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Authors

Gustavo de Souza
Department of Materials Engineering at
São Carlos Engineering School
(University of São Paulo)

Isotilia Costa Melo
Department of Production Engineering at
São Carlos Engineering School
(University of São Paulo)

Daniel Capaldo Amaral
Associated Professor at
São Carlos Engineering School
(University of São Paulo)

ATMAE
701 Exposition Place
Suite 206
Raleigh, NC 27615

www. atmae.org

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Evaluating the Transition for Self-Managed Teams through Analysis of Roles in Agile Product Development Process in a Technology-Based Startup

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ABSTRACT

Self-managed teams are key elements to deliver value to the customer in the development of agile projects in the software industry though not so often described in manufacturing literature. Here one collected a background theory on self-managed teams developed on the basis of software projects and sought to apply the frameworks and roles encountered to a manufactured product development using the concepts of agile product development. Complex Adaptive Space (CAS) and Agile management were the lenses in which the subject was studied and the fundamental role of the coach was discussed as a provider for evolving team maturity. A semi-structured questionnaire was applied to a technological base startup located in Sao Paulo- Brazil in the mid of 2018 in an attempt to evaluate how product development projects and specifically how self -managing teams was approached by the company. Through the analysis of the answers it was evidenced that the company work in its projects following a traditional model, i.e. a centered leader and team members as task executors. Therefore, under the view of the self-managed team theory the main team roles were adapted to the business scenario in a tentative to optimize the way projects are guided. This study elucidates the absence of depth discussion on the topic of self-managed teams in manufacturing projects and the discussion shows that is possible to adapt the concepts developed for the software industry to product development context in order to lead to excellent and more innovative projects.

INTRODUCTION

One of the cornerstones of agile management is the concept of self-managed or self-managing teams, along with establishing the vision and engaging with customers. Self-managed teams are assumed to have autonomy in choosing and how to perform their tasks and sharing project leadership. Therefore, these teams are not part of a top-down system, where a centralized leader figure leads the project coordinating the members which act more as task performers. (Hoda, Noble, & Marshall, 2013).

Building self-managed teams are not unique to agile management. Several studies from different perspectives have investigated this subject over the past 50-60 years as pertinently summarized by (Hoda et al., 2013), starting with the study of autonomous groups (1950), facilitators of holographic organizations (management theory-1980); knowledge creation agents (knowledge management-1980), entities exhibiting spontaneous order from the chaos as studied in the complexes adaptive systems (CAS-1990) and, at last, the agile management perspective, where the coach role appears as core of the development of self-managed teams. However, although extensively explored in the software development literature, the study of self-managed teams and the roles their members play in conducting an agile project is scarcely or superficially explored in the area of product development or manufacturing. (Cooper & Sommer, 2016; Hoda et al., 2013; Kaikkonen, Haapasalo, & Hänninen, 2018; Rebentisch et al., 2018).

This paper aimed to understand how the transition from a traditional work teams to self-managed teams could impacts the project development for manufacturing and how the adherence to agile practices could streamline the development of innovative projects in manufacturing.

For achieving this goal, the current paper presents a conceptual model about self-managed teams and the transition from traditional to self-management, focused on the existing literature for software development compared to the literature for product development. And, finally, a field research to describe the use of self-managed teams in a technology-based startup company in Sao Carlos (Sao Paulo state, Brazil) that works with the development of innovative polymeric materials.

Gustavo de Souza is currently a Ph.D. Candidate at the Department of Materials Engineering at São Carlos School of Engineering (EESC-USP). He has Bachelors in Materials and Manufacturing Engineering (2016) and MBA in Project Management (2019), both degrees from the University of São Paulo (USP). His areas of work include natural polymers from packaging application and composite materials. In the management field, his interests are Project Management and Self-Managed Teams focused on small organizations (startups).

Isotilia Costa Melo is a Ph.D. Candidate at São Carlos Engineering School (University of São Paulo) at the Department of Production Engineering. She has a Masters at the same university and department. She has 5 years of experience as Product Engineer and Test Engineer in the automotive industry. She has a Specialization in Welding Engineering at Mauá Technological Center, internationally recognized by International Welding Society. She has a Bachelor of Mechanical Engineering at São Carlos Engineering School (University of São Paulo).

Daniel Capaldo Amaral is Associated Professor at São Carlos School of Engineering, University of São Paulo, Brazil. His research interests are Product Development and Innovation Management. Recently has dedicated special research effort to understand Agility Construct and Agile Project Management Techniques for innovative products development, including concepts as hybrid models, scalability and improvisation.

The goal was to analyze a product development project carried out by the company (of new material) from the perspective of agile software management for self-managed teams. We sought to connect the gaps in the current management model of the company, which is purely traditional, with a model of actors and self-managed team roles identified in the study of software development companies by Hoda et al. (2013). With product development adaptations, these roles can be played within the project team once the team has gradually transitioned to the agile design philosophy leading the development of more innovative projects in the scenario of recycled materials.

LITERATURE REVIEW

Background on Self-Management

Hoda et al. (2013) shows that the history of the development of the study of self-managed teams had its evolution through four main perspectives, namely: the perspective of organizational theory (1980), the perspective of knowledge management (1980), the perspective of complex adaptive systems (1990) and, finally, the perspective of agile management (2000). From the organizational perspective, it comes to the concept of holographic organizations, where the qualities and characteristics of the whole (organization) can be seen or embedded in each part (teams and team members). This presupposes the alignment of teams with the vision established by top management (Djassemi, 2014; Jensen, 1982).

The concept of vision is commonly defined as a minimum critical specification, which would be the critical factors needed to direct teams. From this perspective, self-managed teams are needed when changes occur in the organization, and they are responsible for increasing company flexibility, as measured as the speed at which responses to change occur (Benassi, Amaral, & Ferreira Junior, 2011). There is also a mention of role redundancy, in which members can perform a diverse set of tasks, and the team does not rely on one or another specific skill of only one member. (Fægri, Dybå, & Dingsøyr, 2010; Hoda et al., 2013).

From the perspective of knowledge management, a team has autonomy when it has the freedom to choose its tasks and there is minimal interference from top management in daily activities. Competency redundancy is here referred to as cross-fertilization which still involves a sense of empathy with the perspective of other team members in seeking a better understanding of the problem and how it will be addressed. An important construct that appears in this perspective is the self-transference, from which the team itself can set their goals and objectives, being able to self-evaluate in pursuit of these goals, looking for the best way to achieve them. Knowledge is transferred among the various hierarchical layers of the organization through tacit and explicit knowledge. (Huber, 2001; Omar Sharifuddin Syed-Ikhsan & Rowland, 2004).

The perspective of complex adaptive systems defines complexity as an environment with a high level of uncertainty, ambiguity, interdependence, high speed, and heavily dependent on innovative processes and operations. This perspective establishes the complex leadership framework and states that this construct has three components: operational leadership, entrepreneurial leadership, and enabling leadership. (Dooley, 1997; Schneider & Somers, 2006; Uhl-Bien, Marion, & McKelvey, 2007).

Operational leadership would be classic leadership, based on the central figure of the leader as a decision-maker from multiple layers of hierarchical levels, aimed at the top management of the organization. Entrepreneurial leadership would be that which occurs at the work team level, with exploratory actions, more informally and without pre-defined rigid structures, to create new forms of knowledge, skills, and products (Yang, 2008). The balance between these two leadership poles would be the enabling leadership, which roughly would be the middle ground between the two leaderships, though with the function of making the two extremes work synergistically to deliver value to the organization and client in search for the so-called adaptive space. (Hoda et al., 2013; Uhl-Bien & Arena, 2018).

The adaptive space acts as a neural network of interactions among the various actors of the organization ranging from structured (operational) to disorganized (entrepreneur), and the connection made by the enabling leadership is considered the "limit of chaos". The existing boundary between structured and informal, always questioning the need for bureaucratic processes and the need for authority in the

development of certain projects. Moreover, complex leadership theory does not focus on leaders as individuals, though rather on the need imposed by the environment in the face of adaptive challenges. Leadership, then, is not about control but about seeking knowledge development, adaptability, and innovation shared among the actors of the organization in a cost-effective way. (Uhl-Bien & Arena, 2018; Uhl-Bien et al., 2007).

Self-Management for Software Development and the Coach Role

From the perspective of complex adaptive leadership, Bäcklander (2019) developed a conceptual model in the search for adaptive space in a streaming company that conducts its projects with agile management practices and principles. The author clarifies the key role played by the agile coach in the search for adaptive space and the continuous improvement in team delivered value. (Bäcklander, 2019).

The perspective of agile software development derives from the accumulation of knowledge generated by the other perspectives and incorporates the main theoretical constructs in agile philosophy. The concept of self-managed staff is one of the principles behind the agile manifesto and is identified as one of the critical factors for the success of agile projects (Sutherland, 2014). Self-managed teams from this perspective are teams of 10-15 people who take responsibility for choosing and the best way to accomplish their tasks. They are guided by a vision built for the company by top management and are committed to value delivery. (Hoda et al., 2013).

From this perspective, the team is not called 'without leadership', it is up to the leader to just set the direction, align members, get resources and motivate the team. The leadership role, however, is not unique to just one member; it can, like the other roles, alternate among members under a specific problem situation, and just as it emerges, that role disappears after the problem has been resolved. It is, therefore, called 'transient'. This alternation of roles occurs informally and spontaneously, with the presence of the coach, who does not actively participate in the delivery of the project, though plays a fundamental role in coordinating and motivating the team. In agile software methods, the coaching role is played by Scrum Masters or XP Coaches, who are also responsible for providing training and ensuring alignment with the agile method practices. (Hoda et al., 2013; Sutherland, 2014).

Precisely because there are no defined roles and there is such role interchangeability among the actors, there is a difficulty in guiding and leading the team and, therefore, many studies in the area of agile software development have explored the definition of the necessary roles in a self-managed team and coach's importance both in the process of transitioning from a traditional team to a self-managed team and in maintaining that team's performance and efficiency in delivering value to the customer and the organization. (Hoda et al., 2013; Rodriguez, Soria, & Campo, 2016).

Hoda et al. (2013) conducted a ground theory study, involving 58 agile practitioners from 23 software organizations in New Zealand and India over four years, to identify the emerging informal roles in agile teams that made them self-managed teams. The roles found and their main functions are listed in Table 1.

Table 1: Roles and main functions of agile practitioners according to Honda (2013).

