

CREATING TEAM-LEARNING AND PROACTIVITY BY EXPANDING JOB DESIGN PRACTISES WITHIN LEAN PRODUCTION

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Abstract

Lean production and team-work are based on seemingly opposing principles of job design, and yet often combined in production systems within industry. In this study we explored conditions for team learning and proactive behaviour within one specific context and version of the lean concept; the Volvo Production System (VPS). *The aim of the study* was to identify job design practises that promote learning in teams in a leaned production system, and identify organizational barriers for team learning in order to promote teams' proactive behaviour. The results are based on quantitative analysis of a) work task analysis of cognitive demand in standardized and non-standardized tasks, a questionnaire to all employees on the shop-floor, production-leaders' ratings of team proactivity, and b) qualitative analysis of interviews with specialists from support functions and production leaders. Standardized tasks, regardless of cognitive demand, do not impact team learning processes or proactivity. Mediation analysis on aggregated data (a) consisting of 41 teams showed that cognitive demand in the most demanding task in the non-standardized work was fully mediated by team learning processes on proactivity and that inter-team collaboration was mediated by team-learning processes on proactivity. A conclusion is that the potential for team-learning processes and proactivity lies in those work activities that are not standardized, and good inter-team collaboration in the work-flow. The non-standardized tasks take very little time, and are not more cognitively demanding than the main tasks, and yet impact team proactivity to a considerable extent as they give input to building a shared meaning of work. The tentative qualitative results (b) show differences between stake-holders input to stagnant and vibrant teams. The main difference is between thinking teamwork or individual work, expanding work into joint problem-solving or defining divided and clear-cut work roles, in

the coordination of different support functions activities, and if teams are involved in prioritizing what should be done.

Introduction

Merging Lean production and teamwork into one strategy is to challenge the assumptions of both concepts. Lean production is characterized by the elimination of non-added-value activities and continuous process improvements, see e.g. [1] Continuous improvements stem from collaboration and collective learning processes [2], and rely on individuals and teams that are proactive [3]. Crant defines proactivity as “taking initiative in improving current circumstances or creating new ones; it involves challenging the status quo rather than passively adapting to present conditions” [4, p. 436]. To reduce non-value adding activities within Lean, means to standardize work and hence reduce autonomy and work task complexity; the two core aspects of job design that extensive research has shown promote team proactivity.

In this study we explore conditions for team learning within one specific context and version of the lean concept; the Volvo Production System (VPS) as it is applied within Volvo Construction Equipment. *The aim of the study* was to identify job design practises that promote learning in teams in a leanned production system, and identify organizational barriers for team learning in order to promote teams’ proactive behaviour.

Team learning processes and job design

In order for a team to be proactive and form a revised strategy for action, the team has to build a shared meaning of what needs to be done, how, with whom, and why [5]. The process of building a shared meaning of a revised strategy for action, a team mission, by refining, building on, or modifying an original offer is described as a team learning process [6]. We define team learning as “a change in the group’s repertoire of potential behaviours” [7, p.

1043]. Team learning is by definition something that is collective, and is the result of the individual's cognitive processes *and* the interactions among team members, and between teams and functions [8].

Team learning has shown to be closely linked to autonomy and work task complexity [9]. Research on effective and innovative team working stress the importance of autonomy and complex tasks for learning processes in teams [10], as complex tasks give input to meaningful discussions and put demand on collective problem-solving [11], and autonomy puts demand on planning and decision making [12]. Complexity refers to demand on knowledge-based and intellectual processes. A complex task has a higher learning potential than a routine task, as it puts demand on individual cognitive processes and on collective cognitive processes in teams [13, 14]. Demand on cognition is closely related to the concepts of autonomy or degrees of freedom. Autonomy is defined as “three interrelated aspects centered on freedom in (a) work scheduling, (b) decision making, and (c) work methods” [15]. Greater autonomy increase scope for using intellectual skills, create potential for learning and proactive behavior. The link between complexity and team learning is well established [10-13, *ibid*]. In a review of research on the impact of team structure on performance, it is concluded that there is a causal link between complex team structures and effectiveness, mediated by team learning processes [16]. Tasks that are suitable for teamwork are “tasks that have high levels of the following characteristics: completeness, varied demands, requirements for interdependence, task significance, opportunities for learning, developmental possibilities for the task and autonomy” [17, p. 490]. A routine task that put little demand on individual cognitive processes, and carrying out standardized work on the shop-floor in a lean industry production does not give much input to a team discussion about goals and job routines. It does not take a process to build a shared meaning of how the task should be carried out in order for the team to perform, and the task has little learning potential in itself. *In this study we hypothesize (H1) that the*

