The Effect of team size on the performance of continuous improvement teams: is seven really the magic number?

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Abstract. Continuous improvement teams play an essential role when implementing a corporate improvement programme, the success of which is significantly dependent on the organization of such teams. This paper specifically addresses the effect of team size on the performance of continuous improvement teams. We take insight into a Norwegian case study during the first two years of a lean transformation to explore if there are any indications of an optimum size for continuous improvement teams**.** The results suggest that there may not be a perfect size for a CI team, rather the performance outcome of different sized teams may depend on the maturity level of the lean programme. Whereas in the establishment phase teams of up to twelve employees seem to perform well, this number appears to reduce when the programme matures. This study may therefore assist practitioners in establishing the right team size dependent on the status of transformation.

Keywords: Lean Production, Team size, Team performance, Continuous improvement.

1 Introduction

Since the term “Lean production” was popularized in The Machine That Changed the World [1], lean thinking has arguably become the most successful approach to business improvement of our generation. What is generally agreed to have begun in the automotive industry based on the management philosophy and working practices demonstrated by the Toyota Production System, lean thinking has now been adopted in most manufacturing environments, as well as construction, healthcare, government agencies, and higher education establishments to name just a few examples.

In order to adopt the lean management philosophy successfully, many companies have developed their own “company-specific production systems” or “corporate lean programmes” [2]. The successful deployment of such programmes is dependent upon a number of critical success factors, including management support and commitment [3], becoming a learning organization via constant reflection and continuous improvement [4], and the holistic adoption of lean as the new management “way” [5]. The latter is considered to be largely reliant upon a resolute process of continuous improvement, where a team-based organizational design has been promoted as an effective means for a successful continuous improvement process [6]. The collaboration of this team-based improvement process is operationalized through regular (e.g., weekly) meetings,

directly on the shop floor. However, little is known regarding the ideal size of a continuous improvement team. This begs the question amongst researchers and lean program coordinators alike: How big should a continuous improvement team really be? To shed light on this topic, we pose the following research questions (RQs):

RQ1: ***How does the size of a continuous improvement team affect team performance?***

RQ2: ***Is there an optimum team size for continuous improvement teams?***

While the limited research on optimal team size is not conclusive, it does tend to suggest that a team size in the range of five to 12 team members is optimal. Nieva et al. go so far as to suggest that a team of seven is the best [7]. Many consultants also advocate that seven is the optimum size for a continuous improvement team, particularly in the field of agile (e.g. [8]), but is this really the case? Is seven really the magic number?

There are of course seven days of the week, seven colours of the rainbow, seven notes on a musical scale, seven seas and seven continents. Snow White ran off to live with seven dwarves, and there were seven brides for seven brothers. Whilst seven appears to be a very popular number in society, this paper explores if seven really is the optimum size for a continuous improvement team.

2 Literature Review

2.1 Lean production and the importance of teams

Lean production stems from the management philosophy and working practices of the Toyota Production System, which has been defined in terms of three fundamental constructs: Just-in-Time, Jidoka, and the Respect-for-Human System [9]. The respect-for-human system is essential for the success of any lean programme, and requires management support and engagement as well as the subsequent empowerment of all employees.

Given that an organization's top- and middle management have pledged their full support and commitment to its corporate lean programme, the success of the lean deployment then becomes firmly rooted with the front line managers in the continuous improvement teams, at the lowest hierarchical level of the firm [10]. This is because continuous process improvement is difficult to achieve without the cooperation of front line workers, in particular the generation of their improvement ideas and improvement implementation efforts [11]. As such, a continuous improvement team can be defined as (a) a group of two or more individuals, (b) who cooperate to deliver one or more core product(s) and/or service(s), (c) with the shared goal of eliminating waste and increasing customer value (adapted from [12]).

2.2 Effective team organization

Several authors present a detailed review of the performance and effectiveness of teams in work organizations, and consider several key factors for team effectiveness,

including team cohesiveness, team composition (e.g. homogeneity / heterogeneity of the group), quality of team leadership, motivation, and clarity of group (team) goals. For example, Magjuka & Baldwin identified factors thought to contribute to the effectiveness with which employee involvement teams are designed and implemented [13]. They found that larger team size and greater access to information were positively associated with team effectiveness. This brings into play questions regarding the effect of team size on team performance. If Campion et al. [14] also found team size to be positively related to effectiveness, why should we believe that the optimum team size is seven?