ROLE	FUNCTIONS
Mentor	Who guides and supports the team at the beginning, helping the members to become confident in the use of agile methods, encouraging the using of self-organizing practices.
Coordinator	A representative of the team in the task of managing clients expectations, guiding the collaboration of the client with the team.
Translator	The "bilingual" between the business language (clients) and technical terms (team), responsible for better communication among the two sides.
Champion	A representative of the agile cause with the senior management and within the organization to obtain support for the team.
Promoter	Who promotes the agile with the clients, assuring the engagement and the collaboration for the team efficiency.
Terminator	Who identify threating members who jeopardize the good working and productiveness of the self-organizing agile team. Responsible for engaging senior management to remove these members for the team.

Whenever a new member is added to the team, it is up to a senior member to guide and mentor him/her in the team/organization culture and in developing the agile practices adopted by the team. The role of the coordinator arises to overcome challenges and facilitate collaboration with customers by coordinating communication and requirements between the two parties and is also responsible for managing customer expectations regarding team deliveries. Developers and costumers use different languages to translate requirements into tasks, and obviously, developers incorporate a more technical language into their activities, and it is up to the translator, with the help of the coordinator, to translate this technical language into a business language, accessible to customers and other stakeholders, and vice versa. It is crucial, therefore, that the translator knows both languages and is comfortable speaking in both. Therefore, the interaction interface of the coordinator and the translator is with the customer. (Hoda et al., 2013).

The promoter is another role that interfaces with the customer. It ensures proper customer involvement in iterations. Many projects fail due to a lack of customer involvement or improper involvement. The promoter has the role of being the thermometer of customer engagement and acting where necessary to make collaboration as effective as possible. It acts in gathering and prioritizing requirements and transmitting feedback. (Hoda et al., 2013).

Another team interface is made with top management in the search for resources and decision-making support and this role is played by the champion. The champion is of fundamental importance because it is also up to him/her to know if agile methods apply to the context of the ongoing project. Whether the role of the champion is also played by a senior member manages the traditional-agile transition has a greater chance of success. (Hoda et al., 2013).

Finally, the exterminator's role is to remove members who do not fit the culture and way of work of the self-managed team, such as authoritarian members or members who do not actively participate in decision making, which may decrease the productivity of the team in performing their tasks. Figure 1 summarizes the main activities and functions performed by the previously mentioned roles. (Hoda et al., 2013).

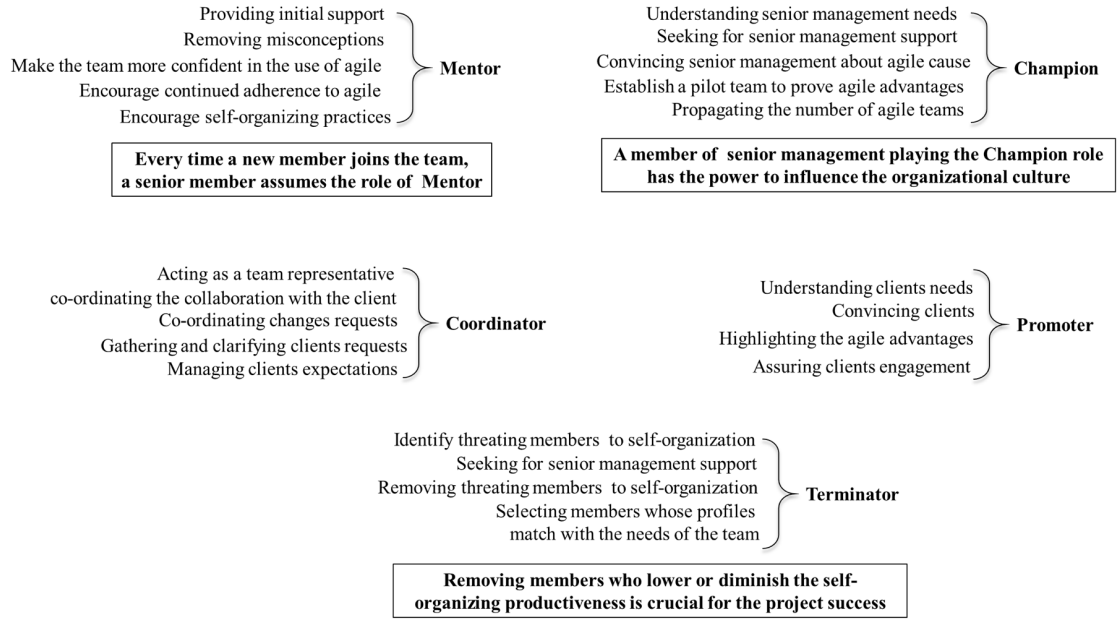


Figure 1. Visual clarification of the roles and main functions of agile practitioners according to Honda (2013).

Transition from Traditional to Self-Managed Teams

It is emphasized by the authors Hoda et al. (2013) and Rodriguez et al. (2016) that these roles emerge to the detriment of the needs and problems faced by the team, and can be performed by any member since the basic requirement is the redundancy of skills among the members. However, in the transition from the traditional team to the agile team, most of these roles are played by the agile coach, who is responsible for transforming the traditional team into a self-managed team. Later, when the team is mature in its activities and can deliver value in iterations to customers, these roles alternate among members, and the coach monitors, coordinates and motivates the team and identifies potential threats to the authorized system and may play the role of exterminator when necessary, as illustrated in Table 2. (Hoda et al., 2013; Rodriguez et al., 2016).

