Relationship between Teams' Co-location and Project Performance

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Abstract: This paper aims to present an analysis between teams' co-location and project performance. In order to achieve product development project success many decisions shall be made before the project kick-off. One of these decisions is to whether co-locate or not the project team. But, what are the effects of teams' co-location on project performance? The paper provides a literature review about teams' co-location, its advantages and disadvantages, virtual teams and project performance parameters. A table is then proposed to be used as a guide to determine the degree of success of projects. This paper also presents a case study where 3 pairs of similar system projects were analyzed. In each pair of cases, the first Product Development (PD) project occurred using a co-located team and, in the second case, a virtual team (not co-located team) was adopted. The project performance parameters for each case were identified using the proposed table from which we concluded that co-located teams appears to deliver better performance at least in the "internal project efficiency" parameters. Further research involving a larger sample of cases is still necessary to confirm these conclusions.

Keywords: Co-location, Project Teams, Virtual Teams, Project Success

1 Introduction

When a company decides to go ahead in a Product Development (PD) project, they invest money, team effort and time. As a result of this investment (project efforts), the company expects to achieve PD success. Unfortunately the literature has consistently demonstrated that the PD "success score" is very low. Figure 1 shows the results of a research [1], which categorizes projects into three resolution types:

- Successful: The project is completed on time and on budget, with all features and functions originally specified.

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- Challenged: The project is completed and operational, but over-budget, over the time estimate, and with fewer features and functions than initially specified.
- Failed: The project is cancelled before completion or never implemented.

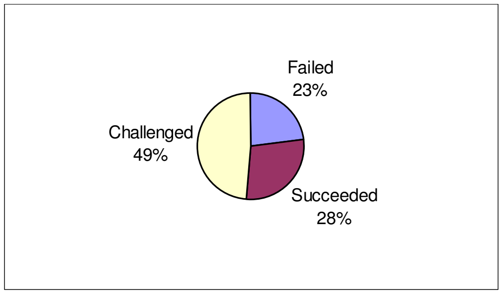

Figure 1. Project Resolution [1]

In this context it becomes important to answer the following question: Why the success rate is so low even with the wide availability of methodologies and tools to support product development projects in all of their aspects, dimensions and processes?

This question has been widely studied in the last 20 years by researchers both from the Product Development and the Project Management arenas. According to these authors [1, 2, 3], many factors may result in a project failed. Within these reasons, it may be pointed a classic reason: the project is not structured appropriately (see, for instance, [3]).

Now, within the broad topic "project structuring" we find the theme "project organization approach". The ideal company can be thought of as one in which a single person in charge, and where knowledge of the market, of design and production and of economic mechanisms are collected together in one person, who is also able to make decisions and willing to run the risks associated to the business [2]. In the real world of modern organizations and complex products a single person is not able to perform all product development activities him/herself. On the contrary, different groups of specialists from different areas are generally need, and are brought together forming what is called multidisciplinary teams. In the case of PD projects, these teams are typically composed of people from Marketing, Manufacturing, various Engineering disciplines, Purchasing, etc, depending of the product type, and project goals.

Many authors [4, 5, 6] and practitioners believe that the ideal situation is getting the team members on a physical common area, which it is called team co-location. Some other authors, on the other hand, believe that co-location is not always a must, and that in some cases it is completely unnecessary and even counter-productive [7, 8]. For the companies, on the other hand, co-location always means extra-costs in the expectation of better team results.

In this context this paper aims to present and discuss the early results of a study at a major aerospace company which tries to shed some light on the complex relationship between teams' co-location and project overall performance.

In order to achieve this goal we start by providing a literature review on project teams, describing teams' co-location, its advantages and disadvantages, and virtual teams (Section 2). In the third section, we propose a table with project performance parameters to be used as a guide to determine the degree of success of a certain project after a number of dimensions. In the fourth section, we present a case study performed in an aerospace company showing the project performance parameters with teams co-located and not co-located. Finally, it concludes with limitations and future research.