2.3 Team size

In sports, teams have a specific number of team players: football teams have 11 players, rugby teams have 15, and basketball teams have five. In the case of work teams, however, it is a little more complex. There is no hard-and-fast rule to determine the optimum size of a team. At Toyota, production employees are typically assigned to groups of 20-30, each with a group leader. These groups are then further subdivided into teams of 5-7, including a team leader [15]. Alternatively, in Agile Software Development, Rising & Janoff state that Scrum advocates the use of small teams, preferably 7 team members (+/- 2) and certainly no more than 10 [16]. Ironically, in the game of Rugby Union, a scrum is a formalised and heavily structured (i.e. non-creative) set piece that consists of eight forwards per team.

Though several researchers have analysed the effect of team size on the performance of teams across different organizational settings, it remains unclear as to the significance team size has on the performance of the team. This is due to an array of inconsistent and inconclusive results as illustrated in Table 1. For example, Katzenbach & Smith suggested that work teams should contain a dozen or so members [17], whereas Scharf suggested that seven was the best size [18]. A variety of other such recommendations are easily found in the extant literature, often with opposing views. Some research suggests that size has a curvilinear relationship with effectiveness such that too few or too many members reduces performance [7], whilst others suggest that increasing team size actually improves performance without limit [14]. Haleblian & Finkelstein also found that firms' performance was better when [top- management] team size was greater [19], whilst Behrens asserts that small teams tend to be more productive [20]. Useem even goes so far as to state that a small team size of precisely 4.6 team members is in fact the optimum [21]. Other studies have simply found team size to be unrelated to performance [22, 23].

Kozlowski & Bell conclude that overall, the question of the "optimal" group size is a complex one and future empirical research is needed to determine the impact of team size given specific team contingencies, such as the nature of the team's task [12]. This research therefore sets out to contribute to the field by examining the impact of team size on the performance of continuous improvement teams during the deployment of a corporate lean programme.

Table 1. Suggested team size by different studies

Reference	Context	Suggested team size
Useem (2006)	Business teams	4.6
Liker & Meier (2005)	Lean teams	5-7
Scharf (1989)	Work teams	7
Rising & Janoff (2000)	Scrum teams	7 (+/- 2)
Katzenbach & Smith (1993)	Work teams	12
Magjuka & Baldwin (1991)	Work groups	The larger the better
Campion et al. (1993)	Work groups	The larger the better

3 Research method

This empirical study examines the impact of team size on the performance of continuous improvement teams during the initial stages of the deployment of a corporate lean programme. The research method for collecting and analysing data is the case study method [24, 25] Data was collected at the case company by way of participant observation – allowing the researcher unlimited use of open-interviews and open-access for the analysis of company documentation. By taking such a role, the quality of the data collected as well as the results of the analysis was increased due to the inherent inside knowledge of the company.

The case company in question is a Norwegian producer of hydro-acoustic sensor systems. Due to increasing competition from low-cost suppliers, in 2014 the case company began its lean journey through the deployment of a corporate lean programme, which itself is based on five fundamental lean principles, one of which is Continuous Improvement. In order to operationalize this principle, continuous improvement teams have been formed throughout the organization.

The continuous improvement teams meet weekly in front of team-specific Kaizen boards to discuss identified problems and improvement suggestions. The teams are encouraged to focus on small, simple improvements rather than larger project-type improvements, and as such are measured on the number of completed improvements, per employee per month (pepm). Larger project-type improvements are subsequently broken down into smaller individual tasks, making the data more comparable from team to team. The number of employees in each team varies across the teams. It is therefore interesting to examine the performance of teams in relation to team size. This study addresses six different continuous improvement teams of varying team size over a two year period (2015-2016).

4 Results

The following results are derived from six different continuous improvement teams and during the first two years of a lean deployment. The analysis is limited to six teams, as these teams are all organized under the same middle manager (the production manager), and all team members carry out manual assembly and test type work (Table 2):

Table 2. Number of completed improvements (PEPM) per team, 2015 & 2016

	2015		2016	
Team	**Size**	**PEPM**	**Size**	**PEPM**
A	7	1,3	6	2,5
B	12	2,1	10	2,9
C	17	1,4	15	1,4
D	4	0,5	5	1,6
E	13	1,5	12	2,0
F	17	0,7	13	1,1

The results are interesting from several perspectives. Firstly, with the exception of team C, all teams reported more improvements in the second year. Secondly, all teams (with the exception of team D) encountered a reduction in team size during the investigation period. This was a consequence of a strategic downsizing process due to the increasingly difficult market conditions experienced by the case company. In spite of this, however, there was still a marked improvement in the number of implemented improvements in the second year. Thirdly, and perhaps essential for this investigation, is the result shown in Figure 1. It appears that there is in fact an optimum team size for effective continuous improvement process, though the result indicates that this may in fact lessen with an increase in lean maturity.

