Virtual Project Management: Challenges of team collaboration in an international project network environment

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1. Introduction

Virtual projects involve team members, each bringing a unique set of talents to the project, who work across time, geographic and organizational boundaries, (Meredith & Mantel, 2012, p. 8). The team members and sub-teams typically interact through interdependent tasks guided by a common purpose (Gassmann & von Zedtwitz, 2003). Thus with the use of advanced telecommunication and computer technologies a web of experts evolves which consists of individuals, local subgroups and clusters. Although geographically distributed, the members of a virtual project team are organizationally assigned to a common project management which can employ formal tools and techniques to manage the project network (Blackburn, 2002).

Virtual project teams imply several significant potential advantages over conventionally organized projects: the integration of the best human resources who may not be co-located within a given time frame (Kirkman et al., 2004), cost reductions in general (Baltes et al, 2002), lower travel-related expenses, time commitments and stress (Orlikowski, 2002), and a creation of greater equality among team members (Hertel et al., 2005). On the other hand, managing a network of virtual teams is especially challenging, because, while in principal the threats for conventional projects still exist, new problems like the lack of personal face to face contact or different time zones can arise (Oertig & Buergi, 2006). There is indication that virtual team projects exhibit more risk due to insufficient knowledge transfer (Reed & Knight, 2010). Building trust across distance is difficult for distributed team members with no prior relationships (Zolin et al., 2004) and team members are likely to base attributions about teammates on scant evidence (Cramton, 2001). Therefore building trust and overcoming communicative challenges are considered vital success factors (Herzog, 2001; Relja & Bandalovic, 2008). It is recommended that members of virtual teams meet face-to-face occasionally, especially during kick-off meetings when launching the project (Lipnack & Stamps, 2000; Watson-Manheim et al., 2002), although, in addition, the possibility of developing personal relationships through information and communication technology is being discussed (Dubé & Robey, 2009).

The goal of this study is to measure the effects on perception of performance that can evolve when direct, face-to-face interaction is minimized for virtual project teams compared to project groups where an interpersonal project kick-off meeting was implemented. The potentially moderating effect of these face- to- face meetings will also be discussed for different scenarios of network complexity. In addition, the effectiveness of different tools for enabling communication and knowledge transfer across the project network will be discussed.

2. Methods

The sample consisted of two cohorts ($N_1=46$, $N_2=84$) of students from Finland, Germany and the USA with heterogeneous project experience. The project teams were randomly generated, thus constituting conventional subteams on a local level and virtual project networks cooperating towards the project goal which for both cohorts consisted of designing a logistics supply chain for a Finnish company. Each virtual project network consisted of one subteam from each participating country with different numbers of local
project team members and one lecturer from each respective country providing support during weekly consulting sessions. As the project teams were competing among each other, there was no interaction between the networks.

While the project teams of the first cohort never had any face to face communication, those of the second cohort had one kick-off meeting together before initiating virtual project activities. Both cohorts and all project teams were provided with identical tools for their project work which consisted of an eLearning communications platform, background material and optional consulting sessions with lecturers which were run weekly via Skype. After the completion of the project all team members had to fill in a questionnaire which differentiated 5 sections of questions. The first and second sections were focused on the evolution of knowledge in the field of logistics and project management over the course of the project, and consisted of a self-assessment for the local subteam as well as a peer evaluation part for the foreign subteam. The following 2 sections contained questions concerning the usefulness of the tools provided to support the project, e.g. the eLearning platform. The questionnaire differentiated between the preparation and the execution phases of the project, while the last section contained a self-assessment and a peer review concerning the quality of team work.