cognitive demand of the main task in the job in a standardized work flow will not impact team learning processes.

Tasks differ in how complex and demanding they are also in a standardized production flow. Different tasks in a job put different demand on cognition and the work task complexity is hence related not only to the main work task in the production, but also to the cognitive demand in tasks that are part of the job, but take little time in relation to the main task. In a study of the relation between job design, team reflexivity and team proactivity in teams in five different branches, the results showed that cognitive demand in the job positively impact proactive behavior, through team reflexivity [11 *ibid*]. However, those teams all had some autonomy in choosing the means for carrying out the job. We argue that the potential for individual learning also in the most demanding tasks has little impact on team learning processes in standardized work, as the team does not need to build a shared meaning of how to carry out the tasks and the result is stipulated. *We hypothesize (H2) that the cognitive demand in the team's most complex work task in a standardized work flow will not impact team learning.*

The learning potential in tasks that are not standardized

In most jobs, also within a lean production system, there is an expectation of an organizational behaviour that involve carrying out tasks that go beyond the main work tasks. Within the lean production system there is an emphasis on carrying out tasks that contribute to ensuring quality, safety, orderliness, standardization and discipline. These activities are part of the job, but the tasks are not standardized. There is also an expectation of change and developmental activities that contribute to making the production more efficient, and elimination of non-added-value activities. These tasks might give input to team learning as the team needs to build a shared meaning of these expectations, what activities should be carried out, how and with whom, although the tasks consume little time of the total work time. Within work task analysis based on

action regulation theory, the standard procedure is to exclude work tasks that take less than five percent of the total work time due to practical reasons [18]. Most often only the main task is analyzed. However, it can be argued that also little time for a challenging task can have an impact on learning. To our knowledge there is no research on the minimum time for a task to influence learning, or work related attitudes and behaviors. *In line with this reasoning, we hypothesize (H3) that the cognitive demand in tasks and activities that are not standardized will positively impact team learning processes.*

Cross functional and inter-team collaboration for team learning

In this study we take interest in how inter-team relationships affect the learning process of building shared meaning. Operational developmental activities can be carried out without inter-team collaboration in a work-flow when they do not impact others work. As soon as they involve or impact the work-flow, and most changes with some dignity do, the work is dependent upon effective collaboration between teams in the work flow. Boundary crossing is essential for team learning, as information sharing and partaking in decisions regarding work enhance cross-fertilisation of perspectives [19]. Previous research [20, 21] give evidence that different aspects of communication and collaboration across borders support knowledge transfer and team learning processes, as well as performance and innovation. As other teams and functions are stakeholders in the team's learning process in a work flow, inter-team relationships will positively affect the learning process at work. *In line with this reasoning, hypothesis 4 (H4) postulates that inter-team collaboration impact on building shared meaning.*

Team learning processes and proactivity

Team learning behaviours have consistently shown strong and positive relationships with performance [22], as with proactive behaviour and innovation

[10 *ibid*]. Through collective reflexivity upon work practises, the team can build a shared meaning of the motives for implementing change, the expected results, the conditions for change and a strategy to guide the performance. In line with extensive previous research on the link between team learning processes, team adaptability, performance, proactive behaviour, and innovation, *hypothesis 5 (H5) postulates that there is a positive relationship between building shared meaning of work and proactive behaviour.*

Organizational barriers for team learning

Previous research identifies all the different stakeholders in the workflow to be important for learning processes in the teams. In this context these are other teams in the workflow, management, close to the production specialists, and support functions. Given that there is empirical evidence for the hypothesis, we pose an explorative research question: What organizational barriers can be identified for the teams being able to partaking in decisions regarding work, planning work and carrying out extra role activities?

