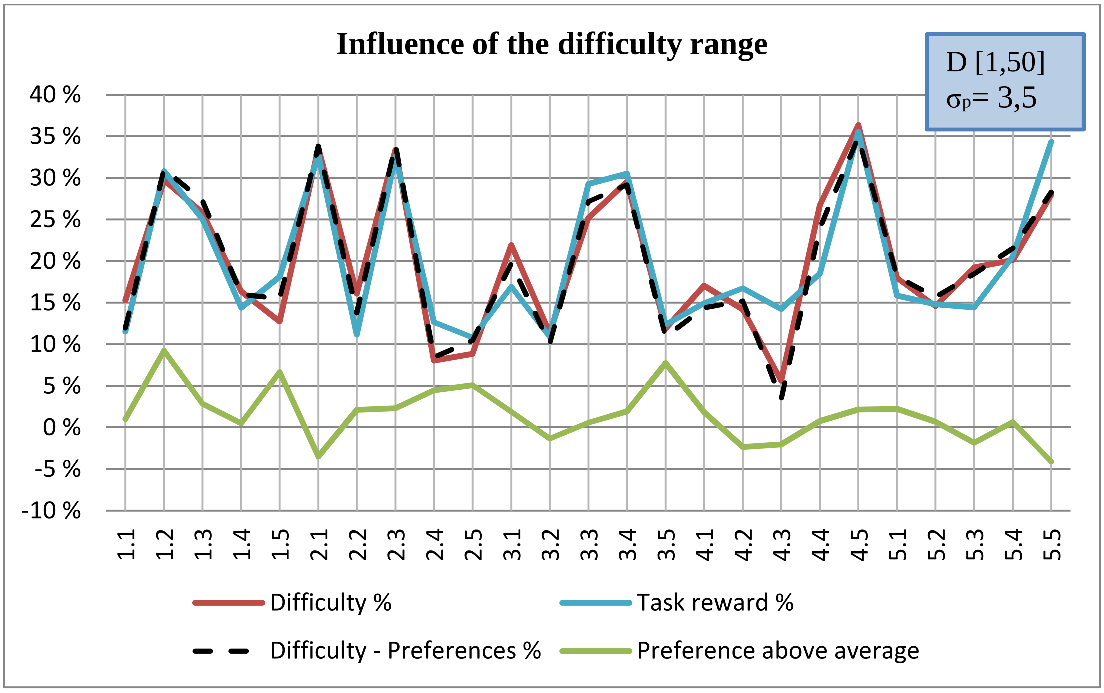

Fig. 22. Influence of the difficulty range. (Difficulty range [1, 50], σ_p= 3.5)

The figure 21, with a difficulty range 1-40, has correlations of 0.88 (without modification) and 0.92 (modified by preference). The average difference is 3.07% with a maximum value of 13.30% (simulation 4.3). The sum of all the preference values gives us 18.05 above the average.

The figure 22, with a difficulty range 1-50, has correlations of 0.9 (without modification) and 0.93 (modified by preference). The average difference is 2.93% with a maximum value of 8.61%. The sum of all the preference values gives us 39.84 above the average.

The distribution has a strong relation with the difficulty and still a stronger one (but almost the same) with the difficulty modified by the team members' preferences. As it was expected, the importance of the team members' preference is diluted by the bigger difficulties of the task.

5.3 Study of the impact of the number of team members

The next parameter under study is the number of team members and tasks. It is seem to be an important factor, but it is not critical at all. The reason for that is for the decision making process, in the way we defined it, there is not influence of the number of team members (only the average value of their votes) and very little influence of the number of tasks. Essentially the team members try to find a “safe solution” of the task distribution process and they adjust their votes in other to have the same utility, doesn’t matter which task they receive.

Anyway we are going to repeat few previous simulations, but now with 20 team members, in order to extract enough data to be able to demonstrate our assumption. That number of team members were chosen because it is generally agreed the maximum number of team members for self-managing teams.

For the next simulations the difficulties and the skill will be defined as a random variable between 1 and 10 and there will be 20 team members and tasks. We will simulate first without preferences (σ_p= 0). The total task reward will be 60 following our previous criteria about that matter.

For each of those values for the total task reward, there will be 2 simulation series (and for each simulation the value of the 20 team members and task). In the abscissa of the next figures there will be two numbers (X.Y); the first one (X) represents the simulation number of the series; and the second one (Y) represents the task number.

Characteristics of the next simulations:

<u>Number of members:</u> 20

<u>Total task reward:</u> 60

<u>Skill:</u> Randomly distributed [1,10], $\sigma_s = 0$

<u>Difficulty:</u> Randomly distributed [1,10]

<u>Preference:</u> 0

<u>X.Y represents</u>: X for the simulation number in the series and Y for the task number.

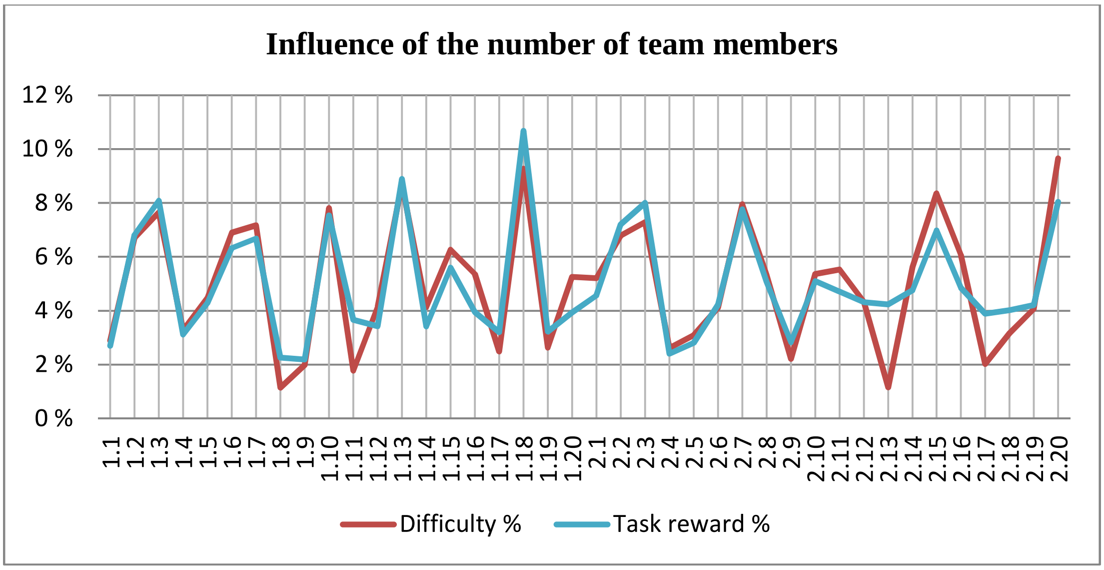

Fig. 23. Influence of the number of team members with preference = 0

As we expected there is an average difference of 0.72 between the reward and the difficulty in each task. The maximum value of that difference is 3.08. Those numbers are very hard to compare with the previous one because the scale is totally difference: with 20 tasks (with difficult randomly distributed) the contribution of each task to the total is smaller.

