A quasi-experimental approach to determining success criteria for ICT projects

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Abstract

Since the 1960's many authors accepted the triple constraints (time, cost, specification) as a standard measure of success and this still appears to be extremely important in evaluating the success of ICT projects. However, a project cannot always be seen as a complete success or a complete failure. Moreover, the parties involved may perceive the terms “success” or “failure” differently. The authors have set up a quasi-experiment (gaming) in order to determine the criteria used by the different parties involved to judge the success of an ICT project.

The results of this quasi experiment were analysed using both linear and non-linear techniques (e.g. general linear models and probabilistic feature models for frequency data – PMD-models)

This research indicates that the impact of the triple constraints on the judgement of success is rather small. Other criteria, as there are user happiness and financial or commercial success are far more important. Furthermore, parties who’s involvement ceases after the handover tend to concentrate more on budget and satisfying the parties involved, while the other parties concentrate more on time, specifications and financial or commercial success, which is a long-term criterion.

1. Introduction

Since the 1960's many authors accepted the triple constraints (time, cost, specification) as a standard measure of success and this still appears to be extremely important in evaluating the success of ICT projects [1,2,3]. It is assumed that if a projects completion time exceeds its due date or expenses overrun the budget, or outcomes do not satisfy a company's predetermined specifications, the project is a failure.

However, determining whether a project is a success or a failure is far more complex [4]. The triple constraints as such are not sufficient to base the judgement of an ICT project upon. To start with, projects cannot always be seen as completely successful or completely failed [5]. Moreover, different parties involved (e.g. management, projectteam, users, supporter, stakeholders) might perceive the project’s success differently [6]. But even among individuals of the same party, opinions might vary, since every individual has his/her own set of criteria against which the project is measured and these may be very subjective [7].

Furthermore, not every criterion can be measured at the same time. Some criteria can only be assessed long after the determination of the project [8]. Consequently, the perception of the project’s success may evolve over time. A software package may seem very promising at the handover, and consequently the project that lead to the development of this package may be judged very positively, while the actual commercial results may alter this perception profoundly.

Nevertheless, in order to examine ICT projects in a quantitative way, criteria should be formulated to distinguish between good, mediocre and failed projects. This set of success criteria should be a well-balanced combination of criteria measured at different stages of the project, reflecting the different viewpoints of the parties involved.

This paper is a first step in that direction. A quasi-experiment (gaming) was set up in order to determine the set of criteria used by the different parties involved to judge the success of an ICT project. Twenty-six experts were asked to participate. They are either employees or consultants for two large Belgian electricity distributors and are well acquainted with ICT-projects. The experts were asked to rate 25 project descriptions that were developed by the authors. This resulted in 650 datapoints, which were
examined using both linear and none linear statistical procedures.

2. Literature review

As Fowler & Walsh [7] state, the definition of the concept of ICT success is, in itself, potentially problematic. There is no consensus on the criteria for ICT project success, except for three standard criteria - meeting time, meeting budget and meeting requirements [8,9].

Several authors suggested enhancing this list with additional criteria. Four groups of additional criteria can be distinguished. A first group of criteria are technical in nature (maintainability, computer operations function, technical performance etc). These criteria were important until a decade ago. The shift from supporting technology to enabler and the increasing impact of ICT provoked a shift from more technical to more management-oriented criteria [10,11].

A second group are criteria that are related with hypes (ex. meeting quality levels was a much-used criterion at the time when TQM became popular). This group of criteria clearly reflected a specific (IT)-management concern.

The third group incorporates the viewpoints of the parties involved, other than the project managers. The triple constraints are often perceived as being too short-term and too much reflecting the project managers’ view [3,5]. Therefore, criteria like “sufficient benefits for the owner” and “satisfying user specifications” were added to the set of criteria to measure success.

A fourth group of criteria enters perceptions into the evaluation. The recognition that the perceived success is of paramount importance to the eventual success of ICT projects regardless the actual return [3,12] lead to a set of criteria that contains criteria like “favourable attitudes towards the system on part of the users”, “happy users & sponsor” [5,13].

Not every party involved in an ICT project uses all these criteria to judge success. The set of criteria is different for every party and often contains a combination of criteria from the different groups. Turner [3] states that the management (owner / sponsor) is primarily interested in the benefits the product brings. Time, cost and specifications are constraints that effect their judgement because they influence the benefits of the project, but they are not the primary concern [3]. Management is thus interested in the triple constraints, but only to the extent in which they contribute to the expected gains.

Users feel that the system delivered should meet their requirements and that they should be happy with the system [5]. Their objective is usually to obtain the best (not optimum) product, at any price. They will not perceive a project as a failure if it is implemented a few weeks too late or over budget.