Method

The results are based on a study conducted at a Swedish manufacturing enterprise. The plant produced transmissions and axles to wheel-lauders. About 700 were employed at the production plant and half of them worked in the production. The production flows were divided into 17 departments with one production leader, and the work was carried out by 41 shift teams. The production work was either machining of core details, assembly work, work in a hardening plant, or work in a paint shop. The production tasks were standardized. The tasks were rotated between team-members, but not all teams practiced full rotation. The teams carried out extra-role activities such as maintenance work to ensure cleaning, inspection and lubrication, quality checks,

target setting and problem-solving to eliminate deviations, and implementing operational developmental activities for enhancing efficiency. These tasks and extra-role activities were not standardized. Targets, problems and on-going activities were described, and followed-up in a team-plan, and the team-leader was responsible for a weekly team plan meeting. However, there could be also spontaneous team plan meetings. The teams participated in scheduled meetings six hours a month, i.e. four percent of the total work time. At least 10 percent of the work time could be used for spontaneous interactions, free discussions and fulfilling responsibilities others than the main production work.

Procedure

The research project was planned in collaboration with the company. Participation was voluntary. The project was presented to employees at a general meeting, and each person received a letter with information about the project and ethical considerations as well. The data collection took place during work. All data were coded in order to ensure confidentiality.

Instruments

Work task analysis

The REBA-instrument is intended for the design and analysis of work content and job design [18 *ibid*]. The data is obtained by observing and putting additional questions to a trained worker carrying out his/her work. A complete work task analysis was conducted, but in this study only the analysis of the cognitive demand is of interest.

Analysis of cognitive demand of the standardized tasks

The main production task was described in the number of sub-tasks and the duration of each task was noted (e.g. different procedures when assembling

details to parts of a gear) in four work areas. The analysis showed that the cognitive demands of the different sub-tasks in the main task were highly correlated (.98). For the remaining work areas the task that took most time was analyzed. This task could be e.g. operating three CNC-machines for the production of shafts for axles. In all work areas there were tasks that were related to the main task, but which were carried out more or less frequently, e.g. following a standardized procedure to test whether a product fulfills the standards for quality. The cognitive demands in these tasks were analyzed as well.

Analysis of the cognitive demand of non-standardized work tasks

The cognitive demand in carrying out extra-role activities and operational development and team-plan activities was estimated by observation and noting work content, problems-solving activities and communication content. Only those activities that were discussed on a team plan meeting, documented in the team plan, and involved at least two team-members were further analyzed regarding cognitive demand. The data consisted of team activities discussed at four team plan meetings in a row during a two month period, and noted on the team plan for each team.

The statistical analysis on team level based on work task analysis

In a first step teams were matched with tasks. It should be noted that some teams performed the same tasks, but in different shifts, and in some cases teams performed similar tasks. All team-members performed the main task. However, depending on whether all tasks were rotated, the cognitive demand of the most complex task more or less could be said to represent the team's work. Each team's rotation was described and categorized on a 1 to 5 scale. There was no correlation between form of team rotation and cognitive demand ($r = 0.14$). Since the task was a team responsibility, and the rotation varied unsystematically with regard to the cognitive demand in the most difficult task, the analysis was conducted on team-level.

Reliability in the work task analysis measurement

Observer reliability was attained by following the handbook for REBA work task analyses, and by using two independent observers for two analyses of machining of tasks and two analyses of assembly work. The initial inter-rater agreement was .94. The discrepancies between observers (no more than one scale step in any evaluation) were further analyzed, and subjected to renewed assessment to reach absolute agreement about criteria for the evaluation. The work task analysis of the standardized main work tasks for the remaining work areas was carried out by one researcher. To ensure reliability in the analysis of the non-standardized work tasks, all tasks were independently rated by two researchers in four work areas. The initial inter-rater reliability was .83. A revision of a) criteria for the categorization of individual and team activities, and b) criteria for the cognitive demand in planning gave an inter-rater reliability of .92. It was decided that all analyses should be carried out by two independent researchers. The final rating is based upon a consensus between the two raters.

The questionnaire

The items capturing team learning processes as Building Shared Meaning has previously been used [6 *ibid*]. The items capturing Inter-Team Relationships is part of the Aston Team Performance Inventory [17 *ibid*]. All items were answered on a scale varying from 1 to 5. A factor analyses with varimax rotation was conducted to see if the indexes represent two dimensions, and as expected the items loaded on two separate factors.

Reliability in team measurements.

To test the reliability in the group measures the intra-class coefficients ICC1 and ICC2 were computed by one-way ANOVAS [24]. ICC1 showed significant F-ratios over 1 for the two indexes Building Shared Meaning and Inter-Team Relationships, and significant F-ratios have previously been used in research to justify aggregation [25]. The two indexes reached the recommended

ICC1 and 2-value of 0.50 or above. (Building Shared Meaning, .47; .19; InterTeam Relationship, .62; .21). Further, an analysis of rwg confirmed the reliability (BSM= .91; ITR=.95) [25]. It was possible to aggregate individual data to group data.

Production leaders' ratings of the teams' proactivity

The production leaders rated each shift -team's proactivity with a set of eight items previously tested and used [26].

Interviews with production leaders and specialists from the support functions

The interviews with production leaders and specialists from support-functions were semi-structured, and covered; goals, strategy, priorities, main work tasks, leadership, work organization and team working, operational development activities, co-operation with and between support functions, and work climate. The interviews took between 90 minutes to two hours. Notes were taken during the interviews, and they were recorded as well.

Qualitative data analysis of interviews

The interviews were content analyzed in line with an iterative model for qualitative data analysis [27]. The data was in a first step reduced so that only statements referring to the teams' non-standardized tasks remained. A next step was to code each statement in different categories with respect to content, and order statements with regard to informant. A thematic analysis was conducted to find patterns of different reasoning within each informant group with respect to each of the 41 teams. The teams were divided into two groups; one group of teams (N=9) that were by production leaders rated as being more than the average proactive (1 Standard Deviation above the mean), and one group (N=12) that were rated as less than average proactive (1SD below the mean). The groups were compared in the thematic analysis.

Two researchers independently coded the statements into categories, after these categories had been identified. The inter-rater reliability was .86, and where there were disagreements, these statements were discussed until consensus was reached.

Participants

Questionnaire

The response rate for the questionnaire was 278 of 352 employees (80 %).

Interviews

Production leaders: All seventeen production leaders participated in the study.

All specialists (N=26) from support-functions (Quality, Logistics, Technical Support and Maintenance) working close to the production were interviewed.

Results

Quantitative analysis

We hypothesized that the cognitive demand in the standardized work (H1 and H2) should not impact on Building Shared Meaning (BSM). These hypotheses were confirmed ($r=.01$; $r=.09$). We hypothesized that the Cognitive Demand in the most Demanding task in the Non-Standardized Tasks (Cogn.DNST) should impact on Building Shared Meaning (H3). Further, that Inter-team relationships (ITR) should impact on Building Shared Meaning (H4), and Building Shared Meaning should have an impact on ProActivity (PAOBJ), (H5).

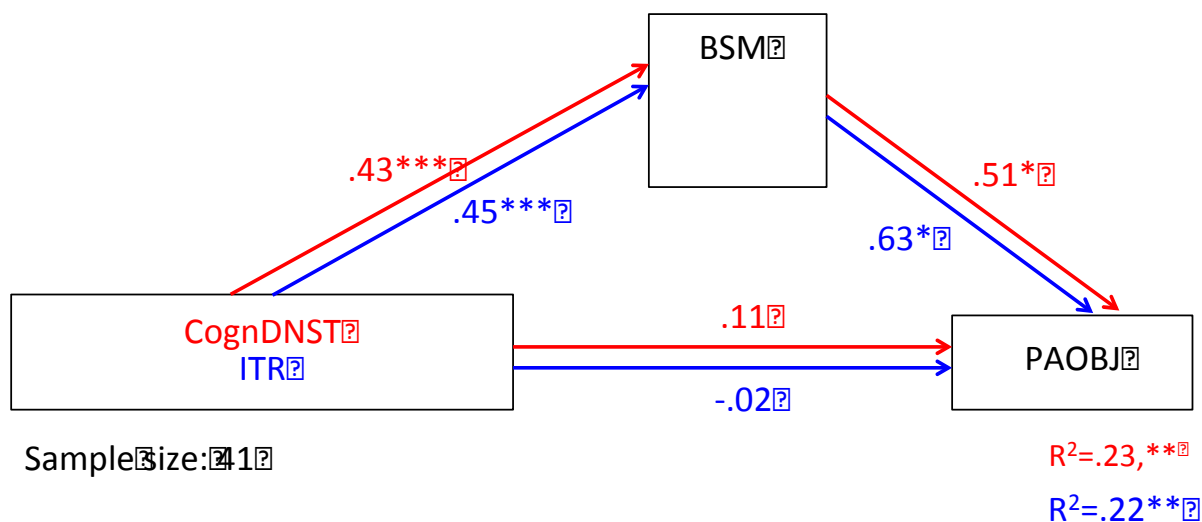


Figure 1. The results of a mediation analysis. Indirect relation of CognDNST through BSM on PAOBJ (5000 BCa bootstrap samples 95% CI) = .002 to .39. Indirect relation of ITR through BSM on PAOBJ (5000 BCa bootstrap samples 95% CI) = .06 to .57

Mediation analysis using Preacher and Hayes macro (2004) on aggregated data consisting of 41 teams showed that Cognitive Demand in the most demanding task in the Non-standardized Tasks (CognDNST in Figure 1 above) was fully mediated by Building Shared Meaning (BSM in Figure 1 above) on ProActivity (PAOBJ). A bootstrapped estimate of the indirect effect (n = 5000, bias-corrected and accelerated) lie between 0.00 and 0.39 with 95% confidence. As zero is not in the 95% confidence interval, we conclude that the indirect effect is significantly different from zero at $p < .05$ (two tailed). Altogether, the model explained 23 per cent of the variance in ProActivity ($p < .01$).

Mediation analysis on aggregated data consisting of 41 teams showed that Inter-Team Relationships (ITR) was mediated by Building Shared Meaning (BSM) on ProActivity (PAOBJ). A bootstrapped estimate of the indirect effect (n = 5000, bias-corrected and accelerated) lie between 0.06 and 0.57 with 95% confidence. Because zero is not in the 95% confidence interval, we can conclude that the indirect effect is indeed significantly different from zero at $p < .05$ (two tailed). Altogether, the model explained 22 per cent of the variance of

ProActivity. However, the result on the second mediation model must be interpreted with caution, since the first condition, that the independent variable is a significant predictor of the dependent variable, was not fully met (coefficient = .26, $p = .09$). On the other hand, this result can be due to the small sample size.

In conclusion: All hypotheses were confirmed.

Qualitative analysis

The interviews revealed that production-leaders and support functions had little to say with regard to how they contribute to the process of building shared meaning or team proactivity. The vast majority did not regard extra-role activities as important as the standardized work tasks, and some did not see it as part of the work at all. Below, in Table 1, the results are presented of the thematic analysis.