On the other hand, the correlation can be compared to the previous ones. The correlation is: 0.91, we found similar values in same simulation with 5 members.

Next we are going to simulate two extreme situations with preferences and difficulty ranges. One with strong preference and low difficulty range another one with strong preference and high difficulty range. The difficulties will be defined as a random variable between 1 and 10 in the first case and between 1 and 50 in the second case. The standard deviation for the preference (σ_p) will be 3.5 in both cases.

There will be 20 team members and tasks and the total task reward will be 102 in the first case and 342 in the second case.

Characteristics of the next simulations:

<u>Number of members:</u> 20

<u>Total task reward:</u> 102 and 342

Skill: Randomly distributed [1, 10], $\sigma_s = 0$

Difficulty: Randomly distributed [1, 10] and [1, 50]

Preference: Normal distribution, media $\mu = 0$, standard deviation σ_p= 3.5

X.Y represents: X for the simulation number in the series and Y for the task number.

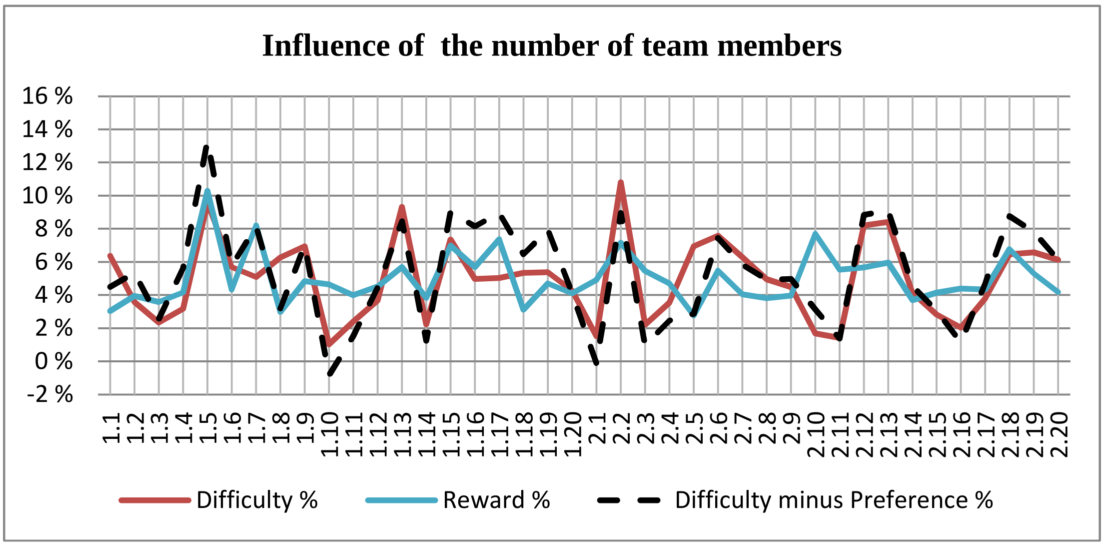

Fig. 24. Influence of the number of team members, σ_p= 3.5 and difficulty [1, 10]

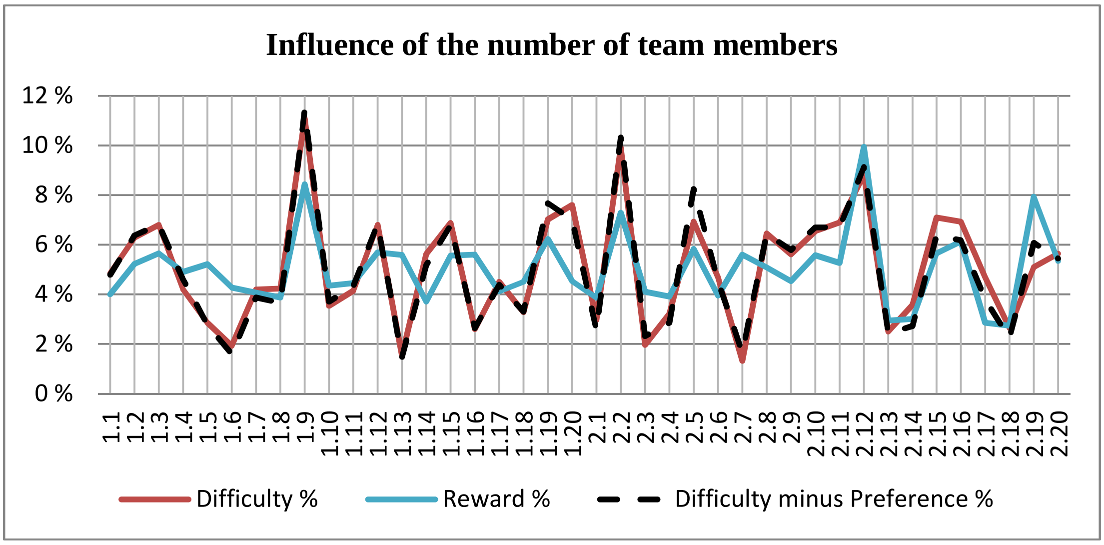

Fig. 25. Influence of the number of team members, σ_p= 3.5 and difficulty [1, 50]

The figure 24, with a difficulty range 1-10, has correlations of 0.4 (without modification) and 0.68 (modified by preference). The average difference is 1.97%

with a maximum value of 6%.

The figure 25, with a difficulty range 1-50, has correlations of 0.71 (without modification) and 0.75 (modified by preference). The average difference is 1.41% with a maximum value of 4.27.

The values of the figures 24 and 25 are significantly worse than in the cases of the values of the simulations of the figures 17 and 22 respectively. That is because the accumulative preference value for each task can be bigger with bigger numbers of team members. In other words, generally the preference sum of all the team members for one particular task would be close to zero because there are some positive preferences and negative preferences. But sometimes, for instance, there are only positive preferences (or the negative preferences are very small), so the sum would be much bigger than zero, creating a distortion effect in that particular task. That effect is multiplied by the number of tasks so it's more important with 20 member than with 5.