Project managers are focusing on the short-term criteria (the triple constraints) that are set by the management because the sponsor judges them on meeting the triple constraints [7]. This behaviour is amplified if their involvement ceases after the handover [3]. Comparing the view of the project manager and the management, one notices that the project manager is primarily concentrating on short-term, process related criteria (Will we finish on time and within budget?) where the owner is concentrating on longer-term, product related criteria (Will the end result deliver gains?) [5].

Since the distance between the supporters (people that supply resources or services to the project in one form or another) and the project manager is smaller than the distance to the owner, the supporters will usually be more concerned about satisfying the project manager then satisfying the owner [3]. They are thus more concerned about the short-term objectives of the project. The stakeholders’ group (people affected by the project, but who receive no direct benefit from it, nor have direct influence on it) exists out of many different subgroups, all with their own goals and objectives. It comes as no surprise that a typical project will have some stakeholders who will support it and some who oppose it [2].

3. Research objectives

The goal of this research is to discover the set of success criteria that are used by the different parties involved in intra-organisational ICT projects. This should lead to a better understanding of the way in which projects are judged. This knowledge can provide information that is of primordial importance in the search for success factors. Furthermore, it can help management to approve their management methods regarding ICT projects.

4. Research design

Seven possible success criteria are selected. This selection is primarily based on the work of J. Wateridge [5,9,14]. Besides the triple constraints, the list is extended with criteria of group 3 and 4.

- On time
- Within budget
- To specification
- Users happiness
- Projectteam happiness
- Management happiness
- Financial or commercial success
In the next step, twenty-five project descriptions are developed. Each description contains these seven criteria. Some criteria are fulfilled, others are not. The descriptions are constructed in a way that the weight of the different criteria in a story had to be more or less the same. Over- or under-stressing a criterion could cloud the expert’s judgement. Moreover, the criteria are not stated openly. Proxies are used (example: in one of the descriptions “management happiness” was translated as “The management showed their gratitude by offering the project team a bonus”. The aim is to avoid that the experts develop an explicit theory by which they judge all cases. No other criteria are introduced into the stories in order not to distract the attention from the seven criteria selected. It was made sure that there was no substantial correlation between the criteria (bivariate Pearson correlations range from –0,351 to 0,342).

After the development of the descriptions, 26 persons were selected to participate in this quasi experiment. These persons are well acquainted with ICT projects and are either employees of one of the two large electricity-distributing companies that were participating, or consultants working for these companies. These persons are referred to as “the expert group”. This group could be divided into four subgroups:

- Management: they represent the parent organization. They provide funds and are the main benefactors of the project.
- End users: the users operate the outcome of the project on behalf of the management to achieve benefits.
- Project team members – benefactors: this group contains people who are members of the project team. They are responsible for planning, organizing, implementing and controlling the ICT project. They receive long-term benefits from the project (this group contains for example project team members that return to their department after the handover of the project to work with the new application).
- Project team members – no benefactors: as with the previous group, this group contains people that are members of the project team. But their involvement ceases after handover. They have no long-term benefits from the project (they may be allocated to other project, or they are consultants whose involvement terminates after handover).

During five consecutive days, the experts received an email with five project descriptions and were asked to judge the project’s success based solely on the information provided. They were asked to reply by email within 24 hours (e.g. before the next set of descriptions arrived) to avoid comparison between answers. Furthermore, for pragmatic reasons it was easier to engage the experts for a limited amount of time every day compared to a situation where they were engaged during several consecutive hours. They were asked to state if the project was a success or a failure and to rate the success on a scale from 0 - 100. This resulted in 650 data points. On the sixth day, the experts received a list of additional questions that were developed to validate the initial selection of the criteria.

Note that neither the supporters nor the stakeholders are represented in the expert group. Their impact on the project is limited and their roles very diverse. Consequently, it is highly unlikely that a set of criteria can be found that is applicable for all supporters or stakeholders. Hence, no conclusions could be drawn for these groups, based on this study.

5. Data analysis

The data was analysed using both linear models and probabilistic feature models for frequency data, which is a non-linear technique. The latter is often referred to as probability matrix decomposition (PMD)- models

The aim of selecting two different techniques for analysing the data is triangulation. If similar conclusions can be drawn from the results of both the linear and the non-linear models, the findings are enforced by each other.

5.1. Data analysis using linear models

The linear models were constructed, both using general linear model and linear regression procedures in SPSS.

The analysis was performed in two major steps. In the first step, the amount of variance caused by the differences in the project descriptions was calculated. In the next step, an attempt was made to determine which sets of criteria the different parties use and to calculate the amount of variance explained by these sets of criteria.