3. Results

3.1 Project network complexity

The complexity of managing project networks increases with the number of elements on the one hand, which can be individual project team members and subsystems (e.g. project groups), and relations (e.g. communication links) which exist between them on the other hand. Thus, they have close similarities to the connectivity of logistic systems (Krampe & Lucke, 2006, 30-32). Now let $M_{\text{total}}$ denote the overall number of project team members and $S_{\text{total}}$ the number of local subgroups (i.e. local project groups) in a project network. Then we can define the complexity $C$ of this project network through the maximum number of nondirectional (e.g. informal) communication links (i.e. relations) between project team members plus the maximum number of nondirectional (e.g. formal) communication links between project subgroups:

$$
C = \frac{M_{\text{total}} \cdot (M_{\text{total}} - 1)}{2} + \frac{S_{\text{total}} \cdot (S_{\text{total}} - 1)}{2}
$$

For the two cohorts that were analyzed, table 1 shows the resulting project network complexities. As can be anticipated and in consistency with span of control theory (Cole, 2004, p. 202), the complexity increases in an over-proportional manner with additional team members and subgroups. Thus it can be assumed that without any countermeasures, orientation, communication and collaboration for project team members in the second cohort should be much more challenging than in the first cohort. The only countermeasure that was taken and which clearly separates the two cohorts is the fact that the project team members of cohort two had one face to face kick-off meeting with their counterparts from the Finnish subteam. Now the question is whether this interaction is
sufficient in order to overcome the adverse effects caused by the additional network complexity.

**Table 1: Complexity of project networks**

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Max. number of team members</th>
<th>lecturers</th>
<th>subteams</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finland</td>
<td>Germany</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1 Finland, 1 Germany</td>
<td></td>
<td></td>
<td>6+1=7</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1 Finland, 1 Germany, 1 USA</td>
<td></td>
<td></td>
<td>36+3=39</td>
</tr>
</tbody>
</table>

**3.2 Knowledge evolution and perception**

All project team members were asked about their perception concerning their knowledge in the field of logistics and project management in general. As we expected that over the course of the project this knowledge would grow, the questionnaire provided questions that differentiated the knowledge in the respective domains at the beginning and at the end of the project. In addition, the participants were asked to assess the knowledge of the foreign subgroup in their respective project network. The rating was based on a 5 point Likert scale from 1-very little to 5-very experienced. The detailed results for the German subteams of the first cohort show that for all categories concerning logistics, the participants perceived a clear increase in their knowledge level (see Fig. 1).

**Figure 1: Self assessment of knowledge increase in logistics for the German subteams first cohort**

![Figure 1](image)

Similar results were obtained for the German subgroup concerning their self-evaluation on project management.
In addition, also the Finnish subteams reported knowledge increases for both logistics and project management, though on a generally lower level.

In a second step we checked for the German subteam if the knowledge they thought they had at the beginning of the project was confirmed by peer-evaluation from the Finnish subteam. This was done by a one-way Anova analysis with the null hypothesis that the inter group variance was not significantly different. The results for the knowledge items reported above are shown in table 2.

Table 2: One way Anova results for knowledge acquisition self-assessment vs. peer-evaluation

<table>
<thead>
<tr>
<th>Item</th>
<th>Germany</th>
<th>Finland</th>
<th>dftotal</th>
<th>F value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Variance</td>
<td>Mean</td>
<td>Variance</td>
<td></td>
</tr>
<tr>
<td>Logistics in general</td>
<td>2,50</td>
<td>0,37</td>
<td>3,05</td>
<td>0,33</td>
<td>41</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>3,00</td>
<td>0,63</td>
<td>3,09</td>
<td>0,72</td>
<td>42</td>
</tr>
<tr>
<td>Transport Logistics</td>
<td>2,30</td>
<td>0,54</td>
<td>2,95</td>
<td>0,52</td>
<td>41</td>
</tr>
<tr>
<td>Logistics System Design</td>
<td>2,50</td>
<td>0,58</td>
<td>3,14</td>
<td>0,53</td>
<td>40</td>
</tr>
<tr>
<td>Information Flow Design</td>
<td>2,50</td>
<td>0,47</td>
<td>3,10</td>
<td>0,59</td>
<td>40</td>
</tr>
<tr>
<td>Int’l Contract Management</td>
<td>1,40</td>
<td>0,46</td>
<td>2,43</td>
<td>0,96</td>
<td>40</td>
</tr>
<tr>
<td>Business Economics</td>
<td>3,55</td>
<td>0,26</td>
<td>3,05</td>
<td>0,45</td>
<td>40</td>
</tr>
<tr>
<td>General Management</td>
<td>3,80</td>
<td>0,48</td>
<td>3,05</td>
<td>0,62</td>
<td>41</td>
</tr>
<tr>
<td>Cost Analysis</td>
<td>3,40</td>
<td>0,36</td>
<td>3,10</td>
<td>0,69</td>
<td>40</td>
</tr>
<tr>
<td>Capital Budgeting</td>
<td>2,89</td>
<td>0,34</td>
<td>2,57</td>
<td>0,86</td>
<td>38</td>
</tr>
</tbody>
</table>