Table 2. Evolution of the roles according to the maturity of agile team according to Honda (2013).

ROLE	NEW TEAMS	MATURE TEAMS	INTERACT WITH
Mentor	Coach	Any Member	Team, Senior Management
Coordinator	Developers, Business Analysts, Coach	Any Member	Team, Customers
Translator	Business Analysts	Any Member	Team, Customers
Champion	Coach	Any Member	Senior Management
Promoter	Coach	Any Member	Customers
Terminator	Coach	Coach (Jointly with the Team)	Team, Senior Management

Specifically, on coaching roles in this early stage of the transition from traditional to agile management, Moe et al. (2015) presents Hackman's framework with three main focuses: i) by effort to minimize coordination and motivation problems (reduce loss effort) and to help members build commitment to the group and its tasks (gain effort); ii) knowledge and skills, to help team members avoid scattered ideas (out of sight) and help the team learn to share their experiences to build a skill repertoire for the group; iii) performance strategies: help team members avoid failing to implement their plans and help the team develop new creative work paths. (Moe, Cruzes, Dyba, & Engebretsen, 2015).

In another study, developed by Rodriguez et al., (2016), two teams of students received Scrum training simultaneously with the same number of hours, meetings, etc. Subsequently, one team developed the project with the presence of an agile coach, and the other developed the project with team members only. From 19 evaluated aspects, the authors were able to build a qualitative analysis of the difference in performance between teams with and without an agile coach in software development. The authors found that the team that was assisted by the coach in the development of the project presented 22% more adherence to the taught agile practices. Among the aspects, those with the greatest difference are listed in Table 3.

Table 3. Aspects with greatest divergence between teams with and without agile coach according to Rodriguez et al. (2016).

MAIN DIVERGENCE ASPECTS	
P1	Establish and keep project plan estimates.
P5	Develop the product or product components of the project.
P8	Conduct the preparation for validation.
P14	Analyze and mitigate risks.
P16	Monitor current project performance and progress against project plan.
P17	Manage corrective actions when results or performance deviate greatly from expectations.
P18	Objectively evaluate the adherence of the methodology used concerning the project products.
P19	Track communication nonconformities and ensure their resolution.

The authors concluded that the quality of team performance increases substantially with active coach participation, which contributes to the incorporation of technical and non-technical skills, aiding in conflict resolution, as well as to the stimulating self-criticism, brainstorming, and motivation. It is further emphasized that the lack of ability to estimate task execution time, how many tasks will be performed in the iteration, and the lack of ability to discard unhelpful codes were characteristics found in both teams, regardless of coach participation. The level of maturity and team experience are success factors in adhering to agile practices and delivering value. (Rodriguez et al., 2016).

Now that the actors and roles developed in a self-managed team have been discussed, it is also pertinent to highlight the factors that influence the transition from a traditional team to an agile self-managed team. Gandomani & Nafchi (2015) developed a complete framework for the transition and adoption of agile project management processes. The authors divided the model into four broad groups: key prerequisites for agile transformation, facilitators of agile transition, transition challenges, and the transition model itself, containing crucial structural characteristics that the organization must present and key activities to be carried out in the transition process, as illustrated in Figure 2. These activities should be performed iteratively.

The goal of the model, according to Gandomani & Nafchi (2015), is to help software companies achieve business value in the shortest possible time by continuously and gradually adopting the framework. Gradual transitions reduce the risks and challenges of the change process by giving team members enough time to adapt and adhere to agile practices. A transition process requires changing mindsets, behaviors, and culture, which takes time. At this transition stage, the authors also identify the coach's role primarily as a motivating agent for team members to adapt and take on new roles and responsibilities.

Figure 2. Activities to be performed iteratively during the transition to agile management according to Javdani Gandomani & Ziaei Nafchi (2015).

❖ **Pre-requirements**

Convincing reasons to change
Clear definition of the business goals
Stakeholders buy-in
Initial training
Initial evaluation
Assembly of the teams

❖ **Transition Facilitators**

Training
Senior management buy-in
Team members buy-in
Have a good coach and mentor
Adequate people selection
Empowering of team members
Agile champions

❖ **Transition Challenges**

Negative human aspects
Inadequate training
Technical issues
Problems with clients

❖ **Transition framework**

Key activities	Structural Features
Methods selection	Value based
Adaptation	Iterative
Evaluation	Continuously
Retrospective	Gradual
Adjust	

Jovanović, Mas, Mesquida, & Lalić (2017) presented an "inadequate to agile transition" model developed from the study of a large Information & Technology (IT) company during its transition period. In this paper, the authors showed the context and causes that lead to inefficient or inadequate transitions in a traditional organization for the creation of self-managed teams, presenting the main consequences. It can be said that the model is complementary to the model presented by Gandomani & Nafchi, (2015) because the critical success factors cited by Gandomani & Nafchi, (2015)are the main points where errors occurred in the transitions in the model of Jovanovic et al. (2017). (Gandomani & Nafchi, 2015; Jovanović et al., 2017).