2 Literature Review on Project Teams

2.1 Teams' Co-location

The concept of a "team" is described as a small number of people with complementary skills who are equally committed to a common purpose, goals, and working approach for which they hold themselves mutually accountable [8]. It is important to notice that getting a group of people to work together (physically) is not enough to make this group of people into a "team". Teams are different from working groups. The first one promises greater performance than the last one. In this paper, the word "*team*" means a real team not just a working group.

When the team members are co-located there is a common physical area specifically allocated to the execution of the tasks related to the project. The team members shall seat close together. By close, it is defined as close enough that they can overhear each other's telephone conversations [5].

The informal communication is dramatically enhanced with the co-location [4]. Allen (1977) has quantified the effect of distance on communication. Figure 2 shows how the probability of communication is high with small physical separation distance and falls off drastically when people are located more than 10 meters from one another [9].

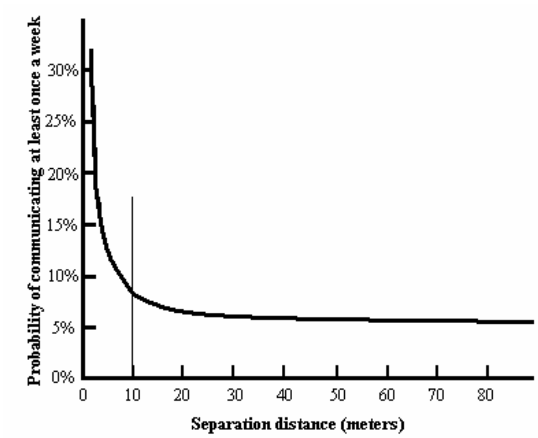

Figure 2. Project Communication frequency versus separation distance [9]

The key point is that co-location enables the informal communication. The water cooler metaphor is used to explain this phenomenon. The water cooler effect represents a belief that conversations that develop in and around a water fountain, or in a cafeteria, significantly enable knowledge transfer, which indirectly contributes to positive work relationships [10].

The team members may be co-located so they can focus their collective energy on creating the product. This situation can result in lasting camaraderie among team members [4].

So, the co-location is essential to achieve a huge project challenge: The **team spirit**.

2.2 The Advantages and Disadvantages of Co-location

As advantages, the literature shows that co-location provides an adequate environment condition for communication, decision making, team spirit among others. Co-location is regarded as one of the key ingredients in shortening development cycles at many companies, such as Chrysler, Black & Decker, and Motorola [5].

However, team co-location means a representative project cost increase, sometimes including the need for people re-location or even the requirement for new infrastructure to allocate the complete team. During the development of its ERJ 170/190 series, for instance, Embraer Aerospace had to build an entirely new building in order to accommodate the entire product team of around 600 engineers from various Countries. This collocation costs indeed increases drastically when we consider that in some industries such as the aerospace; the needed specialists are spread around the world. Some more concerns are summarized below:

- Lack of a permanent office home and as a consequence, the employee will be distant from his functional area, loosing some technological up date [5];
- Functional bosses worried about losing control of theirs employees [5].

Further, based on the authors' experience, some more concerns would be included:

- The fact that moving very often represents an inconvenience and/or a trouble for the involved people;
- Adaptation difficulties in another place, sometimes in other countries (cultural differences and operational difficulties, e. g.: need to move the entire family).

2.3 Virtual Teams

Communication versus separation distance studies have been performed by authors such as Allen [9]. At the time of his studies (1977), modern electronic systems and solutions were not widely available as today, such as e-mail, video conferencing, internet, intranet, web, voice mail, faxes, etc. More recently various authors have put forward the proposal that these electronic resources are able, to different degrees, to supersede the physical co-location and make the virtual teams possible.

Smith & Reinertsen (1998) [5], for instance, believe that the virtual co-location tools available today can supplement physical co-location but not supersede it.

Katzenbach & Smith (2003) [8], on the other hand, assert that "electronic" interactions can work, especially if they are supplemented from time to time by traditional get-togethers.

However, studies from the human communication point out the enormous importance of the human aspects which can be observed in a conversation; as body language, intonation, etc [5]. According to these studies, face-to-face conversation is still much richer than an electronic conversation due to the fact that available media and technology is not able to capture and transmit these human behavior characteristics [5, 6, 7].