5.1.1. Determining the variance, caused by differences in the project descriptions

The variances in the success ratings are caused by a number of things. Differences between individuals for example, explain part of the variance (26 experts rated 25 projects: this is a form of repetitive measurement). Another part of the
variance is explained by the fact that the experts belong to groups, but the part that is of interest is the variance caused by differences in the project descriptions.

To examine this, a linear model was developed for every party. The independent variables are 24 dummies, all representing a specific case. The rating on the projects success is the dependent variable. The R² of these regression models are a measure for the variance caused by the project descriptions. The results of the regression models are summarized in table 1.

<table>
<thead>
<tr>
<th>Table 1: variance explained by project descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Party</td>
</tr>
<tr>
<td>All experts</td>
</tr>
<tr>
<td>Users</td>
</tr>
<tr>
<td>Project team members – no benefactors</td>
</tr>
<tr>
<td>Project team members – benefactors</td>
</tr>
<tr>
<td>Management</td>
</tr>
</tbody>
</table>

Note that the figures in this table are calculated after the rejection of 10 extreme influential datapoints (see infra).

Since every project description can be uniquely identified by its combination of fulfilled and unfulfilled criteria, these criteria can be used as proxies for a project description. I.e. there is a bijective (1-to-1) relationship between the project descriptions and the set of criteria. The project descriptions are constructed based solely on the seven criteria that were tested. No other criteria were entered into the descriptions. Consequently, the variance caused by the seven criteria can’t exceed the variance caused by the project descriptions. In other words, the predictive power of the models that use the seven criteria as independent variables (see infra) should be compared against the R²’s presented in table 1.

5.1.2. Determine which criteria the different parties use

The examination of the criteria used by the different parties is done in two subsequent stages. In the first stage, the seven criteria are examined without the interaction terms. It provides information on the impact of every criterion, without considering possible interplays between them. In the second stage, the models are refined by entering interaction terms. It provides a more detailed inside in the decision process of the different parties and it enhances the predictive power of the models.

In the first stage, a univariate factorial analysis of variance procedure was used to examine of the impact of the seven individual criteria on the ratings of the different parties. This technique uses analysis of variances to test whether or not every individual criterion has a significant impact on the success ratings. Moreover, it produces coefficient estimates as well, which can be used to construct a linear model. The results of these tests are presented in table 2.

<table>
<thead>
<tr>
<th>Table 2: General Linear Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>(constant)</td>
</tr>
<tr>
<td>On time</td>
</tr>
<tr>
<td>Within budget</td>
</tr>
<tr>
<td>To specifications</td>
</tr>
<tr>
<td>Management happiness</td>
</tr>
<tr>
<td>Project team happiness</td>
</tr>
<tr>
<td>User happiness</td>
</tr>
<tr>
<td>Financial / commercial</td>
</tr>
<tr>
<td>success</td>
</tr>
</tbody>
</table>

* significant at the 0.05 level

The results in table 2 indicate that the party whose involvement ceases after the handover of the project (e.g. project team members – no benefactors) uses a different set of criteria than the parties whose involvement does not cease. Furthermore, the examination of the main effects point out that “on time”, “user happiness” and “financial or commercial success” are prime criteria for the end users, project team members – benefactors and the management, though the impact and the proportions of these criteria differ between the parties.

In the second stage of the analysis, interaction terms were entered into the analysis. Two-way interaction terms were entered into all the models (pairwise multiplication of the criteria), three-way interaction terms were entered into the models for the project team members – no benefactors and the management. The latter because the variance explained was still rather low.

The analysis was performed in two different steps. In a first step, the dataset was split up ad random in two sub-groups, each containing 50% of the cases. A linear regression model was developed for both groups. The main effects (the seven criteria) were forced into the model, while the 2-way (and 3-way) interaction terms were entered into the analysis by using a stepwise technique. This resulted in 2 linear models that contain all criteria and only those interaction terms that have a significant impact on the success ratings.
Inspection of the distribution of the residuals and the partial regression plots indicated no problems. The influential statistics (DFFIT) showed a few extremely influential points. After examination, these data points were filtered out and the regression models were recalculated.

Finally, a linear model was developed that contained all main effects and those interaction terms that occurred in the linear models of both sub-groups.

By using this two-step technique, some valid interaction terms might be excluded from the analysis. Moreover it will diminish the predictive power (R^2) of the final model. But the final model will be more robust. Moreover, this technique avoids chance capitalisation, a pitfall that has to be considered when a large number of interaction terms are examined.