In 7 out of the 10 categories analyzed we found significant differences between the self-perception of the German team members and their assessment by their Finnish counterparts. It is remarkable that for 5 out of these 7 significant effects, the self-perception was below the results of the peer evaluation, meaning that the Finnish members of the project networks thought the knowledge of their German counterparts in the respective categories of logistics at the beginning of the project was higher than the German members themselves valued their knowledge. Only for Business Economics and General Management it was the other way around.

However, both situations are critical when analyzed from a performance point of view. In a scenario where members of a virtual project team mistakenly assume their counterparts possess skills that are not fully developed, wrong task assignments as well as excessive expectations might occur. On the other hand, overassessment of one’s own capabilities might result in reduced team coherence and suboptimal team decisions.
Besides logistics, the evolution of project management knowledge was analyzed for both the Finnish and the German team members. Figure 2 shows the results for the Finnish participants.

**Figure 2: Self assessment of knowledge increase in project management for the Finnish subteams first cohort**

While all categories show low results for the beginning of the project, there are general huge increases in self-perceived knowledge concerning important aspects of project management over the course of the project. In fact, the overall average increase is 45.7 per cent, showing that for virtual project teams, knowledge evolution is possible at least if the complexity of the project is moderate.

### 3.3 Tool support

As has been discussed before, adequate tool support is of vital importance if a project network consisting of virtual project teams is going to be successful.

The tools that were provided to the project team members of the first cohort included a kick-off video conference, written information on the project and basic logistics (depicted as the “logistic survival kit”), an eLearning platform (Moodle) which could also be used as a platform for communication and collaborative activities on project work packages as well as typical communication media such as email or Skype sessions. In addition, the teams could book counseling sessions in which consulting, guidance and Q&A-sessions were provided by the lecturers.

While there is some variation with regard to the concrete values of importance, for the Finnish as well as for the German team members the three top important tools were Skype meetings and emails with their teammates as well as the weekly counseling sessions (see Fig. 3). This might be an indication that before anything else, communication within local subteams, with the foreign subteams as well as with support units was of utmost importance. This view is plausible considering the fact that, besides the local team members and the local lecturer, the project resources never met in person. In addition, it is interesting to see that if there was a choice between asynchronous,
written information exchange (i.e. emails with instructors) and oral / visual, real time interaction with the lecturers (i.e. counseling sessions), the Finnish and the German team members clearly preferred the latter.

**Figure 3: Importance of tool support for project success, Finnish and German team members, first cohort**

The eLearning Moodle platform scores surprisingly low compared to the other options which were available. We had rather expected that this tool would have been regarded as being of much higher importance to the members of the project network. This might, however, be due to the fact that the system introduction was not optimized when the project started. Further research on the effectiveness and efficiency of different tools seems to be required in order further understand the findings.

### 3.4 Perception of motivation and cooperation

The final section of the questionnaire contained questions regarding motivation as well as cooperation and communication within the local subteam and with the respective foreign teams that were part of the project networks. Based on the findings discussed before, we expected a significantly better perceived performance on both variables within the respective local subteams. In addition, differences between self-perception and peer-review seemed plausible. In a third step, differences of these findings based on the moderating effect of a face-to-face kickoff workshop for the second cohort will be analyzed.

Both variables (motivation and cooperation / communication) were measured on a 5 point Likert scale from 1 (extremely poor) to 5 (excellent). The results of a oneway Anova show that the self- perception concerning motivation of German team members of the
first cohort was clearly higher (\(\bar{x} = 4,40; \sigma^2 = 0,46\)) than that of the Finnish team project members (\(\bar{x} = 3,75; \sigma^2 = 0,63\)). The same applies for communication and cooperation with the German team members (\(\bar{x} = 4,75; \sigma^2 = 0,30\)) and for their counterparts from Finland (\(\bar{x} = 3,88; \sigma^2 = 0,81\)). All comparisons between self-perception and peer evaluation show highly significant differences (see Fig. 4).