Many firms apply project teams spread around the world in their development efforts [5]. Management either believes that such spread is essential, or is not willing to pay the high price of co-location. But, sometimes, management just is not aware of how inefficient its dispersion makes its teams. These authors [5] mentioned an example where there were three teams located in sites with the time differences of about as high as 8 hours: When the first team finished its work, it was shipped electronically to the next office, which then worked on the design for a shift. Then the design was moved to the next office so that they actually get three times as much effort per day as the design circles the globe. However, what really happens: they saw firsthand how designs tend to get redesigned each time a new designer takes over. It was three redesigns per day.

Literature in virtual teams states that this type of teamwork has still not achieved the same performance as teams co-located [5, 6, 7].

3 Parameters of Project Performance

In order to evaluate the project performance and how it relates to team success, it is first necessary to answer some questions: How to evaluate the success rate of a project? What is project success?

The classic response is being "on time, within budget and meeting requirements" [11]. However, many would agree that there is more to project success than meeting time, budget and requirements [12].

A factor which points if the project achieved the success is when its stakeholders (in your majority) end up satisfied [11]. But how can this satisfaction be measured?

Three parameters to evaluate project performance have been proposed: quality, lead time and productivity [13].

1 – Quality: The project affects quality at two levels: the level of the design; design quality, and the organization's ability to produce the design; conformance quality [13].

2 – Lead time: To achieve a high performance considering the lead time is not just meeting schedule. Lead time is a measure of how quickly an organization can move from concept to market. It is important to development lead time because the time to market is shorter than ever [13].

3 – Productivity: It is considered as the level of resources required to take the project from concept to commercial product. This includes engineers hours worked, materials used for prototype construction, and any equipment and services the organization may use. Productivity has a direct though relatively small effect on unit production cost, but is also affects the number of projects an organization can complete for a given level of resources [13].

Figure 3 shows the interaction among these 3 dimensions of project performance proposed by [13].

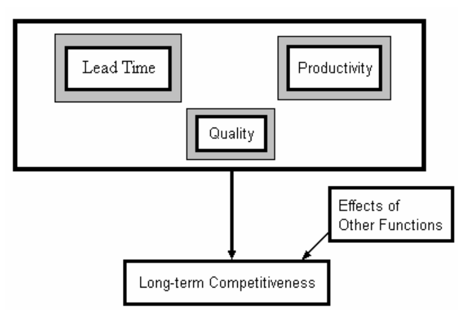

Figure 3. Project Performance [13]

In addition, Shenhar et al. present a set of measurable success criteria, divided in four primary categories as seen at project completion [11]:

1) Project efficiency: Internal project objectives such as meeting time and budget goals.

2) Impact on the customer: Immediate and long-term benefit to the customer.

3) Direct and business success: Direct contribution to the organization.

4) Preparing the future: Future opportunity (e.g. competitiveness or technical advantage)

The Table 1 is proposed as a guide to determine if the analyzed projects achieve the success or not. It is a parallel between the key success indicators proposed by (Shenhar et al. [11]) and parameters project performance proposed by (Clark et al. [13]). The table is applied in the case studies discussed in the following section.

4 Case Study

What are the effects of teams' co-location on project performance? What are the relationship between co-location and lead time; co-location and productivity; co-location and quality? To answer these questions a case study was performed in a major aerospace company. Figure 5 illustrates the relationships to be investigated empirically through this case study.

	Key Success Indicators	Parameters
	Internal Project Efficiency (Pre-completion)	
1	How quickly is the project	Lead Time
2	Meeting schedule	Lead Time
3	Completing within budget	Productivity
	Impact of the customer (Short term)	
4	Meeting functional performance	Quality
5	Meeting technical specifications & standards	Quality
6	Favorable impact on customer	Quality
7	Fulfilling customer's needs	Quality
8	Solving customer's problem	Quality
9	Customer is using product (e.g. aircraft despachability)	Quality
10	Customer expresses satisfaction	Quality
	Business and Direct Success (Medium term)	
11	Immediate business/commercial recognition	Quality
12	Immediate revenue & profits enhanced	Quality
13	Larger market share generated	Quality
	Preparing for the future (Long term)	
14	Will create new opportunities for the future	Quality
15	Will position customer competitively	Quality
16	Will create new market	Quality
17	Will assist in developing new technology	Quality
18	Will add/has added capabilities & competencies	Quality