In line with the conclusions of [7], Figure 1 suggests that team size has a curvilinear relationship with team effectiveness, such that too few or too many members reduces performance. It shows an overall trend for greater team performance with a team size between (approx.) seven and 12. Interestingly, the "sweet spot" appears to become more prominent with a higher level of lean maturity (i.e. in year two of the investigation). In this case, it would appear that nine is the "magic" number. Furthermore, and regardless of the maturity level of the teams evaluated, there does appear to be an accelerated decline in team performance as team size increases beyond 12 members.

From the results of this research, we can make several propositions:

P1. Team size seems to have a curvilinear relationship with team performance such that too few or too many members may reduce performance (as also suggested by [7]).

P2. A team size greater than 12 may result in a significantly reduced level of team performance. (Contrary to the findings of [13] and [14])

P3. For organizations in the early phases of a lean implementation, larger continuous improvement teams may provide the basis for greater team performance.

P4. As the lean programme develops and matures, a slight reduction in team size may allow for more effective team performance.

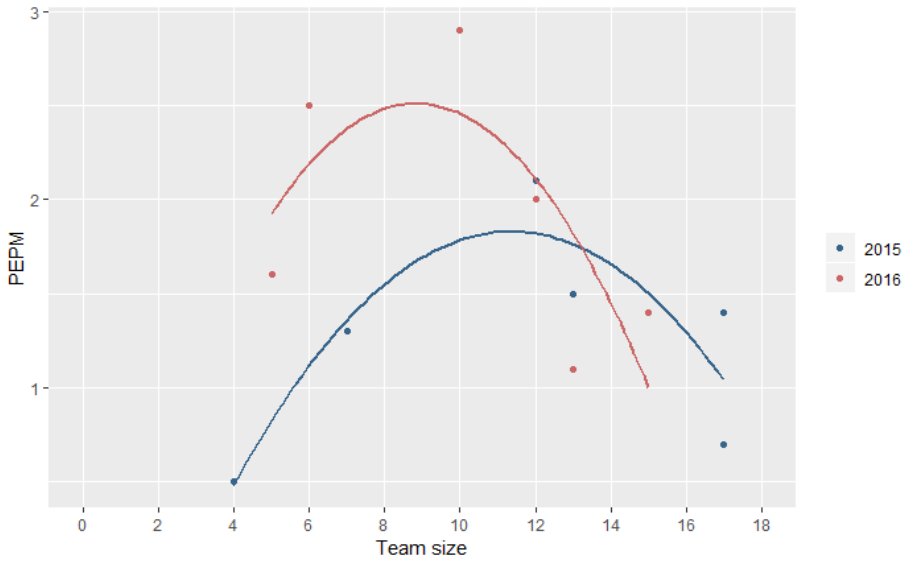

Fig. 1. PEPM in relation of team size

5 Conclusions

Though the results presented here cover only a sample of six continuous improvement teams during the first two years of a lean implementation, the results do seem to indicate that seven is not the magic number when it comes to peak performance of continuous improvement teams. Neither is 12. Nor in fact 4.6. Revisiting the RQs that guided this investigation, the results tend to suggest that there is not an optimum team size for continuous improvement teams. However, the results do allow us to present a set of propositions that may guide managers and practitioners in harnessing the greatest level of performance from continuous improvement teams during the initial stage of lean transformation.

We suggest that further work should evaluate if this is still true as the company continues to progress with the lean implementation, taking into consideration the maturity levels of the various teams, and including a greater sample of continuous improvement teams at the case company. Further work should also investigate the level of education and training of various continuous improvement teams contra their achieved performance. One would expect greater performance from teams with more skills from the continuous improvement toolbox, for example. Other factors that were identified in the literature review should also be evaluated in terms of their effect on team performance, in particular team composition (e.g. homogeneity versus heterogeneity), quality of leadership, level of motivation, and clarity of team goals.

Acknowledgements

The authors would like to acknowledge the continued support of the Research Council of Norway, through the research programmes Lean Management and SFI Manufacturing.

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