The results of the regression models are summarized in the following tables:

Table 3: linear model for the end users, containing interaction terms

<table>
<thead>
<tr>
<th>End users</th>
<th>Coefficient</th>
<th>Sig.</th>
<th>VIF-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>38,38</td>
<td>0,000</td>
<td></td>
</tr>
<tr>
<td>On time</td>
<td>12,99</td>
<td>0,001</td>
<td>3,02</td>
</tr>
<tr>
<td>Within budget</td>
<td>2,12</td>
<td>0,435</td>
<td>1,64</td>
</tr>
<tr>
<td>To specifications</td>
<td>-7,65</td>
<td>0,058</td>
<td>3,33</td>
</tr>
<tr>
<td>Management happiness</td>
<td>6,15</td>
<td>0,330</td>
<td>8,98</td>
</tr>
<tr>
<td>Projectteam happiness</td>
<td>-3,65</td>
<td>0,109</td>
<td>1,15</td>
</tr>
<tr>
<td>User happiness</td>
<td>9,34</td>
<td>0,001</td>
<td>1,87</td>
</tr>
<tr>
<td>Financial / commercial success</td>
<td>21,18</td>
<td>0,000</td>
<td>2,59</td>
</tr>
<tr>
<td>To specifications * management happiness</td>
<td>17,18</td>
<td>0,003</td>
<td>5,43</td>
</tr>
<tr>
<td>Management happiness * fin / com success</td>
<td>-18,10</td>
<td>0,001</td>
<td>5,06</td>
</tr>
<tr>
<td>On time * Management happiness</td>
<td>-13,73</td>
<td>0,014</td>
<td>4,93</td>
</tr>
</tbody>
</table>

The R^2 = 0.280. This means that (28,0 / 33,0 * 100 =) 84,8 % of the variance, caused by the difference in project descriptions can be explained by this model.

Table 4: linear model for the projectteam members - no benefactors, including interaction terms

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig.</th>
<th>VIF-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>37,84</td>
<td>0,000</td>
<td></td>
</tr>
<tr>
<td>On time</td>
<td>0,44</td>
<td>0,924</td>
<td>2,39</td>
</tr>
<tr>
<td>Within budget</td>
<td>10,05</td>
<td>0,006</td>
<td>1,49</td>
</tr>
<tr>
<td>To specifications</td>
<td>-1,71</td>
<td>0,682</td>
<td>1,82</td>
</tr>
<tr>
<td>Management happiness</td>
<td>24,12</td>
<td>0,000</td>
<td>3,83</td>
</tr>
<tr>
<td>Projectteam happiness</td>
<td>10,39</td>
<td>0,030</td>
<td>2,56</td>
</tr>
<tr>
<td>User happiness</td>
<td>24,47</td>
<td>0,000</td>
<td>4,35</td>
</tr>
<tr>
<td>Financial / commercial success</td>
<td>15,18</td>
<td>0,002</td>
<td>2,63</td>
</tr>
<tr>
<td>Management happiness * fin / com success</td>
<td>-34,20</td>
<td>0,000</td>
<td>4,21</td>
</tr>
<tr>
<td>Projectteam happiness * user happiness</td>
<td>-23,78</td>
<td>0,001</td>
<td>4,49</td>
</tr>
<tr>
<td>On time * management happiness * user happiness</td>
<td>-28,52</td>
<td>0,001</td>
<td>3,25</td>
</tr>
</tbody>
</table>

The R^2 = 0.269. This model thus explains 95,4% of the variance caused by the project descriptions.

Table 5: linear model for the projectteam members-benefactors, including interaction terms

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig.</th>
<th>VIF-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>34,87</td>
<td>0,000</td>
<td></td>
</tr>
<tr>
<td>On time</td>
<td>-2,56</td>
<td>0,560</td>
<td>4,24</td>
</tr>
<tr>
<td>Within budget</td>
<td>1,95</td>
<td>0,435</td>
<td>1,37</td>
</tr>
<tr>
<td>To specifications</td>
<td>15,93</td>
<td>0,000</td>
<td>3,43</td>
</tr>
<tr>
<td>Management happiness</td>
<td>10,34</td>
<td>0,001</td>
<td>2,21</td>
</tr>
<tr>
<td>Projectteam happiness</td>
<td>-12,30</td>
<td>0,001</td>
<td>2,83</td>
</tr>
<tr>
<td>User happiness</td>
<td>23,14</td>
<td>0,000</td>
<td>5,36</td>
</tr>
<tr>
<td>Financial / commercial success</td>
<td>24,98</td>
<td>0,000</td>
<td>2,65</td>
</tr>
<tr>
<td>Management happiness * fin / com success</td>
<td>-25,94</td>
<td>0,000</td>
<td>3,95</td>
</tr>
<tr>
<td>Projectteam happiness * user happiness</td>
<td>17,96</td>
<td>0,000</td>
<td>4,63</td>
</tr>
<tr>
<td>On time * projectteam happiness * user happiness</td>
<td>-17,32</td>
<td>0,001</td>
<td>5,43</td>
</tr>
</tbody>
</table>

The R^2 = 0,382. This model explains 81,1 % of the variance caused by the project descriptions.
Table 6: linear model for the management, including interaction terms

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Sig.</th>
<th>VIF-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>28,01</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>On time</td>
<td>12,39</td>
<td>0.006</td>
<td>1.91</td>
</tr>
<tr>
<td>Within budget</td>
<td>7,34</td>
<td>0.050</td>
<td>1.32</td>
</tr>
<tr>
<td>To specifications</td>
<td>-5,10</td>
<td>0.242</td>
<td>1.67</td>
</tr>
<tr>
<td>Management happiness</td>
<td>5,24</td>
<td>0.127</td>
<td>1.13</td>
</tr>
<tr>
<td>Projectteam happiness</td>
<td>-12,61</td>
<td>0.002</td>
<td>1.57</td>
</tr>
<tr>
<td>User happiness</td>
<td>19,26</td>
<td>0.000</td>
<td>1.65</td>
</tr>
<tr>
<td>Financial / commercial success</td>
<td>20,69</td>
<td>0.000</td>
<td>1.91</td>
</tr>
<tr>
<td>On time * to specifications * projectteam happiness</td>
<td>22,09</td>
<td>0.000</td>
<td>2.16</td>
</tr>
</tbody>
</table>

The R² = 0.339. This model explains 58.2 % of the variance caused by the project descriptions.

5.1.3. Interpretation

The interpretation of the models starts with the interaction terms. The sign of these terms is examined. A positive sign signifies that there is a synergy. The total impact is greater then the sum of the impacts of the individual criteria. A negative sign indicates that the criteria are (partly) substitutes. The total impact is smaller then the sum of the impact of the individual criteria. Besides the sign of the interaction term, the value of the coefficients of the interaction term and the criteria it is composed of are of importance as well.

After the interpretation of the interaction terms, the main effects (criteria) are examined. Those criteria that are part of an interaction term are already accounted for; criteria with no significant P-value are not examined. For the remaining criteria, the sign and the value of the coefficients are a direct indication for their impact.

Users

- **To specifications * management happiness**: The sign of the coefficient of the interaction term is positive. This means that there is a synergy. Developing the project to specifications has far greater impact when there is management happiness.
- **Management happiness * fin / com success**: The sign of the interaction term is negative. This indicates that both terms are partly substitutes. Furthermore, the coefficients indicate that “management happiness” is the prime criterion. The contribution of the criterion “fin / com success” is far greater if there is no management happiness.

- **On time * user happiness**: User happiness and management happiness contribute highly to the predicted ratings for success. “On time” has a much smaller contribution, except when both management and users are satisfied. In that case, it has no positive impact.
- **Management happiness * fin / com success**: the analysis of the interaction term indicates that management happiness and financial / commercial success are substitutes. But, since the impact of “management happiness” exceeds the impact of “fin / com success”, one can state that satisfying the management is of more importance than financial or commercial success.

- **Projectteam happiness * user happiness**: When the projectteam is satisfied with the result, the opinions of the users are of no importance. The user happiness is only taken into consideration when the projectteam happiness is not achieved.
- **Within budget** is a criterion that is of significant importance and that is no part of an interaction term. It contributes more than 10% to the predicted score, e.g. it is a major concern of the projectteam members – no benefactors.

- Note that “To specifications” has no significant P-value and is no part of an interaction term either. This seems to indicate that it is of no importance in comparison with the other criteria.
Project team members no – benefactors are oriented towards short-term criteria. Realizing the project within budget and satisfying the parties involved (including themselves) is of major importance.

Financial or commercial success is important, but it is of minor importance compared to management happiness. This might be explained by the fact that the opinion of the managers is of crucial importance for their evaluation. Satisfying the management at the time when the project is handed over is of primordial importance to the project team members – no benefactors.

**Project team members – benefactors**

- **Management happiness * Financial / commercial success**: As with the project team members – no benefactors, the sign of the interaction term is negative. These criteria are thus partly substitutes. But the difference is that in this case, the criterion “fin / com success” has a greater impact than the criterion “management happiness”, e.g. long-term gains (fin / com success) are thus of more importance than satisfying the management.
- **On time * Project team happiness**: There is a synergy between both. The criterion “project team happiness” only contributes to the model when the criterion “on time” is fulfilled and visa versa. Note that the criterion “on time” has a slightly greater impact, e.g. is the most important of the both.
- **To specifications * user happiness**: The criterion “to specifications” only has a positive impact when there is no user happiness. This indicates that the criterion “user happiness” is the most important of the both.
- **The analysis of the model indicates that the criterion “within budget” is of little or no concern compared with the other criteria.**

In opposite to the project team members – no benefactors, financial / commercial success is perceived as a prime criterion. This indicates that the project team members – benefactors are more long-term oriented than the no benefactors. This comes as no surprise since their involvement does not cease after the termination of the project. In other words, they directly benefit from the financial or commercial success the application generates while being in production.

Besides these two criteria, the criteria “To specifications” and “user happiness” are important in this model as well. The importance of the criterion “to specifications” can be explained by the fact that in most cases, the project team members – benefactors have an impact on the formulation of the specifications. Consequently, satisfying the specifications is satisfying (part of) their wishes. The impact of the criterion “user happiness” can be explained by the fact that the project team members - benefactors benefit from the acceptance of the application.

Note that the criterion “within budget” has not significant impact. Apparently, the other criteria are far more important.

**Management**

- **On time * to specifications * project team happiness**: The sign of the interaction term is positive. There is a synergy when the three criteria are fulfilled. Note that the management does not appreciate project team happiness if the two other criteria are not fulfilled. Neither does management appreciate the fulfilling of the criterion “to specifications” if the project runs over time. The criterion “on time” has the greatest impact of the criteria in the interaction term.
  - **Note that the criteria “user happiness” and “fin / com success” are very important. They account for nearly 40% of the success rating.**
  - **The criterion “within budget” has a significant P-value, but the impact is far less than the criterion “fin / com success” which indicates a preference for long-term gains.**

There are three major criteria upon which the management judges the success of an ICT project. These criteria are “fin / com success”, “user happiness” and “on time”.

Realizing the application to specifications and satisfying the project team is of importance, but only when the application is delivered in time. The management perceives satisfying these criteria while exceeding the time limit negatively.

**5.2. Data analysis using probabilistic feature models for frequency data**

In the foregoing, classical regression techniques were used in order to predict a continuous global measure of the perceived success of ICT projects in terms of specific success criteria such as time, budget, etc. In this section, a restricted version of the probability matrix decomposition (PMD) model [15,16] is used in order to investigate whether success on a specific criterion may be a sufficient or a necessary reason to consider the entire project as a success or a failure. As such, the PMD analysis differs from the classical regression approach in
two important aspects: First, unlike classical regression it uses a binary criterion (i.e., perceived success or failure of a project) as a dependent variable. Secondly, the model is non-linear in nature because it focuses on the necessity or sufficiency of a certain criterion in order to predict the success of the entire project. However, in this paper a restricted variant of the model is used, which expresses the log of the success probability as a linear function of parameters that pertain to the different parties that were used to judge the projects.

In the following paragraph, the unrestricted variant of PMD models is discussed more in detail. Secondly, the restricted variant is presented that is used to model the data of the present paper. Thirdly, the application of the model to the data and its results are discussed.

### 5.2.1. Probability matrix decomposition models

PMD models may be used for the analysis of binary three-way three-mode or two-way three-mode data. An example of three-way three-mode data is the case in which persons are asked to judge whether or not objects have each of a number of attributes. An example of two-way three-mode data is the case in which persons who are nested in a certain group judge a number of items. The data that are analysed in this paper are of the latter type, that is, persons i (i=1,...,I) of a certain party j (j=1,...,J) (e.g. user; project team members, both benefactors and no benefactors; management) judges the success or failure of each of a number of ICT projects k (k=1,...,K). The observations, denoted as D_{ijk}, equal 1 if person i of party j judges project k to be a success, and 0 otherwise. To explain the observed data, PMD models assume a twofold process:

First, it is assumed that, when judging the success of a certain project, persons covertly classify projects with respect to a number of latent features f (f=1,...,F) which are perceived as relevant for the project's success. In the present context, the features might refer to specific success criteria such as finishing the project within the specified time limits, keeping the costs within budget, and so on. On the other hand, persons are also covertly classified as to whether they find a particular specific criterion important for their global judgement of the project. An important assumption of the model is that persons of the same party have the same probability to perceive a certain specific criteria as fulfilled in a project. Hence, this rule states that fulfilling certain specific criteria is necessary for the success of the ICT project (e.g. management perceives “on time” as an important criterion to judge a project). In the same way, Y_{kfij} equals 1 if, in judging project k, person i of party j perceives criterion f to be fulfilled in project k (e.g. project is finished in time).

Note that, when applying PMD models, the number of features is usually to be determined by the researcher. Similarly as with for example factor analysis, one should determine the number of features on the basis of a balance between parsimony and goodness of fit, on the one hand, and the interpretability of the obtained solution, on the other hand.

Second, it is assumed that the observed global judgement of a person on a project on the specific criteria that are perceived as fulfilled in a project and on the specific criteria that are judged to be important by the person. In other words, it is assumed that the global judgement D_{ijk} is a function of covert classifications X_{jfik} and Y_{kfij} (f=1,...,F). This function is denoted as the mapping rule. When applying PMD models to real data, two mapping rules are especially useful:

A first rule reads that a person will judge the entire project as a success if at least one specific criterion is fulfilled that the person judges to be important. Stated otherwise, satisfying one specific criterion is regarded as sufficient for the success of the entire project. This rule is referred to as the conjunctive rule.

A second rule states that the entire project is a success if all the specific criteria that are judged to be important by the person are fulfilled. Hence, this rule states that fulfilling certain specific criteria is necessary for the success of the entire project. This rule is referred to as the disjunctive rule.

From the above assumptions one may derive, for each of the mapping rules, the probability that a person of a certain party judges a project to be successful. It turns out that this probability is a non-linear function of parameters (σ_{jf}) associated to each of the parties and project parameters (ρ_{f}). Note that the model does not include any individual differences within parties as persons of the same party have the same probability to perceive a project as a success. Meulders, De Boeck and Van Mechelen [17] extended PMD models to include individual differences between persons within the same group (e.g. party). However, these models are not applied in the present paper because they require a larger number of persons within each party.
group in order to have reliable estimates of the parameters associated to the groups.

5.2.2. A restricted variant of the PMD model

To model the data in the present paper a specific restricted variant of the PMD model is considered. This restricted model is obtained by assuming that the relevant specific criteria are the criteria that were used to construct the project descriptions, that is, “on time”, “within budget”, “to specifications”, “users happiness”, “projectteam happiness”, “management happiness” and “financial success”. More formally, we assume that $F = 7$ and that the variables $Y_{ikj}$ are not random, but constants determined by the design of the study. As a result, the only parameters involved are the parameters associated to the parties that indicate whether members of a party find a specific criterion of importance for the success of the entire project. As shown by Meulders, De Boeck, & Van Mechelen [18] this restricted variant may formally be regarded as a generalized linear model with a binomially distributed random component and a log link. This means that the logarithm of the probability of success is modelled as a linear function of the parameters associated to the parties.

5.2.3. Applying the restricted PMD model

The parameters of the model are estimated using a Markov chain Monte Carlo method such as the Gibbs sampler [19]. This method allows computing a sample of the posterior distribution of the model's parameters, which can serve as a basis to compute point estimates and 95% posterior intervals (comparable to 95% confidence intervals of a classical approach) of the parameters. Meulders et al. [16] implemented the Gibbs sampler for the PMD model. Their algorithm could be easily modified to implement the restricted variant of the model that is used in the present paper.

Table 7 presents the posterior median (point estimate) and the 95% posterior interval of the party parameters for the conjunctive model. The parameters in Table 7 indicate the probability that a certain criterion is necessary for the success of the entire project.

Before discussing the results in detail, a general remarks should be made: on the basis of the 95% posterior intervals of the estimated probabilities, one can conclude that differences in the perceived necessity of different criteria for the same party are generally larger than the differences in the perceived necessity of a the same criterion for different parties. In other words, the main-effect of the different criteria is rather clear whereas there exists less evidence for the differences between the parties.

<table>
<thead>
<tr>
<th>Projectteam -</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>median</td>
<td>PI</td>
</tr>
<tr>
<td>on time</td>
<td>.32 (.04,.52)</td>
</tr>
<tr>
<td>within budget</td>
<td>.12 (.01,.39)</td>
</tr>
<tr>
<td>to specifications</td>
<td>.12 (.01,.37)</td>
</tr>
<tr>
<td>management happiness</td>
<td>.12 (.01,.35)</td>
</tr>
<tr>
<td>projectteam happiness</td>
<td>.05 (.00,.21)</td>
</tr>
<tr>
<td>user happiness</td>
<td>.42 (.24,.57)</td>
</tr>
<tr>
<td>fin/com success</td>
<td>.43 (.20,.61)</td>
</tr>
</tbody>
</table>

5.2.4. Interpretation

The figures in table 7 represent a distribution of the estimated probabilities. For example: the chance that criterion “on time” is judged as being necessary for success by the users lies between 21 and 62% with a 95% certainty. The median is 45%, indicating that the most likely chance that the users judge this criterion as important is 0.45.

The higher the median, the more important the criterion is. The smaller the interval PI, the more
the distribution is concentrated around the median, i.e.
the smaller the interval the better.

For users, especially the criteria “on time”, “fin / com success” and “user happiness” are important. The
 criterion “fin / com success” has the highest median,
e.g. is the most important criteria. As Wateridge
 indicated (see supra), “user happiness” is an issue. But
it is judged as being of less importance compared with
long-term gains (e.g. fin/com success).

Satisfying the users is the prime criterion for the
projectteam members – no benefactors. Long-term
gains (e.g. fin / com success) are importance as well,
but are placed at the same level as the criteria “on time”
and “within budget”. This indicates that this party
focuses more on short-term criteria.