Table 1: Primary success categories, key success indicator, and project performance parameters

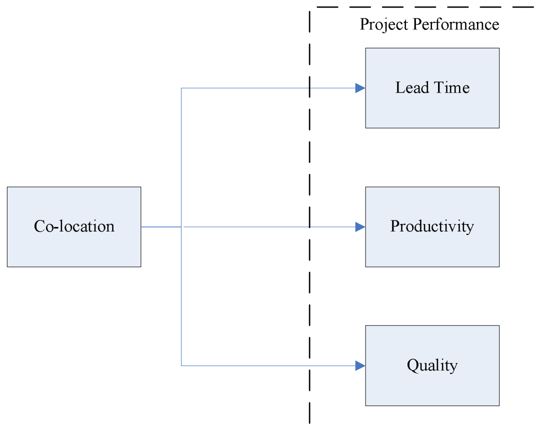

Figure 5. A framework of the possible relationship between teams' co-location and project performance

4.1 Case Study and Data Collection

3 pairs of similar system development projects were chosen and analyzed. In this study we defined "similar systems projects" as those involving the development of systems with similar design characteristics and identical or close number of technologies. It was also used as selection criteria to choose the projects with the following items: Minimum of seven different technologies involved in the project (including manufacturing) and a minimum of 10 people involved in the responsible project team. For each pair of projects, the first involved team co-location whereas the second was carried out by a non co-located team.

The previous proposed table (Table 1) was used to evaluate the success project. The project performance parameters were identified according to ranking below. Values from 1 to 5 were attributed for each parameter.

Very low (1) About 20% do total
Low (2) About 40% do total
Medium (3) About 60% do total
High (4) About 80% do total
Very high (5) About 100% do total

The data used to attribute the values were: data from project planning as planned project duration and real project duration, time to market, planned budget and real budget, data from commercial and marketing areas as customer daily report, marketing perception, customers complains, and people interviews.

The case study results are presented in Table 2.

	Key Success Indicators	Parameters	Co-located	Not Co-located	Co-located	Not Co-located	Co-located	Not Co-located
	Internal Project Efficiency (Pre-completion)							
1	How quickly is the project	Lead Time	5	3	5	1	5	1
2	Meeting schedule	Lead Time	5	5	5	1	5	3
3	Completing within budget	Productivity	5	3	5	3	5	1
	Impact of the customer (Short term)							
4	Meeting functional performance	Quality	5	5	5	5	5	5
5	Meeting technical specifications & standards	Quality	5	5	5	5	5	5
6	Favorable impact on customer	Quality	3	3	5	5	5	3
7	Fulfilling customer's needs	Quality	3	3	3	5	5	3
8	Solving customer's problem	Quality	3	3	5	5	5	3
9	Customer is using product (e.g. aircraft despachability)	Quality	3	3	5	5	3	3
10	Customer expresses satisfaction	Quality	3	3	5	5	5	3
	Business and Direct Success (Medium term)							
11	Immediate business/commercial recognition	Quality	5	5	5	5	5	3
12	Immediate revenue & profits enhanced	Quality	5	5	5	5	5	1
13	Larger market share generated	Quality	5	5	5	5	5	3
	Preparing for the future (Long term)							
14	Will create new opportunities for the future	Quality	3	3	5	5	5	3
15	Will position customer competitively	Quality	3	3	5	5	5	5
16	Will create new market	Quality	5	5	5	5	5	5
17	Will assist in developing new technology	Quality	5	5	5	5	5	5
18	Will add/has added capabilities & competencies	Quality	5	5	5	5	5	5
			4.2	4	4.9	4.4	4.9	3.3

Table 2: Project performance parameters for the analysed projects

4.2 Data analysis and Results

In the 1st Case, the performance achieved with the co-located team is little higher than the performance achieved with the not co-located team (4,2 and 4 respectively). The difference appears in the Internal Project Efficiency (Pre-completion) in the parameters: how quickly is the project and completing within budget which indicate lead time and productivity.