Self-Management for Product Development

As observed in the software industry, the study of self-managed teams and their fundamental role in the implementation of agile management has been developed in-depth by the various research groups. For the manufacturing industry, however, few papers are found in the literature on self-managed teams or project management transition models for agile projects. (Kaikkonen et al., 2018).

Kaikkonen et al. (2018)analyzed 7 manufacturing companies, working with rapid product development for small-scale production, aiming to correlate the development performance of these products with the presence of self-managed teams. In this study, the authors analyzed the presence of self-managed teams from the perspective of high-performance teams from 1950, also commented by Hoda et al. (2013). Nine characteristics were considered important and make a self-managed team. These are presented in Table 4.

Table 4. Important characteristics for a self-managed team (Kaikkonen et al. ,2018; Hoda et al., 2013).

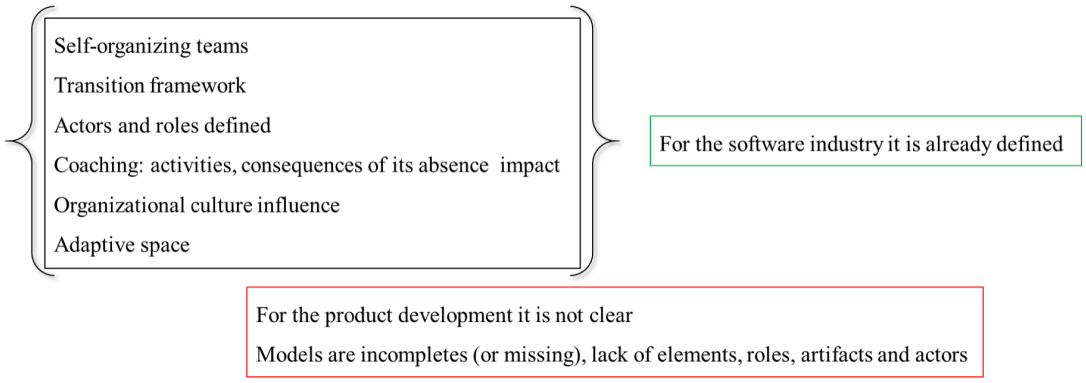
FEATURES OF A SELF-ORGANIZING TEAM
Team members are formally hired.
Team members are dedicated to one project only.
Team members are allocated in the same space.
Control of resources distributed among members.
The leader is the sole evaluator of team members.
Staff need not follow organizational practices and procedures.
Staff can set their own goals and incentives.
The team is responsible for the success of the project.
Cross-functionality.

Table 5. Factors for the team's success in performing the tasks (Kaikkonen et al., 2018).

SUCCESS FACTORS IN RAPID PRODUCT DEVELOPMENT
Clear workflow
Competent team members allocated in the same space
Competent engineers
Prior knowledge of the project at hand
Informal workflow (less bureaucracy)
Self-organization of work for development and project
Good communication of requirements

Whether the study conducted for manufacturing companies is compared with those previously shown for the software development industry, it is observed that Kaikkonen et al. (2018) followed an older perspective, still treating self-managed teams as the sole dependents of a leader with one set of skills and technically competent members to carry out their duties. So Kaikkonen et al. (2018) analyzed at the macro-level. There is a lack of in-depth discussion at the micro-level, which would define the organizational context in which the team needs to manage projects in an agile manner, the roles to be played by the team and top management, and how it fits into the delivery of value to the performed tasks. There is also confusion in the meaning of the term agile. The name "agile" for authors seem to mean faster development and faster market entry, without any mandatory link with the agile philosophy. Figure 3 summarizes what was discussed above.

Figure 3. Visual clarification of the existing theory for agile management in the software industry and the relationship with the context of physical product development.



However, even in agile software development teams, it is difficult to find examples of self-managed teams that have all the roles mentioned by Hoda et al (2013). For example, in the paper of Tengshe & Noble (2007), where the authors tracked the implementation from an Agile Project Management Office (PMO-agile), the role of the champion played by a member of senior management and responsible for ensuring the organization's adherence to agile practices was evident, which was considered a success factor in implementing this office. In another study, Rajeev & Hejib (2018) followed the implementation of the agile culture in a team from Siemens's digital division, which develops the control and automation part of the company. In the team structure, it is clear the role of the mentor, responsible for training new members, and the role of the champion, responsible for representing the "agile cause" before the top management. (Hoda et al., 2013; Rajeev & Hejib, 2018; Tengshe & Noble, 2007).

Methodological Procedures

As this paper aimed to analyze a product development project management of a startup company focused on new material technology development from the perspective of agile software management for self-managed teams, this research is characterized by a qualitative, exploratory and descriptive nature.

The technology startup company, which operates in the area of polymer innovative solutions - inner of São Paulo state, Brazil - was selected because, due to its sector nature, the company simultaneously presented the characteristics of a manufacturing company and of an agile software company, which is, from one side, traditional management methods and, on the other side, small teams (maximum of 16 people), pressed to bid and win government calls PIPE –FAPESP *(Pesquisa Inovativa em Pequenas Empresas – Fundação de Amparo a Pesquisa do Estado de São Paulo* – free translated to English as *Innovative Research in Small Business – São Paulo Research Foundation*), through technological product development proposals that must be developed in no longer than three months (the calls classified as Phase 1).

As presented in the literature review, the first step was to perform a literature review focused on ground theory and similar applications to manufacturing industries in a context of a developing country, especially focused on those companies transitioning from traditional to self-managed team.

Considering the lack of literature in this subject, the second step was to visit and observe (without interaction) which were the project management practices, focused on mapping the history of project management and to characterize the company, focusing on its ideation processes, proposals, and project management practices. A total of six visits were executed in July 2018. In the last week of the month, it was performed a semi-structured interview with a senior manager of the startup, with the same focus as the observational visits. Finally, the obtained answers and observations were critically analyzed to identify the main gaps in the current management model and how the implementation of the roles and self-management actors (from the software industry) can contribute to improving the current project management of the startup.

This procedure is similar to what was executed by Kaikkonen et al. (2018), though instead of multi-case studies, it is performed in only one case study. Although the limitations and subjectivity of method, it

presents the descriptive scenario of the transition of a company from traditional to agile methods, in the context of a developing country in South America. It is a scarce and relevant theme, thus far, the literature on the topic does not appear to be established. In this way, the present paper is groundbreaking for helping to consolidate the literature.

PRESENTATION AND ANALYSIS OF RESULTS

Characterization of the Startup and its Processes

Firstly, it should be noted that although the company is relatively young (6 years old) and has few employees, it already has an R&D office, thanks mainly to the implementation of PIPE-FAPESP projects, which have resources to foster innovation in the company. This reality is differential since the vast majority of national companies (already consolidated) do not have an R&D office. Also, the Project Manager (PM) attributes the company's success factor and competitive advantage to the high technical skills of its staff.

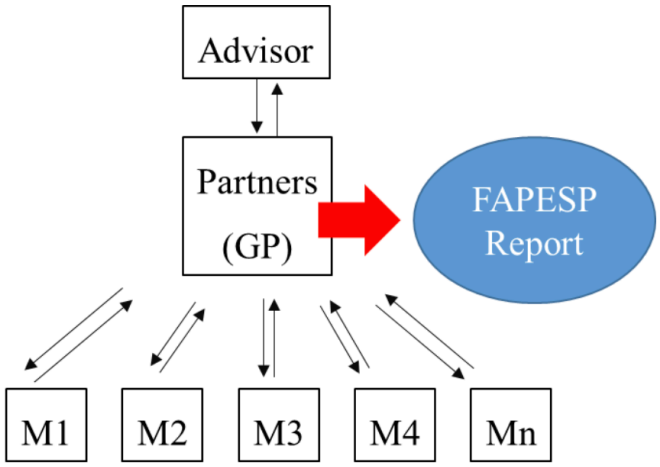
As for the development of the PIPE-FAPESP projects, the ideation arises in meetings between two partners (doctors in materials engineering) and a retired Ph.D. professor, who acts as an academic advisor and mentor. The focus of the projects is on composites of recycled polymeric matrices reinforced with vegetal fillers, area of formation and great domain of the involved ones. The innovative degree of the projects lies in the strong environmental appeal for the development of commodity polymers from solid waste of the producing industries, both matrix polymer, and fillers (vegetable waste). The potential of the project in creating circular economy routes is of great interest to large industries.

After the ideation phase, both partners write the project and one of them officially becomes the PM. The project is then technically reviewed by the advising professor and subsequently submitted to FAPESP (São Paulo Research Foundation). In the project, besides the conception and the way of conduction, the detailing of the scope, the budget, and the deadlines for the accomplishment of the activities are crucial factors. Given approval, the activities must be carried out as proposed and signed in the granting term.

After the project is approved, which can take 9 to 15 months, the work team is formed and the PM distributes the tasks, managing the project by controlling the stipulated schedule in the work plan. The tasks involve the assembly and performance of technical tests, which are divided between employees and third parties. PMs analyzes the results and write the final report.

Daily follow-up meetings are held with team members to discuss the progress of tasks and the PM holds a monthly meeting with the mentor (advisor) to show the progress of the project. The tasks performed and the pre-established development steps in the work plan are the milestones and progress meters of the project. The meeting space is internal to the company, though it is not exclusive to the project area, being shared with the other areas of the company. The scheme shown in Figure 4 illustrates the current PM-centered model where M1, M2, M3 ... Mn represent the project team members.

Figure 4. Visual representation of the current hierarchical management process of the studied company where M1, M2...Mn are representation of team members.



At the end of the project, the PM organizes the main results and writes the final report. The report is reviewed by the advising professor and submitted to FAPESP. The approval of the report marks the end of the project. There is no closing meeting with staff and there is no record of lessons learned during the process.

Current Management Model and Its Gaps

From the analysis of the current conduction model of the PIPE projects, developed by the company, it was identified some elements that favor the traditional management model such as scope, fixed time, and the development of the project centralized in the PM, which monitors project progress by controlling the schedule of activities. The model based on the central and controlling figure of the PM has its limitations, especially when working with a skilled team, such as the company in question. The role of task executor for employees can, in the medium and long terms, demotivate the group due to the lack of innovation and the routine generated by the technical activities. Since they do not actively participate in decisions, a sense of non-belonging can be developed by not following the development of the project as a whole.

Besides, having the final report as the project's only at the closing milestone can impoverish the employees' relationship with the project, so that the members do not have (or have a lesser degree) the sense of accomplishment and achievement reached at the end of a project. As a result, the level of motivation for new challenges in later projects may be lower. Although it was reported by the respondent that communication within the project team is good, it was observed in the evaluation that project team members communicate mostly with the PM, reporting on the progress of their technical activities.

Finally, the absence of a project-only physical space can inhibit integration among team members who divide attention between the ongoing project activities and other company functions (service and consulting). Another point is that without recording lessons learned by the PM and other members, future projects can waste time and resources on challenges that have already been overcome in past projects.

Company Analysis from the Perspective of Self-Management

Analyzing the company from the perspective of agile project management and the actor and role model developed by Hoda et al. (2013) for self-managed teams, it is possible to observe that, currently, none of the roles are being played by the team that executed this PIPE project (Table 6).

Table 6. Actors and roles currently in visage by the analyzed company.

Role from Theory	Organizational Position	Evidence (from questionnaire)
Mentor	*None*	*Agile methods and self-managed practices are not used in the company as the managing activities is centered on the PM decisions.*
Coordinator	*None*	*The actual project product is the final report. Therefore team members and also the project leaders do not deal directly with potential customers.*
Translator	*None*	*The technical character of the project does not require a translator role yet. However, in the future this role could be interesting in order to widespread the project achievements to non-technical perspectives to sell the project concept/ material more easily to a potential costumer.*
Champion	*None*	*Team members are yet structured as task executors. Yet no autonomy is giving to any member to proper develop self-managed skills*
Promoter	*None*	*Collaboration between team members is aided by the PM. However, there still no effort on bringing the team to interact with possible clients as picked above.*
Terminator	*Partners (PM)*	*Like other traditional teams, the PM has the power to hire and dismiss any team member that is not meeting the expectations. However, the self-managed parameters of performance (expectations) are still not set by the partners and team members.*

The first step for the team, following the transition model of Gandomani et al. (2015), would be for the PM to receive adequate training to incorporate agile practices and philosophy into the company. (Gandomani & Nafchi, 2015; Hoda et al., 2013).

Another possibility would be to bring in an outside coach, as was done in the Siemens project described by Rajeev et al. (2018), which would have the role of training the entire team and performing these roles until their full maturity. Once the practices were selected and made the necessary adaptations to fit them in the organizational culture, the team would be able to begin to develop its activities more independently.(Rajeev & Hejib, 2018).

Adapting the context of the six roles to product development of Hoda et al. (2013), we believe that the role of the "champion" would initially be a function of the current PM, which would play a key role in ensuring that team members and senior management adhere to agile practices, since he holds a high position in the organization, as proposed in Tengshe's PMO-agile transition example (Tengshe et al., 2007). Once the agile philosophy has been incorporated into the team, there will be a greater concern in identifying potential customers, shifting the project's milestone from being just the delivery of the final report to identifying potential customers for the developed materials and bringing these stakeholders jointly to collaborate in the early stages of development. (Hoda et al., 2013; Tengshe & Noble, 2007).

In this respect, the presence of the coordinator and translator would be essential to manage customer expectations, while translating market requirements into technical requirements and shaping project progress to reach targeted products faster. In this interface with the customer, the role of the promoter would also arise responsible for convincing customers of the gains in working by following the agile approach. The exterminator role would again fall to the current PM that, once the team is at a satisfactory maturity level, could slow down or even stop its technical roles and perform only the coaching role.

It is noteworthy that assembling the team with members from different backgrounds to have a wider range of skills available is essential. The current configuration of the teams does not priories diversity and different skills aggregation. Consequently, when the culture of shared knowledge is implemented in the organization there is also an essential aspect to the success of self-managed teams that is to avoid role redundancy. This factor was also mentioned in the rapid product development model of Kaikonnen et al. (2018).

As described in detail in the literature review, there is no complete and in-depth self-managed team implementation and transition model for the product development industry as there is for the software development industry. As a result, manufacturing companies miss out on bringing the value delivery of the agile project management approach into the organization.

CONCLUSION

In the present paper, it was sought to execute a review about the development, transition, roles, and actors involved in the process of transformation from a traditional team to an agile self-managed team. It has been observed that in software development theory traditional-agile transition models, along with success factors and major causes of inefficiency, are well established through complete conceptual models.

The actors and roles that must be played to build and evolve a self-managed team have also been established through ground theory studies. In this case it was possible to present a method that can be successfully applied to verify the transition state from traditional to self-managed teams using the conceptual model of Hoda et al (2013).

In the area of physical product development and manufacturing, on the other hand, the theoretical models are rarely considered, most of the studies remained in superficial analyzes (macro-level). The current paper sought to apply the actors and roles model developed for self-managed teams in software development in the analysis of the product development team that traditionally manages their projects and, therefore, faces some difficulties and limitations. From the perspective of self-managed teams, it has been shown that roles can be adapted to develop physical-product development projects with greater value delivery to the organization and potential customers.