**Figure 4:** Differences between self-perception and peer evaluation, first cohort

Thus, the expectations were confirmed: all local subgroups showed a significantly better self-perception than their respective peers evaluated on motivation or cooperation and communication. From a project management point of view this is a pretty undesirable situation that might adversely effect the cohesion of the entire network. At the end of the day this might even lead to effects of groupthink, although this phenomenon has so far been identified as being mainly a problem for conventional project groups (Posor, p. 62).

In general, it can be expected that such unwanted effects do not decrease with network complexity. Indeed, a positive correlation seems rather probable. One countermeasure is the implementation of face-to-face kickoff workshops, which was analyzed by repeating the measurements of self-perception and peer-evaluation for the second cohort. Here, a conventional kickoff was organized for the Finnish and German team members, whereas US team members only joined in through a video conference. The complexity of the project network for cohort 1 was considerably higher than for cohort 2 (C_{Cohort1}=7 versus C_{Cohort2}=39). In addition, time zone effects have to be considered: while the maximum time difference for subteams in cohort 1 was 1 hour (time difference between Finland and Germany), it was up to 7 hours for cohort 2 (time difference between Finland and the USA).

Nevertheless the results clearly show that the differences between self-assessment and peer-evaluation are reduced for cohort 2. While these differences were all significant (measured by one way Anovas) for cohort 1, this is only the case for the variable describing cooperation and communication for the Finnish subteam in cohort 2 (see Figure 5). All other effects are no longer significant.
In addition to significance, the effect sizes were measured and compared (see Table 3). While in cohort 1 all peer evaluations showed lower scores than those for self-perception, there now is one effect (motivation, German self-assessment versus Finnish peer review) that is inverted.

Table 3: Effect size of differences between self-assessment and peer-review for cohort 1 and cohort 2

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Country</th>
<th>Motivation</th>
<th>Difference [%]</th>
<th>Cooperation / Communication</th>
<th>Difference [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Germany</td>
<td>4.40</td>
<td>3.88</td>
<td>-11.9</td>
<td>4.75</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>3.75</td>
<td>2.60</td>
<td>-30.6</td>
<td>3.88</td>
</tr>
<tr>
<td>2</td>
<td>Germany</td>
<td>4.02</td>
<td>4.33</td>
<td>+7.7</td>
<td>4.21</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>3.80</td>
<td>3.31</td>
<td>-12.9</td>
<td>4.07</td>
</tr>
</tbody>
</table>

= significant effect

All effect sizes were clearly reduced considering the relative difference between self-perception and evaluation through the respective foreign teammates in the second cohort.

4. Discussion

The integration of virtual project teams offers several specific potential advantages over conventional project organizations. However, there are also some potential drawbacks associated with this form of project management which have been reported by both research and practitioners. Few studies so far have addressed the question of quantitatively describing the effects on perceived knowledge transfer and performance
which can be attributed to the fact that personal face-to-face contacts are reduced to a minimum.

The results described above show that some of the problems that can develop within virtual project networks might be more severe and frequent than expected. Clearly, modern tools of communication can help to ease potentially negative effects. However, in this study, significantly different perceptions of knowledge and performance for project teams were found depending on self-assessment versus peer evaluation even for relatively simple project networks if the personal kick-off workshop was omitted. If such a personal contact was implemented at the beginning of the project, a strong moderating effect occurred thus reducing the differences which are undesirable from a project management point of view. This happened even though the project complexity was distinctively increased.

There are, however, certain limitations in these findings which must be taken into account. First, even though the project experience of the two cohorts can be expected to be similar, there was no test regarding homogeneity of the two samples. In addition, all Anova results were obtained by testing all answers from the Finnish subgroups versus those of the German teams. Pooling the data and comparing the results for each of the network elements (i.e. subteams) individually has not been done yet. Such an analysis might, however, add another focus. Therefore, further research including the test and quantification of other tools and their effectiveness of managing project networks which employ virtual teams is recommended. In addition, a possible correlation of effects, efficiency of tools and network complexity needs to be investigated and quantified.

References:


