The Assessment of Knowledge Worker Team Productivity[1]

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Abstract: Virtual teams have been distinguished from "normal" teams in literature to understand the impact of information, communication, trust, or culture on productivity. Like traditional teams and projects, not all virtual teams are equal. This paper establishes five ideal types of knowledge worker teams, the firm internal team, the supply chain team, the prime contractor led team, the strategic network team, and the virtual community team, which all combine traditional and virtual team characteristics. The focus of the paper is an assessment instrument with which productivity of the teams can be measured by profiling a real team situation with the help of the ideal types. A statistical analysis of 157 responding project managers shows that productivity of teams is not necessarily higher when they are less virtual, but higher when teams are more consistent to one of the ideal team types. For practitioners the assessment identifies concrete issues to increase consistency of the team for higher productivity.

Keywords: project management, knowledge work, living labs, productivity

1. Introduction

The development of collaborative work environments is driven by the aim to enable to "work smarter not harder" [1]. Drucker [2] compares this situation to the early days of industrial engineering around 1900, when new production technologies were combined with "scientific management" [3] of industrial work. The foundation of scientific management is to replace "rules of thumb" by "scientific" measurement [3] of productivity, which led to a 50 fold productivity increase in the course of the 20th century [2]. With increasing availability of information systems to support collaboration [4], the question is whether a similar gain of productivity can be reached for knowledge workers. This cannot be thought of without information system innovation. However, the success in improving work routines and organization will affect productivity as much as software technology and functional quality does.

Productivity measures for knowledge work are less developed in contrast to the mature measures for industrial work productivity or software quality. Measures for knowledge work productivity and appropriate measurement methods, however, are equally important to guide the improvement and re-organization of knowledge work as they are for the validation of emerging software tools to support knowledge work. This is especially true for experiments in so called "living labs"[5] that aim at combining the validation of new information systems with behaviour change and the implementation of new work

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routines in one and the same experiment. Only with operational empirical measures and measurement methods, such experiments can be undertaken. Those experiments in living labs engage large numbers - for statistical reasons - of knowledge workers in their normal life settings - for conceptual reasons -, which requires minimal invasive measurement instruments and high automation of data collections and analysis to make the research process feasible.

Measures and measurement methods are not only instruments for research, but document intermediate research results because they carry explicit as well as tacit knowledge and understanding of knowledge work. Productivity measures for industrial work are well elaborated but should not be copied onto knowledge work if we assume that it is inherently different from industrial work. For example, more output of a kind is not necessarily more productive: the length of a report is not correlated with its value. Or, as Steve Barley puts it, we have to go back to the early days of studying work and apply these studies to conceptualizing knowledge work in its own right. Measures and measurement instruments are the essence of any laboratory infrastructure, because they are needed to achieve internal validity of experiments. In other words, if living labs are to gain scientific relevance, they need to develop an appropriate set of instruments for a focused domain of interest.

The aim of the paper is to present a measurement instrument for knowledge worker productivity, which is web based and focuses on the assessment of knowledge worker teams. The paper describes initial findings from 157 assessments of teams in Switzerland. The paper is structured as follows. First, the measurement model is introduced and rooted in literature. Then, the data sampling methodology of the study is summarized and the data are discussed. From which finally, conclusions for knowledge work and further development of the assessment tool are drawn.

2. The Productivity Assessment Tool for Knowledge Worker Teams

The assessment is based on a traditional contingency hypothesis of organizational theory that productivity increases when the capabilities of the organization, in this case the project team, "fit"[6] the requirements that it faces in its environment [7]. A look at the literature on virtual teams and projects [e.g. 8; 9; 10; 11] reveals that the primer concern of the past was to understand the specifics of virtuality, namely that the members of a virtual team are geographically and organizationally distributed and that communication amongst them is often mediated by information systems. These studies are obviously motivated by emerging new information technologies and organizational phenomena whose future adoption is barely contested. Rather than assessing and describing the newness of virtuality in contrast to traditional project teams, for this study I assume that virtual artefacts readily exist and that the assessment tool needs to be based on emerging new organizational concepts and forms in their own rights, which avoid reference to legacy from industrial age organizational forms.

Identifying "ideal types" [12] is one way of theorizing otherwise complex phenomena like organizational configurations. Basically, the many characteristics of organizations are clustered into a limited number of groups. It is not likely that many real situations exactly meet the ideal type. But once the type is established, observing a concrete team situation starts with identifying the most similar type(s), which typically involves collecting answers to much less questions than would be necessary to describe all characteristics. Once the type is established, further characteristics of the team can logically be concluded from the knowledge of internal conceptual consistency and / or empirical statistics on the correlation of different characteristics within the ideal type.