5.4 Study of method performance

Once we know the behavior of the model under different conditions, we are going to compare our distribution method with an external agent's distribution. The performance of both will be measured and compared.

The external agent will organized the team member by skills and will assign them in order of skills to the task in order of difficulties. At the end, every member will receive a part of the equal part of the total task reward.

The external agent doesn't know the skill values of the team members exactly. There is a "subjectivity distortion". The skill value the external agent perceives S_i^* is a normal distribution with mean equal to the actual value S_i of the team member i and with a standard deviation of σ_S.

The external agent has also a personal opinion of the different tasks P_j^*. In order to make the whole system simpler, the personal opinion has the same distribution as the preference parameter (P_{ij}) of the team members.

As we commented before defining the model, also the team members don't know their own values exactly. Their "subjectivity" skills are a normal distribution with mean equal to the actual value S_i and with a standard deviation of σ_m.

We are going to compare the satisfaction of the team member after finishing the task and receive the task reward. And also we are going to compare the probability of successes of each task.

In the first series of simulation, σ_m and σ_e will be 0, just to check how the distribution method works compared to the "classical" distribution performed by the external agent.

The difficulties and the skill will be defined as a random variable between 1 and 10 and there will be 5 team members and tasks.

For each of those values for the total task reward, there will be 150 simulations.

Characteristics of the next simulation:

Simulation Name: Performance without skill subjectivity.

Number of members: 5

Reward: 18

Skill: Randomly distributed [1,10]

Preferences: Normal distribution, media $\mu = 0$, standard deviation σ_p= 1

Abscissa represents: Simulation number (1-150)

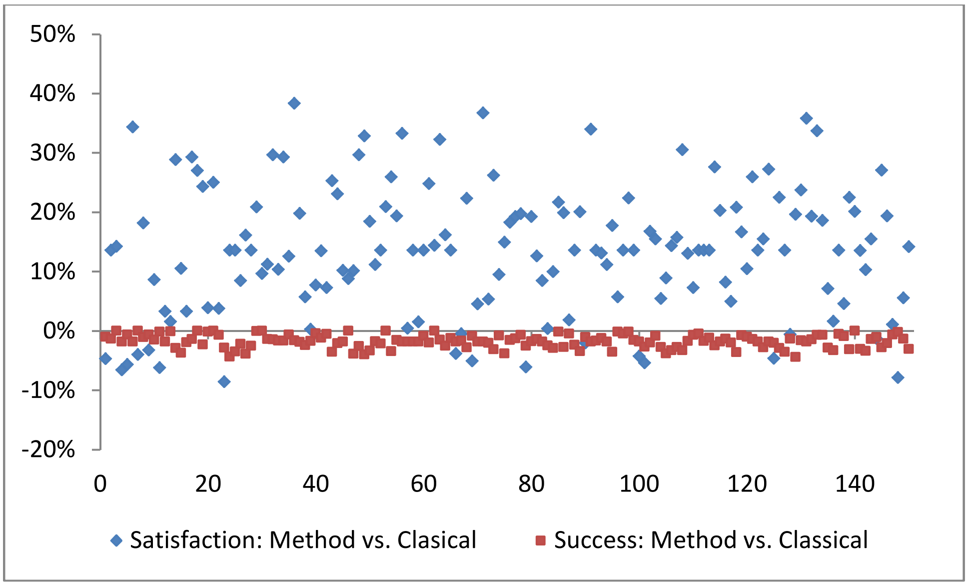

Fig. 26. Satisfaction and success comparison (no skill subjectivity)

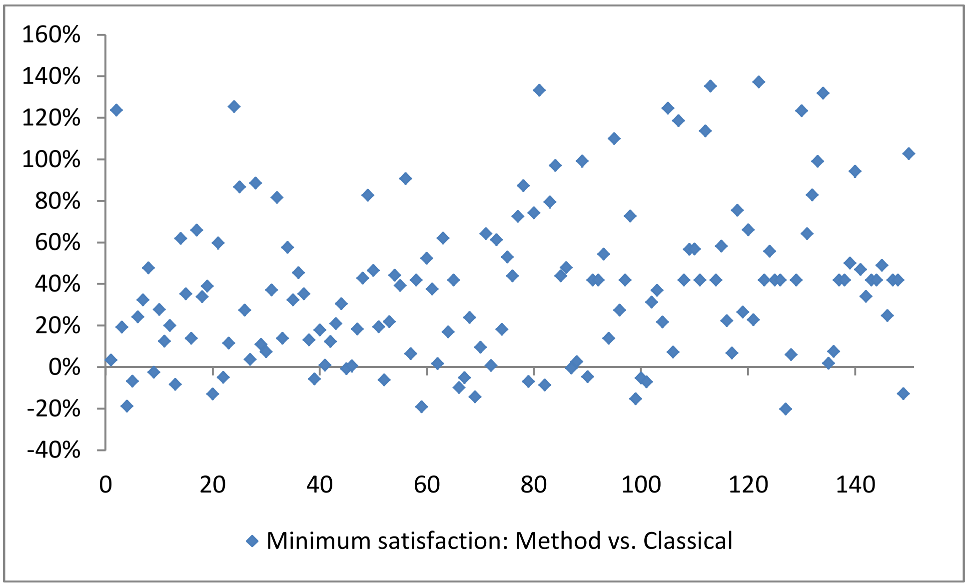

Fig. 27. Lowest satisfaction within the team comparison (no skill subjectivity)

The average satisfaction difference between the method and classical task distribution is 13% and the average success is -1.7%. The minimum satisfaction value difference average is 39.4%.

In the next series of simulation, σ_m and σ_e will be a random variable, from 1 to 20, the same for both of them. We are going to check how the distribution method works compared to the “classical” distribution performed by the external agent with increasing subjectivity.

The difficulties and the skill will be defined as a random variable between 1 and 10 and there will be 5 team members and tasks.

For each of those values for the total task reward, there will be 200 simulations.

Characteristics of the next simulation:

Simulation Name: Performance without skill subjectivity.

Number of members: 5

Reward: 18

Skill: Randomly distributed [1, 10]

Preferences: Normal distribution, media $\mu = 0$, standard deviation $\sigma_p = 1$

Abscissa represents: , σ_m and σ_e values [1, 20]

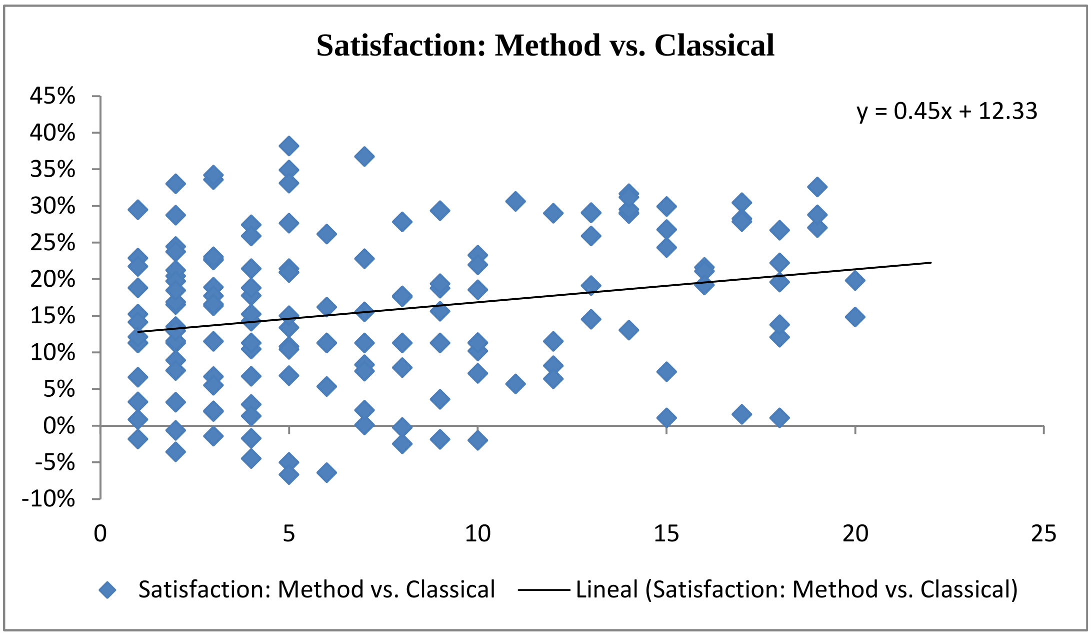

Fig. 28. Satisfaction comparison (variable subjectivity)

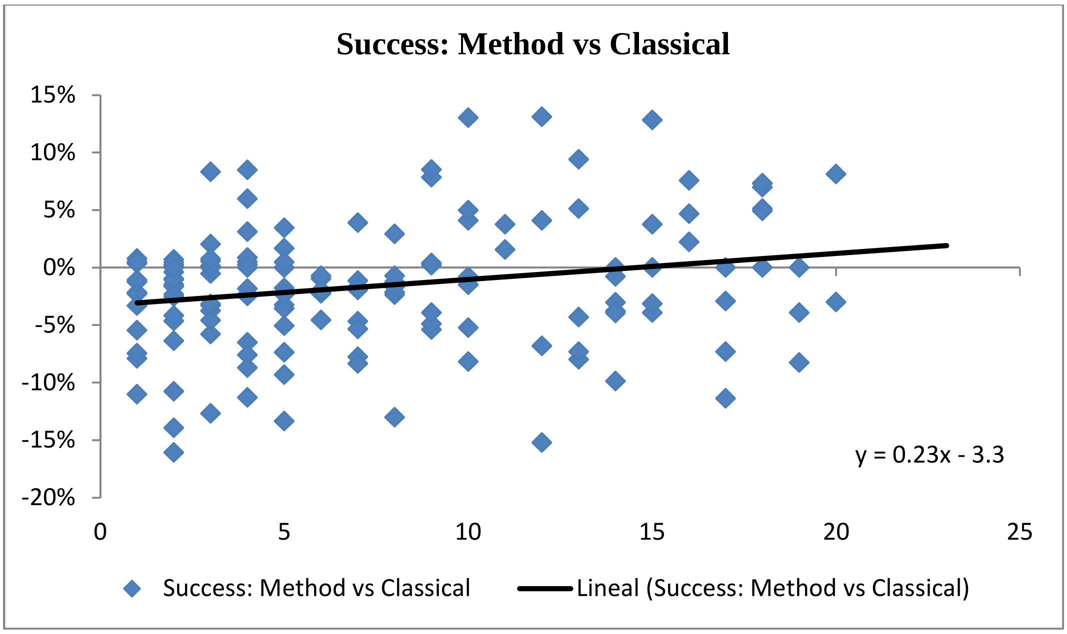

Fig. 29. Success comparison (variable subjectivity)

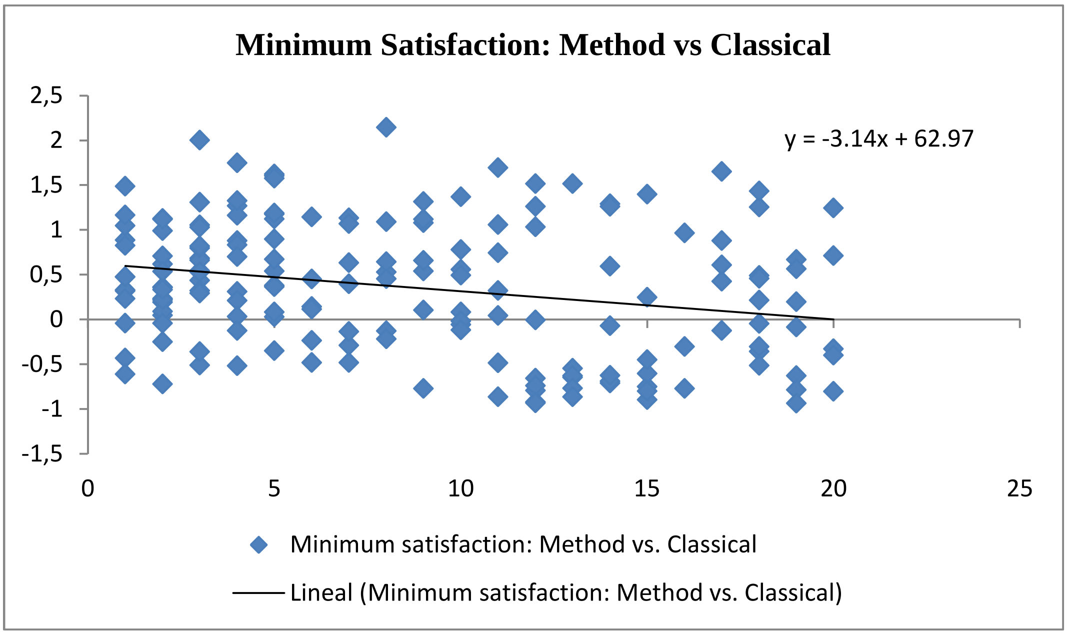

Fig. 30. Minimum Satisfaction comparison (variable subjectivity)

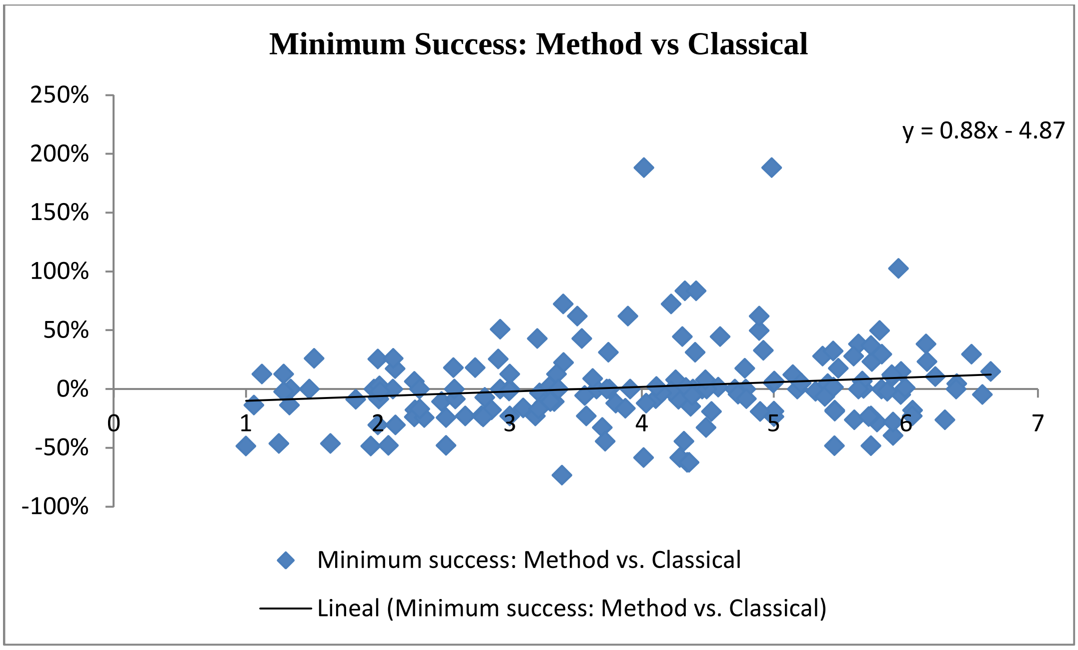

Fig. 31. Minimum Success comparison (variable subjectivity)

Now with a subjectivity constant in both cases (σ_m=σ_e=1) we are going to study the performance of the method compared with the classical distribution. The standard deviation of the team members' preferences will be equally distributed random variable from 1 to 7.

As in the previous case, the difficulties and the skill will be defined as a random variable between 1 and 10 and there will be 5 team members and tasks.

For each of those values for the total task reward, there will be 200 simulations.

Characteristics of the next simulation:

<u>Simulation Name:</u> Performance with variable preferences.

<u>Number of members:</u> 5

<u>Skill:</u> Randomly distributed [1, 10] σ_m=σ_e=1

<u>Preferences:</u> Normal distribution, media $\mu = 0$, standard deviation σ_p [1, 7]

<u>Abscissa represents</u>: preference standard deviation σ_p

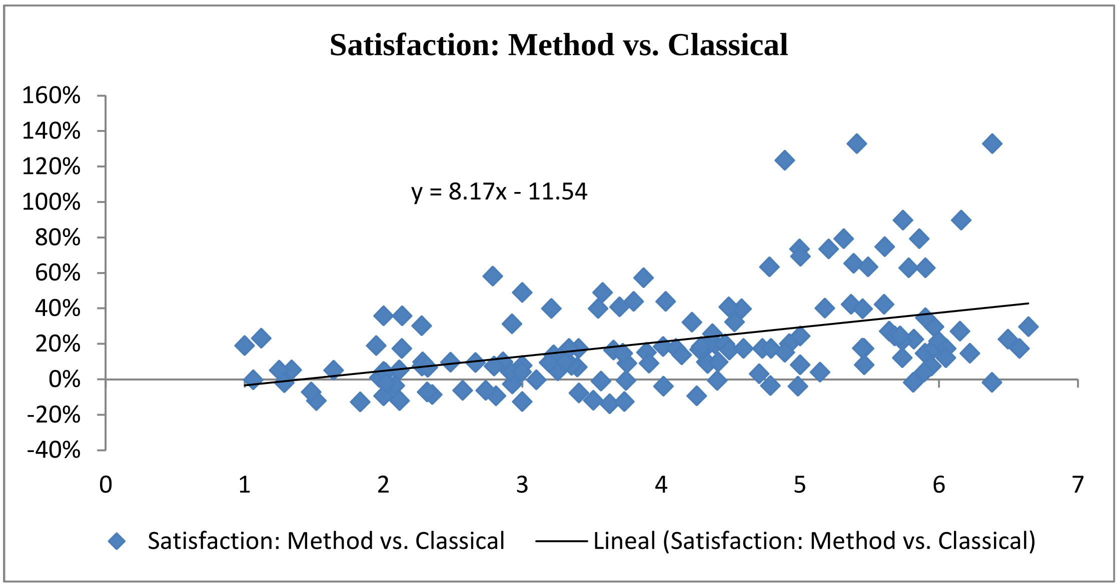

Fig. 32. Satisfaction comparison (variable team members' preferences)

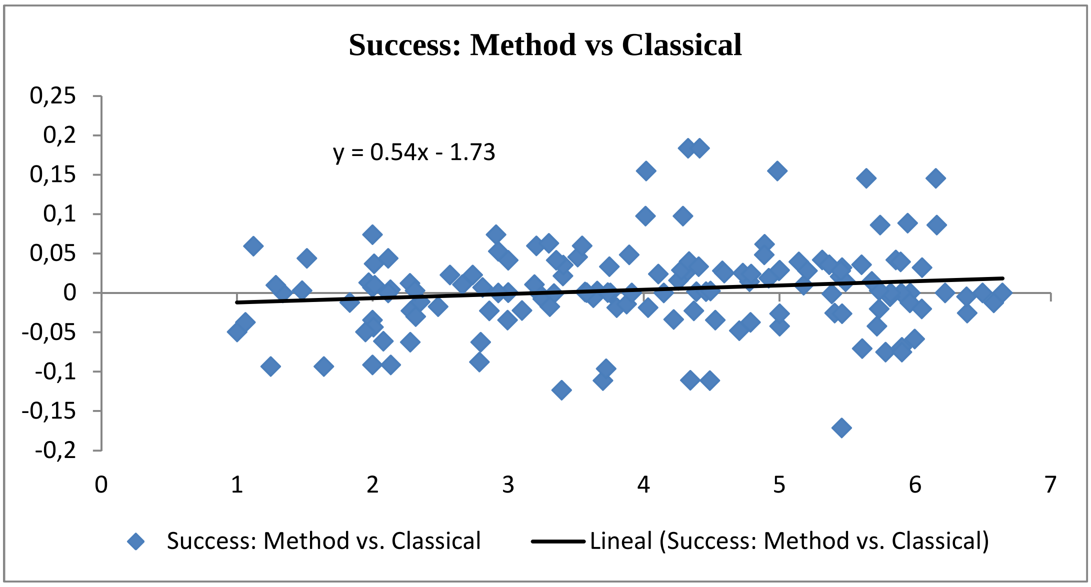

Fig. 33. Success comparison (variable team members' preferences)

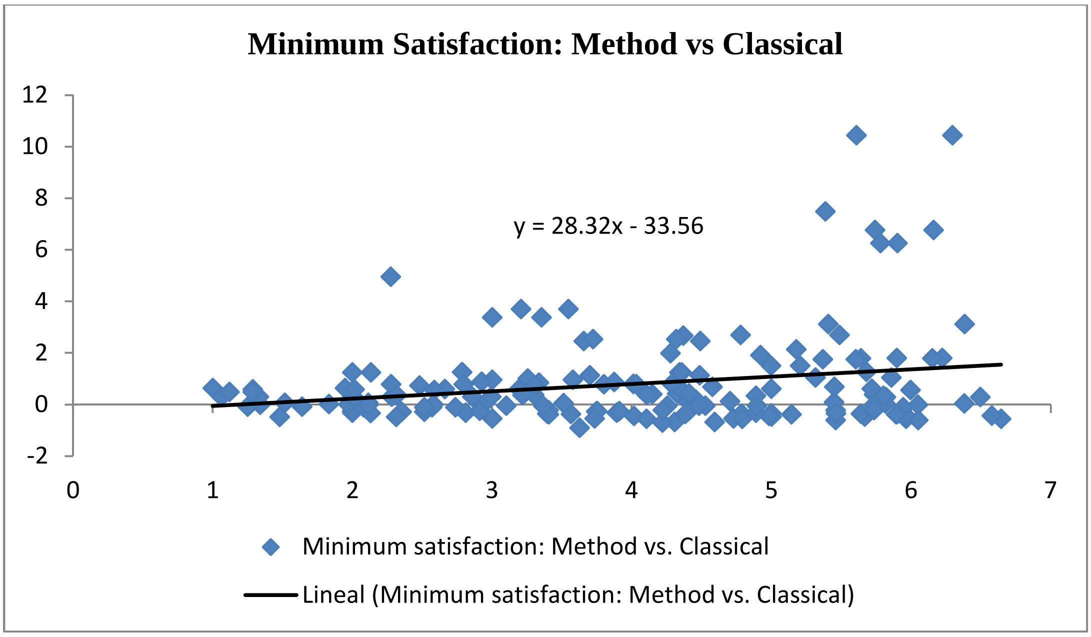

Fig. 34. Minimum satisfaction comparison (variable team members' preferences)

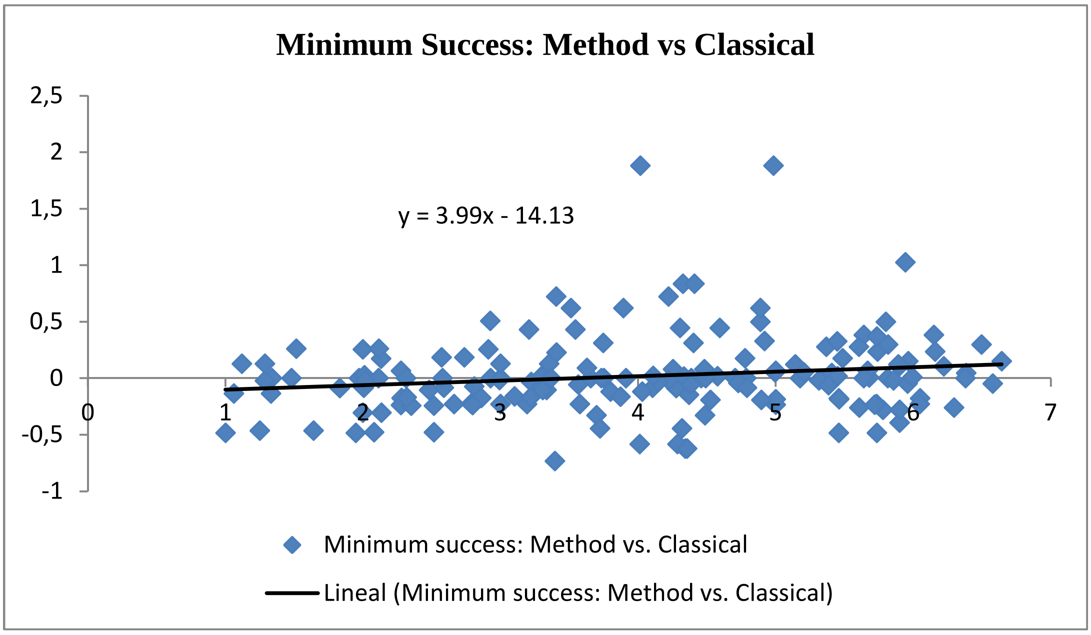

Fig. 35. Minimum success comparison (variable team members' preferences)

6 ANALYSIS OF THE METHOD

This chapter will report the findings from the analysis derived from the description of the method and simulations of the model. These results will point to the conclusion of what are the plausible problems and restrictions this method will face under different situations. In addition this chapter will consider and suggest the responses to those problems and restrictions.

6.1 Basic method characteristics

First we are going to check if the method, as we described it, fulfils the required condition:

- Specify responsibilities clearly: It's clear the limits of the responsibilities of the team members and the managers.
- Provide adequate authority and specify limits of discretion: The managers should respect the results of the method
- Specify reporting requirements: The project manager has to make a big effort specifying very clear the requirement of the task the team members have to perform. "… the project manager defines the requirements for each task. Any criteria of good requirement could be used (for instance, they shall cover all the aspects of the SMART criteria). Even if it's not possible to define clearly each task (it's very common to find ambiguity and non-defined areas at the beginning of the many projects), the project manager shall remark those non-well defined tasks. Wherever there is a possible change in the requirements of the task should be identified, because it's an important factor to be considered by the team members".
- Ensure subordinate acceptance of responsibilities: The team member received a lot of responsibility and the method remark the importance of that "It is very important that the people (specially the team members) involved in this process understand the implications of the method they have and how it works. Because essentially, the team members are taking a lot of responsibility in the task and reward assignation, and the managers are delegating their power. Both must be aware of it and they must agree to take the possible consequences".
- Inform others who need to know: This is a key factor in the method, "the project manager may prepare a briefing with the team members about the project and the tasks."
- Monitor progress in appropriate ways: As we commented in the third chapter,

“From the moment that the information is delivered, the project manager has a passive role in the distribution process.” And “…even if he is not specifically part of the team it is required his support of the team during the whole project”.

- Arrange for the subordinate to receive necessary information: “The aim of this briefing is to provide to the team member receive the necessary information to understand the difficulties the each task. Depend of the complexity of the project; more information may be delivered to the team member in form of hand-outs, software, digital or online documentation”. So the need of correct and complete information is completely clear.
- Provide support and assistance, but avoid reverse delegation: The managers will provide support in many ways but, as we commented, before the result of the method has to be accepted. It is not allow the intervention except for a clear case of tactical voting.
- Make mistakes a learning experience: The team member could know and understand better their abilities if they are part of the process of choosing the task. Team members are forced to analyse their abilities with each vote and the error will teach them more about themselves. Unfortunately this topic is not deeply studied in this thesis.

We continue summarizing the information provided by the simulations, we method had the following characteristics:

1. The global task reward is essential because if there is no a reward encouraging the work as team (in our method the global reward), the method incentives the individualism and its effectiveness decreases.
2. In situations without influence of the team members’ preferences, the method provides an excellent measure of the task difficulties.
3. The reward has a high correlation with the difficulty modified by the preference of the team members, no matter the value of the preference.
4. In average the method fulfils members’ preferences. When team members in average received a task, in general, they have more preference in that task than the average of the whole team members.
5. In ideal situation the method provides much better satisfaction and minimal

difference respect to the optimal distribution in term of relation skill-difficulty.

6. Under increasing uncertainty conditions, the method provides increasing performances and satisfaction.
7. Under increasing preference importance, the method provides increasing performances and satisfaction.

6.2 Basic method restrictions

Summarizing analysis we performed before about the distribution method we found the following restrictions:

1. All the team members should be able to perform all the tasks of the project.
2. The tasks with lowest and highest difficulties trend to have higher and lower rewards respectively. Medium difficulties trend to have more accurate task reward.
3. There is inverse proportion between the team members' preferences importance and the accuracy of the distribution of the rewards.
4. There is a "limit distortion" due to there is a maximum and a minimum value the team member can vote.

6.3 Complex methods

Now we are going to develop different distribution method in order to solve the different problem we described before:

6.3.1 Some members are not able to perform some tasks.

For that problem there are few solutions. If there is only one task and one team member with that problem, the first possible solution is to continue working with the method exactly in the same way. The member should vote 1 for that task and consequently he is not going to receive that task a least that task is the last one to be assigned and that team member is the last to be assigned. In this case that member will be interchange with the member assigned to the last task but one.

Another solution, when few team members cannot perform one or more tasks, is to have a special vote (Not able, for instance) for those cases where those team members have to vote those tasks. The method will distribute the task starting with the task with more special votes and continuing until there are no more tasks with those special votes. Those special votes will have a particular weight (for instance, 0.5, 0 or -1) when team rates are added up.

In the case that there is only one member that can perform one particular task or one task can only be performed by one particular member, that task will be assigned to that member and the normal distribution process will start without that team member and that task. When the task rewards have to be assigned to each task, the one assigned before the normal distribution process will receive a reward according with its situation. If there was only a member who could perform it, then it will receive the same reward as the maximum task reward of the normal process (or even more that depends of the nature of the task). If the team member could only perform one task, then it will receive the minimum task reward (or even less, as in the previous case, depends of the nature of the task).

6.3.2 Incentives for the hardest rewards

The main causes of the distortion in the highest and lowest tasks are two: the limit range of votes and the greedy effect (moderated but no eliminated with the correction of the global success reward).

If that task is really critical for the project and its difficulty deserves more reward, one solution of the problem is to keep one part of the total task reward without distribution and assign it to the hardest task (project manager's opinion). Also that extra reward could come from the excess of the task reward with lowest difficulties.

In other words, the team rates will be pondered by certain factor. That factor could come from the project manager or be a formula (for instance, the maximum rate will receive 10% more votes and the minimum rate 10% less).

6.3.3 Multiple questions

If a high accuracy in the distribution (difficulties with proper abilities) is very important and the influence of the team members' preferences is considerable, we need to separate their preference and the skills.

With this complex method the team member will answer two questions instead of just one. The first: “What do you think it is ability level for this particular task compared with your team?”; and the second: “How much do you want to be assigned to this particular task?”

Doing that the different factor that influence the team members’ behaviour may be analysed separately.

6.3.4 Distribution process by members skills

As we studied before, there is a problem with the assignment of the task when the skill is very low compared with the average skill. One solution for that case is to distribute of the task by skills instead of distribution by difficulty.

Starting with member with highest sum of votes, if one unassigned task has its highest vote from that member, it will be assigned to him, if there is no task fulfilling the previous condition, this member will not be assigned at that moment and continuing with the next member with the highest sum of votes. When a member receives one task, that member cannot be assigned to another task. The next member for assignation will be the member with the second highest sum of votes and the process is repeated. In case of a tie between two or more task with the same vote form that member, this member will not assigned in that moment. This member will receive a task when there is only one of the tasks of the tie still unassigned. The flowchart of the assignations is the follow:

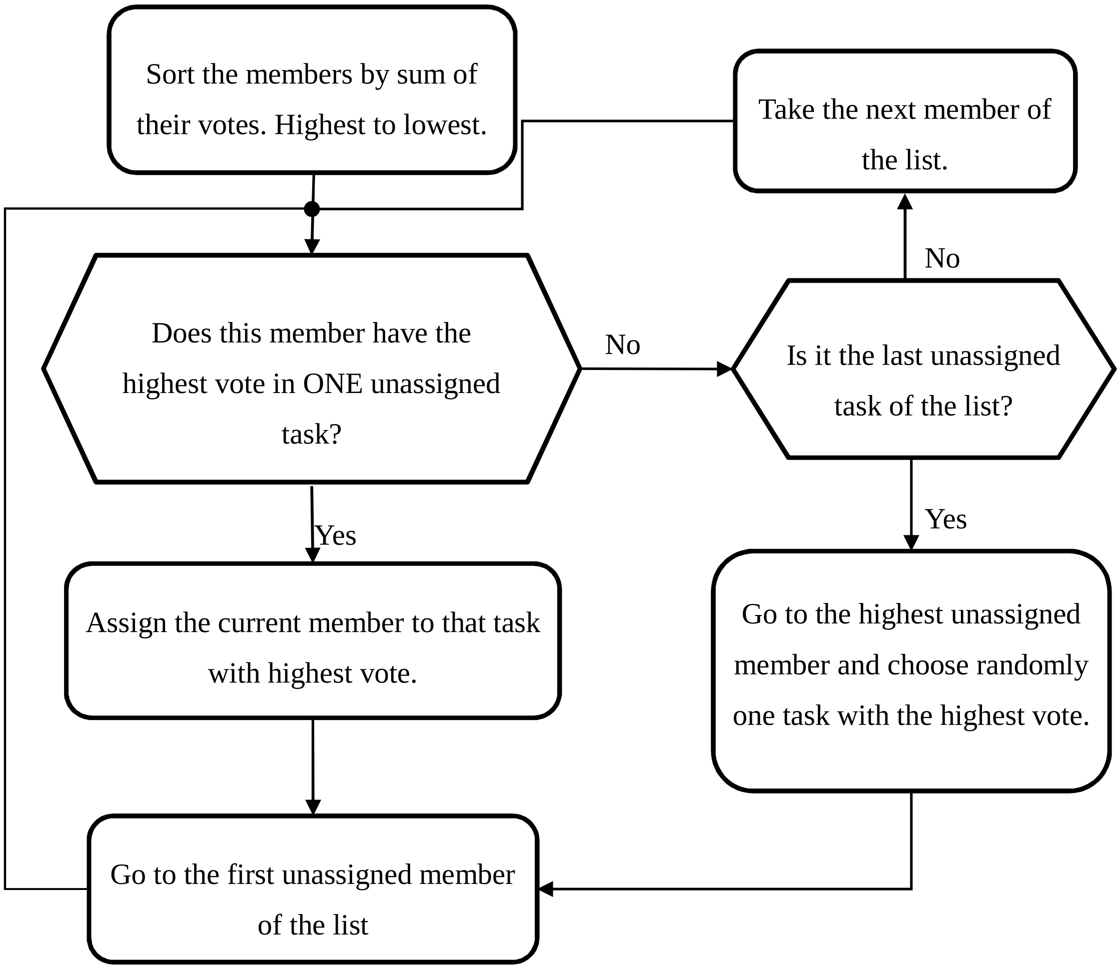

Fig. 36. Flowchart of the assignation process by skill

This assignation process has its disadvantage, it is more sensitive a preferences. The team members are sorted by the sum of all their votes, assuming their skills form them. In the ideal situation (without preferences) that is true but with similar skill and strong preferences, that is not true at all.

6.3.5 Manager supervision of the distribution process

If the managers have doubts about the possible outcome of the distribution process, they might use the vote and the distribution of reward but they might distribute the team member among the task with their own criteria.

It is different from the surveillance of the manager in the basic method; there they want to assure the correct working of the project. Here they interfere because they expect better result even if there is no fraud.

Those managers with fear to lose the control of the task assignment, but they are looking for a method for distributing the rewards, will find very helpful the data provided by this method. Mainly in situation where the preferences are not very important and there is a big difficulty variation in the tasks or a big skill variation in the team members.

Essentially the method will work in the same way, and the manager may interference with the distribution process as much as they want: altering the task between two or more team members, deciding the order of importance of the tasks before distributing, choosing one team member for a specific task, etc.

7 CONCLUSION: IMPLICATIONS AND LIMITATION

As the title of this chapter suggests, the discussion here will approach our experimental findings from three different perspectives. First we discuss limitations in the research and how they can be addressed. Then we consider the implications of our work. Finally, we propose a plan for investigating in the lines opened in this thesis.

7.1 Research limitation

The current research acknowledges a few limitations that should be noted to help with interpretation of the results. Essentially the search limitations come from the model design, the measurement design and sample size.

The current thesis employed an economic model in order to forecast employees' votes. The validity of this research lies on the model design. As long as the model is valid, the research will be valid. A preliminary experiment, performed in order to test the results provided by the model, with a group of 5 people, provides some support to the model design. But those situations, where the model doesn't predict the behaviour of the team members, cannot be covered by this study.

To work with human behaviour is to walk into marshlands. There is an incredible amount of factor to be considered: many input variables, collateral relations, cultural influence, etc. The ideal complement for this research would have been to develop set of experiments in other to deal with all those non-linear factors. Unfortunately, time limitations made it impossible.

But even with its limitations, the model design provides a huge amount of meaningful information about the method covering many situations in a very cost/efficiency way; and, of course, experiments are not free of limitations.

Same arguments may be written about the measurement design but in this case are not so relevant. The key factor now is which parameters are relevant enough to be measure and compared. From the early stage this thesis has worked with economic model behaviour but when we are going to transform a monetary unit to satisfaction or task success the link is not clear. So the study is limited to those cases were satisfaction of team members and task success have a linear relation with the parameters we have modelled in our measurement design.

Finally a small sample size might carry distortion on the results. As any other work with random variables, the results should be interpreted under the perspective of a statistical approximation. In general terms, the trend of a series of results is more important than a specific individual result, and those ones cannot be extrapolated to a general case.

7.2 Research implication

Despite limitations of the current research, the findings of the current research make a simple but valuable contribution to the field of project management and self-managing teams.

As we commented before, one of the main problems for failure of self-managing teams within these organizations has been the lack of clear working methodologies. Some leaders saw this as an excuse to delegate more work and gave away many of their unwanted duties only to burden the staff with tedious responsibilities without considering the necessary training and experience.

With this method, an organization has an easy to use tool. It may be a pivotal point where the organization may test and develop their self-managing team system.

7.3 Further research

The main direction of the future studies should be the expansion of the validity and reliability of the research results.

As we commented before some experiments and testing implementations are without any doubt the next step after this thesis.

Continuing working in theoretical layer, the research should be focus in improving the model and the measurement design. Also more comparatives and studies of scenarios will develop the work started in this thesis. A good starting point may be the complex model described in the chapter 6. We expect that those models may solve many problem of the basic distribution model but there is not theoretical or experimental evidence supporting that assumption. More simulations and analysis covering those areas are our preferable next step and an excellent supplement for this thesis.

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