Table 1. Stakeholders' input to team learning processes

	Proactive teams N= 9	Stagnant teams N= 12
Managers	Focus on: <ul style="list-style-type: none"> • collective tasks • collective responsibility • participative goal setting • expanding work beyond main tasks • team learning • rewarding social skills 	Focus on: <ul style="list-style-type: none"> • individual tasks • individual responsibility • presenting goals • clear cut definitions of roles/tasks • individual' training • rewarding hard skills
Support	<ul style="list-style-type: none"> • problem definition and problem-solving • co-operation with the team • co-operation and task sharing with teams • priorities are set together with the team. • support specialists coordinate their collaboration with teams • support functions' goals are aligned and coordinated with team goals. 	<ul style="list-style-type: none"> • problem-solving • co-operation only with individual team members • tasks and ownership of tasks (between team and support) is clearly divided • support set priorities themselves • support specialists approach teams uncoordinated. • support functions' goals are not coordinated with team goals

The tentative results presented in Table 1 show differences between stakeholders input to stagnant and vibrant teams. The main difference is between thinking teamwork or individual work, expanding work into joint problem-solving or defining divided and clear-cut work roles, in the coordination of different support functions activities, and if teams are involved in prioritizing what should be done.

Discussion

It isn't breaking news that innovation processes and operational development rely on learning processes, or that there is a conflict between standardized and routine work on the one hand, and learning at the workplace on the other. Many similar versions of the lean production system include teamwork as a pillar for operational development. "Real" teamwork in a lean setting on the shop-floor in industry is somewhat of a paradox. The aim of the study was to identify job design practises that promote learning in teams in a leanned production system, and identify organizational barriers for team learning in order to promote teams' proactive behaviour. The results are based on different methods and quantitative and qualitative analysis. Mediation analysis on aggregated data consisting of 41 teams showed that cognitive demand in the most demanding task in the non-standardized tasks was fully mediated by building shared meaning on proactivity and that inter-team relationships was mediated by building shared meaning on proactivity. A conclusion is that the potential for team-learning processes within Lean lies in those activities that are not standardized, and in good collaboration in the work-flow. The interviews revealed differences between stakeholders' input to vibrant and stagnant teams.

Limitations

The results are based on different methods, all with different problems when it comes to reliability and validity. To carry out work task analysis in a production is a tedious task, and it can be argued that all separate sub-tasks should have been analysed. However, an analysis showed strong correlations between cognitive demands in different subtasks. The analysis of the non-standardized work tasks is somewhat problematic as the results are based on team-plan meetings and the documented team-plan. Since the teams are not totally stable, there is an error in the aggregation from individual data to team data. The different methods used showed good reliability and the chosen instruments have in previous research been shown to be reliable and valid. Further, the sample is not very large (N=41), and the results need to be interpreted and generalized with caution as they are based on cross-sectional data. Different methods were used in order to reduce the risk of common variance, and obviously this gives the established links between the main variables creditability. Future research should establish whether the research model is solid by testing it on longitudinal data.

Contributions

The lean concept relies on all employees' involvement in enhancing efficiency. The main tasks in the production on the shop-floor show no potential for creating proactivity through team-learning in this study. The contribution lies in the finding that activities that are not standardized, and although *these take very little time of the total work time and are not more complex than other tasks*, impact on proactivity. These extra-role activities, and collaboration with other teams, give input to proactivity *through* team-learning processes. To our knowledge this time-perspective has not been studied when it comes to the

impact of job design on team processes or outcomes such as proactive behavior. We have not found other studies where standardized and non-standardized work is compared in relation to team-work. Most research is based on the main task and subjective measurements of work task autonomy rather than work task complexity, although autonomy in many standardized jobs is uttermost restricted. The results should provide managers and employees with a better understanding of how to create job design practises that promote learning important for proactive behaviour and operational development, and how to change those that impede learning possibilities. If team-work is to result in proactive behavior and operational development, as is expected in the lean Volvo Production System, stakeholders in the work-flow need to make give input to team-learning processes. The teams' involvement in the non-standardized work is dependent on the input from stakeholders.

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