The criteria used by the projectteam members –
benefactors and the management both resemble the
criteria applied by the users, but the proportions differ.
Being on time is of less concern to the projectteam
members – benefactors compared to the other criteria,
while the mean of the criterion “fin/com success” is
slightly less than the mean of the criteria “on time”
and “user happiness” for the managers.

Overall this model indicates that the projectteam
members – no benefactors use a different set of criteria,
compared to the other parties involved.

Furthermore, fin /com success is a prime criterion for
the users, projectteam members – benefactors and the
management, while it is of less concern for the
projectteam – members – no benefactors. This seems to
indicate that the latter are focussed more on short-term
goals, while the other parties are more concerned about
the long-term results.

Note that satisfying the predetermined specifications
is of little importance to all the parties involved.
Apparently, as long as the users are happy, the
application is delivered on time and there is fin / com
success, it does not matter if the application is not
constructed following the specifications.

6. Triangulation

When the PMD model is compared with the linear
model that examined the main effects (e.g. the models
without the interaction terms), there is a high
resemblance for the users, projectteam members –
benefactors and the management. Both type of models
indicate that “on time”, “user happiness” and “financial /
commercial success” are the prime criteria. Even the
relative proportions between these three major criteria
are similar.

It is more difficult to compare the outcome of
the PMD model for the projectteam members – no
benefactors with the outcome of the linear model,
since the latter had only one criterion with a
significant P-value, e.g. “within budget”. The PMD
model indicated that this is an important criterion,
but the criteria “on time”, “user happiness” and “fin
/com success” have an important impact as well.

When the results of the PMD model are
compared with the linear model that contains
interaction terms, the impact of the criteria “user
happiness” and “fin / com success” can be
confirmed. The criterion “on time” is of
importance, but only under certain circumstances.
The interaction term that includes the criterion “on
time” gives a more differentiating view on this
criterion.

7. Additional questions

The experts were asked if, besides the seven
criteria, there were other criteria of importance to
them. The aim of this question was to verify if the
selected criteria were sufficient to base a judgement
upon.

Seven experts extended the list. Three noted that
sufficient documentation and knowledge transfer is
a criterion for them, two noted that a smooth
aftermath of the implementation is a criterion. The
remarks made by the two other experts are
perceived by the authors as success factors rather
than criteria, and thus neglected in this part of the
research.

The fact that a broad majority of the experts did
not enlarge the list indicates that they agree with the
selection of criteria used in this research.
8. Conclusions

In this research, seven possible criteria to judge the success of intra-organisational ICT projects were examined. The aim was to indicate which criteria were used by each of the groups involved in the implementation of ICT projects.

- First, there is no such thing as a set of criteria that is uniform for all the parties involved in intra-organisational ICT projects. The different parties use different sets of criteria, with different proportions to rate the success of an ICT project.
- Second, none of the parties examined used the triple constraints to rate an ICT project. Consequently, one should not judge a project solely based on the triple constraints.
- Third, for all parties examined, financial or commercial success is an important criterion. It is a prime criterion for the users, the project team members – no benefactors and the management, but for the project team – no benefactors, the weight of this criterion is exceeded by the weight of other criteria. This indicates that the latter are interested more in short-term gains. The statement posed by Turner (see supra) that project team members primarily use short-term criteria could thus only be confirmed for the project team members – no benefactors. This does not hold for project team – benefactors.
- Fourth, as the literature indicated, the management focuses on the long-term gains (financial or commercial success). But “on time” and “user happiness” are important criteria as well. This can be explained by the fact that both criteria contribute to the long-term gains the application generates.

Based on these conclusions, the authors suggest the following management guidelines:

- The selection of the project manager and the project team members should be based upon the characteristics of the project. If the aim of the ICT project is to generate long-term gains, management should mainly recruit people that benefit from the project after handover (project team – benefactors). Long-term gains prevail over short-term criteria. If the characteristics of the project are such that the short-term criteria prevail (examples: upgrade an application, apply to changed regulations…), one should select people who’s involvement ceases after handover. They will focus on the happiness of the parties involved and on budget, but the specifications are of less concern.

Moreover, if consultants or other people whose involvement ceases after handover are working on a project that should deliver long-term gains, they should be able to profit from the gains the application generates (for example by using bonuses). This will shift their attention from short-term criteria (the application has to look good at the handover stage) towards long-term criteria (does the application deliver gains).

- Management should be aware that the criteria that are used to judge ICT projects vary for every party involved and consequently, the opinions of the parties involved may be different towards a certain project. In order to get a full view on the success of a project, management should consult all groups.

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[8] Wateridge, John; “Delivering successful IS/IT projects: eight key elements from success criteria to review via appropriate management, methodologies and teams”, PhD. Henley management college. Brunel University, 1996