In the 2nd Case, the performance achieved with the co-located team is also little higher than the performance achieved with the not co-located team (4,9 and 4 respectively). The difference appears in the Internal Project Efficiency (Pre-completion) in the following parameters: how quickly is the project, meeting schedule and completing within budget which indicate lead time and productivity. In addition to this, a difference appears during the Impact of the customer phase (Short term), when the PD with a co-located team has achieved a performance lower than the not co-located team, in the fulfilling customer's needs parameter which indicates quality.

In the 3rd case, the performance difference between the 2 projects is highest (4,9 and 3,3). Besides the differences in the Internal Project Efficiency (Pre-completion), there are also differences which appear in Impact of the customer phase (Short term), Business and Direct Success (Medium term) and Preparing for the future (Long term). These differences are showed in figure 6.

The common differences in the 3 cases, related to the PD with co-located and not co-located teams, are associated to the Internal Project Efficiency involving parameters which highlight lead time and productivity, such as: project duration, meeting schedule and completing within budget.

5 Conclusion, limitations and Future Work

Study findings indicate that the PD with a co-located team achieves a better lead time and a higher productivity. There is no evidence that co-location impacts quality. However, besides co-location, others project's factors, as team manager, team experience among others could be influented the results.

The number of case studies is small and more projects have to be analyzed in order to validate the results. The next step of this work will be to increase the number of cases.

Future work will study the relationship between project contextual characteristics and their impact on teams' co-location. Based on effects of co-location on project performance it will be traced a relationship between project contextual characteristics and the decision of co-location.

6 References

[1] STANDISH GROUP, The extreme chaos report. Standish Group International, 2001. Available at: <http://www.standishgroup.com/sample_research/>. Accessed on: 02/15/06.
[2] ANDREASEN, M. M.; HEIN, L. Integrated product development. A reprint of the 1987 edition. Institute for Product Development, IPU, 2000.
[3] McGRATH, M. E. Setting the PACE in product development – a guide to product and cycle-time excellence. Butterworth-Heinemann, 1996.
[4] ULRICH, K. T.; EPPINGER, S. D. Product design and development. McGraw-Hill, 1995.
[5] SMITH, P. G.; REINERTSEN, D. G. Developing products in half the time: new rules, new tools. 2nd ed. John Wiley & Sons, 1998.
[6] HERBSLEB, J. D.; MOCKUS, A.; FINHOLT, T. A.; GRINTER, R. E. Distance, dependencies, and delay in a global collaboration. Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work, 2000, pp. 319 - 328.
[7] LEHMANN, J. Virtual meetings: not just an option anymore! Proceedings of the 2003 IEEE Managing Technologically Driven Organizations: The Human Side of Innovation and Change, 2003, pp. 443 - 447.
[8] KATZENBACH, J. R.; SMITH, D. K. The wisdom of teams: creating the high performance organization. Harvard Business School Press, 2003.
[9] ALLEN, T. J. Managing the flow of technology. Harvard Business School Press, 1977.
[10] DAVENPORT, T. H.; PRUSAK, L. Working knowledge: how organizations manage what they know. Harvard Business School Press, 1998.
[11] SHENHAR, A. J.; WIDEMAN, R. M. Optimizing Project Success by Matching Management Style to Project Type. PMForum, 2000. Available at: <http://www.pmforum.org/library/papers/2000/PM_Style&Scss.pdf>. Accessed on: 02/15/06.
[12] SHENHAR, A. J.; DVIR, D.; LEVY, O.; MALTZ, A. C. Project success: A multidimensional strategic concept, Long Range Planning, Vol. 34, No. 6, pp. 699 – 725, 2001.
[13] CLARK, K. B.; FUJIMOTO, T. Product Development Performance: Strategy, Organization, and Management in the World Auto Industry. Boston: Harvard Business School Press, (1995).