Such assessment tool therefore is not designed and implemented in one step, but continuously evolves because more assessments enlarge the empirical base of team situations, which allows theory building and improving the logic of the assessment tool. In this respect, surprising answers to the assessment tool and apparently contradicting outcomes of assessments are opportunities for learning. Equally important as the correctness of the identified types therefore is their potential to collect further data that enrich the empirical basis for the improved definition and characterisation of the types. The here presented paper reports an early step in the evolution of the assessment.

For this limited purpose of the development of a base version of the assessment tool, we distinguish five types of teams that reasonably well cover the span of teams from "traditional" to "virtual". The ideal types are conceptually derived from literature and then validated in a number of qualitative case studies. Rather than establishing a dichotomy of virtual versus traditional, these five ideal types allow for more subtle differences between the teams:

- I refer to conventional project teams as one type where a line manager inside a hierarchical organization builds the team. Team members are not dispersed geographically or across organizational boundaries. Productivity then is mainly driven by the effort it takes to produce an outcome that is valued by the line manager.
- A second type of teams are supply chain projects, where coordination is similarly integrated as in hierarchical organizations, but across organizational boundaries and with geographical dispersion.
- A third ideal type of teams, to which I refer as prime contractor led team, centres on agility. The configuration of partners in the team is unique for the occasion and has to be aligned quickly under hierarchical coordination of the prime contractor.
- As a fourth type I use teams in strategic networks, for example in airline alliances, where teams form, operate and disband with high degrees of autonomy as long they stay within the boundaries of the strategic scope.
- Finally, the fifth ideal type are peer-to-peer networks, for example of business partners, or teams of scientist which are highly networked project teams of peer partners, where coordination is negotiated per case on the basis of roles.

None of the five types is more preferable or better that any other. Instead, it is the fit between the external requirements and the internal set-up of the team, which is assumed to affect its productivity. The calculation of this fit is based on questions about the respondent´s perception of the external requirements and about the internal capabilities of the project team. In order to standardize the questionnaire in a Web based instrument, five multiple-choice answers are given for each of the questions. The answers do not consist of numbers but natural language descriptions of typical characteristics through which the respondent can recognize the situation of an ideal type.

The assessment is based on four fit dimensions, which were distilled from the case studies:

- Team culture covers the dimension studied by organizational psychology on how team members collaborate
- Communication covers the dimension studied by information system research on different communication patterns
- Project management covers the dimension of project coordination studied by project management, and
- Benefit realization covers the dimension of controlling of team output.

Two questions, one about external requirements and one about the team practice, cover each of the four dimensions, so that the assessment is based on a total of eight questions only. These are complemented by context questions, such as for the example the industry in which the project team operates, or the experience of the team members, from which conclusions on the external requirements can be derived. For example, if a project team is operating in the construction sector, the likelihood that it is a prime contractor led team is comparably high.

Productivity assessment is the calculation whether the respondent chooses all answers from one ideal project type, which means that the project is in fit, or whether there are misfits, what types of misfit there are, and how strong the misfits are. For example, the answers can indicate fit concerning the perceived internal configuration and concerning the perceived environmental requirements, but reveal a misfit between external requirements and internal practice, which can indicate that a well-established team is asked to operate outside its traditional field of expertise – and hence might suffer from productivity loss. Or, misfit emerges between the four dimensions, for example that the team has developed a collaborative culture, communication style and project management approach, but still has to report in bureaucratic controlling instrument, from which dysfunctionalities emerge.

Providing immediate and understandable feedback to respondents is of relevance in living lab settings, which engage both researchers and practitioners. Figure 1 shows a screen shot from the online feedback provided by the survey instrument. Each of the four quadrants covers one of the domains and the two axes represent the answers to external requirement question and the internal team practice question. If all answers are in fit, the line connecting the answers forms a circle. Misfits will deform the circle, which allows quick identification of the specific areas of misfit. The acceptance of assessment results, the face validity of the instrument proved to be good amongst the respondents of the pilot study.

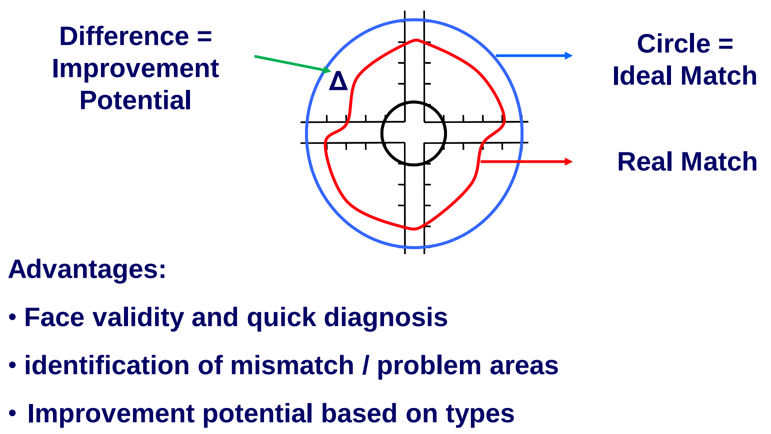

Figure 1: Graphical Feedback Team Assessment

2.1 – Data Sampling

Data were collected through the Website www.productive-schweiz.ch (in German), www.svizzera-produttiva.ch (in Italian) and www.suisse-productive.ch (in French), where the team assessment instrument is online and accessible.
The remainder of this paper is dedicated to the analysis of a sample of respondents. Other than the analysis of the individual assessment and feedback for improving the specific team situation, the analysis of larger samples is intended to validate the team assessment instrument itself, improve it, and generate generalized insights for theory building.

Respondents are a random sample with N = 157 participants of Swiss registered project engineers. Therefore, the study does not have (observable) non-response cases. Out of the participants n_{LF} = 37 were French speaking and n_{LG} = 120 were German speaking. n_{rm} = 17,2% replied that they were project member, n_{rt} = 12,7% declared themselves team leader, and n_{rp} = 70,1% were project leader or project manager. n_{E0} = 22.9% projects replied that they have no experience with similar projects, n_{E1} = 12.7% have one project, n_{E2-5} = 33.1% have 2-5 projects, n_{E5} = 30.6% have experience with more than 5 projects.

Participants stem from all sizes of firms with n_{S9} = 15.3% with 1 to 9 employees, n_{S50} = 15.9% with 10 to 49 employees, n_{S250} = 13.4% with 50 to 249 employees, n_{S500} = 7.6% with 250 to 499 employees, n_{S1000} = 9.6 % with 500 to 999 employees, n_{S10000} = 19.7% with 1000 to 9999 employees, and n_{SL} = 17.8% with more than 10000 employees. The regional distribution of participations as well as the distribution by major industries is quite homogeneous.

Participants were asked about their perception of achievement of the operative measures time, budget and quality. The responses are given in Table 1 and show that achievement of budget goals is highest, followed by quality goals, and time goals ranking third, which lets assume that teams compromise more redaily on the time goals.

Table 1 operational efficiency and productivity responses

Time goal:	M = 4.10	SD = 1.55	n = 153
Budget goal:	M = 4.67	SD = 1.48	n = 146
Quality goal:	M = 4.45	SD = 1.31	n = 148
(Likert scales ranging from 1 (= not achieved) to 6 (= fully achieved)			
Productivity:	M = 3.47	SD = 1.04	N= 154
(Likert-Scale ranging from 1 to 5)			

3. Discussion

The sample is too small to be representative for all Switzerland, still, participants do stem from a wide variety of regional, industrial, company and project size with generalizable insights.

This study, like many others, measures perceived productivity because objective productivity measures are not readily available. Perception bias therefore has to be taken into consideration. One-way ANOVAs in Table 2 indeed show significant main effects of the role of the respondent in the project (team member, team leader, project leader) regarding all four productivity dimensions. In other words, the higher the responsibility of the respondent in the team, the more positive is the perceived performance assessment.

Table 2: project outcome in relation to respondent role in the project

Time goal	$F(2, 150) = 6.40^{**}$	$p<.01$
Budget goal	$F(2, 143) = 7.83^{**}$	$p<.01$
Quality goal	$F(2, 145) = 2.47^{\dagger}$	$p<.10$
Productivity	$F(2, 151) = 5.94^{**}$	$p<.01$
Note: † p < .10; * p < .05, **p < .01		

An option for future versions of team assessment therefore can be to have several team members participate in the survey and introduce an interpersonal consistency assessment. This can be extended to all dimensions of the assessment, not only the performance dimensions. Apart from eliminating bias in a statistical sense, the discussion of perception differences in a team can have practical benefit in identifying improvement areas for the team.

The second interesting question is in how much the hypothesized "fit" dimensions between external requirements and internal team capabilities affect productivity, which is confirmed as Figure 2 shows.

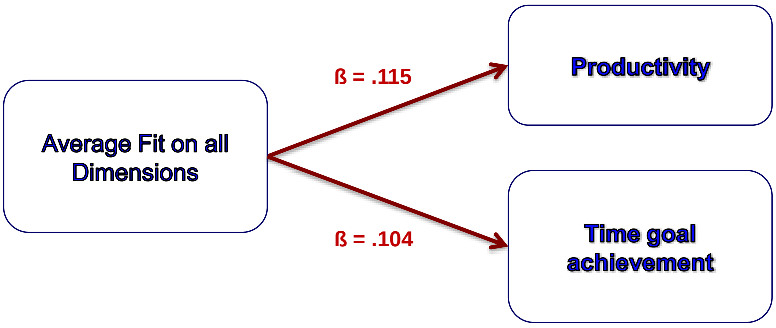

Figure 2: Correlation "Fit" and team productivity

Multiple regression analysis on this correlation with one-sided tests shows results given in Table 3.

Table 3: Productivity and Misfit in sample

	ß
Misfit Team Culture	-.008 ns
Misfit Communication	-.101†
Misfit Management	-.008 ns
Misfit Benefit realisation	-.126†
Note: † p < .10; * p < .05, **p < .01	

In other words, only misfits on the dimensions communication und benefit realisation have a negative impact on the productivity, misfits in culture and management are not significant. This even stronger applies to geographically dispersed, virtual teams (n= 92).

Table 4: Productivity and Misfit in virtual teams

	ß
Misfit Team Culture	-.012 ns
Misfit Communication	-.114†
Misfit Management	-.008 ns
Misfit Benefit Realisation	-.222*
Note: † p < .10; * p < .05, **p < .01	

This result is surprising and could be interpreted as a falsification of insights from literature, which links team performance with the team´s culture and its leadership and management, which at this stage would be premature. A more in-depth analysis in Figure 3 shows differences related to the ideal types of teams.

Figure 3: Impact difference of dimension on productivity of a) co-located and b) virtual teams

The two dimensions communication and benefit realisation are those which change more substantially when changing from face to face teams in traditional settings to distributed, virtual teams. An alternative interpretation could be that the influence of team culture and management is strong in face-to-face teams that actually are close enough for this. In virtual teams, communication and benefit realization plays a stronger role, which includes the definition of the architecture of substantial contributions to the overall team outcome. This is in line with Piore and Sabel´s [13] argument that different types of work are coordinated through different types of contributions, namely substantial contribution, which they associate with craftsmanship, and procedural contributions, which they associate with industry. If this is so, this finding would support the relevance of the hypothesized ideal types in that different capabilities are necessary for the different types of teams. In any case, for future versions this part of the assessment questions deserves updating.

4. Conclusions and Recommendations

The here presented team assessment tool is designed for use in so called living labs, which are open innovation environments that engage scholars as well as commercial developers of information systems and knowledge workers. The instrument therefore has to be easy to use, it is available on the internet to be independent from physical laboratory environments and requires less than 5 minutes time for the completion of an assessment. It therefore fulfils the requirements of a little invasive measurement instrument that provides and immediate feedback and benefit to the “living” participants.

“Lab” is the ambition to create new knowledge through application of scientific experimental methods. The second line of argument in this paper is that the presented sample of assessments can be treated as responses to a survey that can statistically be analyzed. In fact, the presented sample shows statistically significant correlations between the internal configurations of the project team and the productivity of the teams. From this result we can conclude that the here identified ideal types of projects are indeed consistent configurations of project team characteristics. From the four dimensions identified from literature, only two proved statistically correlated to team productivity in this study, which leads to a number of future research questions.

The validity of the study is limited by the number of respondents, which is large enough to give statistically relevant numbers of responses in all categories. Further research therefore should be undertaken to increase the number of responses, which will be done in the already assigned collaborative work environment projects.

The here developed basis further allows for a number of extensions. The dimensions can be refined and extended based on the obtained results, which will increase the academic contribution of the work.

The fit model further allows developing automatic feedback to the participants so that the assessment can be used by knowledge workers to analyse and improve their collaborative project. In terms of open innovation, such practical value could motivate engagement of knowledge workers, information system developers and other stakeholders in a joint research process.

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