References

Bäcklander, G. (2019). Doing complexity leadership theory: How agile coaches at Spotify practice enabling leadership. *Creativity and Innovation Management,* 28(1), 42–60. https://doi.org/10.1111/caim.12303

Benassi, J. L. G., Amaral, D. C., & Ferreira Junior, L. D. (2011). Product vision management: concept and models evaluation. *Product Management & Development,* 9(2), 163–172. https://doi.org/10.4322/pmd.2012.008

Cooper, R. G., & Sommer, A. F. (2016). Agile-Stage-Gate: New idea-to-launch method for manufactured new products is faster, more responsive. *Industrial Marketing Management*, 59, 167–180. https://doi.org/10.1016/j.indmarman.2016.10.006

Djassemi, M. (2014). Lean Adoption in Small Manufacturing Shops: Attributes and Challenges. *Journal of Technology, Management, and Applied Engineering,* 30(1), 2–10.

Dooley, K. J. (1997). A Complex Adaptive Systems Model of Organization Change. *Nonlinear Dynamics, Psychology, and Life Sciences Volume, 1*, pages69–97. https://doi.org/https://doi.org/10.1023/A:1022375910940

Fægri, T. E., Dybå, T., & Dingsøyr, T. (2010). Introducing knowledge redundancy practice in software development: Experiences with job rotation in support work. *Information and Software Technology*, 52(10), 1118–1132. https://doi.org/10.1016/j.infsof.2010.06.002

Gandomani, T. J., & Nafchi, M. Z. (2015). An empirically-developed framework for Agile transition and adoption: A Grounded Theory approach. *Journal of Systems and Software*, 107, 204–219. https://doi.org/10.1016/j.jss.2015.06.006

Hänninen, K., Haapasalo, H., & Kaikkonen, H. (2018). Characteristics of self-managing teams in rapid product development projects. *International Journal of Value Chain Management, 9*(1), 1. https://doi.org/10.1504/IJVCM.2018.10012143

Hoda, R., Noble, J., & Marshall, S. (2013). Self-Organizing Roles on Agile Software Development Teams. *IEEE Transactions on Software Engineering, 39*(3), 422–444. https://doi.org/10.1109/TSE.2012.30

Huber, G. P. (2001). Transfer of knowledge in knowledge management systems: unexplored issues and suggested studies. *European Journal of Information Systems, 10*(2), 72–79. https://doi.org/10.1057/palgrave.ejis.3000399

Jensen, M. (1982). Organization Theory and Methodology. *The Accounting Review, 58*(2), 319–339. Retrieved from http://www.jstor.org/stable/246838

Jovanović, M., Mas, A., Mesquida, A. L., & Lalić, B. (2017). Transition of organizational roles in Agile transformation process: A grounded theory approach. *Journal of Systems and Software, 133*, 174–194. https://doi.org/10.1016/j.jss.2017.07.008

Kaikkonen, H., Haapasalo, H., & Hänninen, K. (2018). Characteristics of self-managing teams in rapid product development projects. *International Journal of Value Chain Management, 9*(1), 1. https://doi.org/10.1504/IJVCM.2018.091097

Moe, N. B., Cruzes, D. S., Dyba, T., & Engebretsen, E. (2015). Coaching a Global Agile Virtual Team. In *Proceedings - 2015 IEEE 10th International Conference on Global Software Engineering, ICGSE 2015* (pp. 33–37). https://doi.org/10.1109/ICGSE.2015.26

Omar Sharifuddin Syed-Ikhsan, S., & Rowland, F. (2004). Knowledge management in a public organization: a study on the relationship between organizational elements and the performance of knowledge transfer. *Journal of Knowledge Management, 8*(2), 95–111. https://doi.org/10.1108/13673270410529145

Rajeev, B. V., & Hejib, V. (2018). Control based management to self organizing agile teams. In *Proceedings of the 13th Conference on Global Software Engineering - ICGSE '18* (pp. 16–20). New York, New York, USA: ACM Press. https://doi.org/10.1145/3196369.3196394

Rebentisch, E., Conforto, E. C., Schuh, G., Riesener, M., Kantelberg, J., Amaral, D. C., & Januszek, S. (2018). Agility factors and their impact on product development performance. *Proceedings of International Design Conference, DESIGN, 1,* 893–904. https://doi.org/10.21278/idc.2018.0236

Rodriguez, G., Soria, A., & Campo, M. (2016). Measuring the Impact of Agile Coaching on Students' Performance. *IEEE Transactions on Education, 59*(3), 202–209. https://doi.org/10.1109/TE.2015.2506624

Schneider, M., & Somers, M. (2006). Organizations as complex adaptive systems: Implications of Complexity Theory for leadership research. *The Leadership Quarterly, 17*(4), 351–365. https://doi.org/10.1016/j.leaqua.2006.04.006

Sutherland, J. (2014). *Scrum: The Art of Doing Twice the Work in Half the Time*. Crown Business.

Tengshe, A., & Noble, S. (2007). Establishing the agile PMO: Managing variability across projects and portfolios. In *Proceedings - AGILE 2007* (pp. 188–193). https://doi.org/10.1109/AGILE.2007.24

Uhl-Bien, M., & Arena, M. (2018). Leadership for organizational adaptability: A theoretical synthesis and integrative framework. *Leadership Quarterly, 29*(1), 89–104. https://doi.org/10.1016/j.leaqua.2017.12.009

Uhl-Bien, M., Marion, R., & McKelvey, B. (2007). Complexity Leadership Theory: Shifting leadership from the industrial age to the knowledge era. *Leadership Quarterly, 18*(4), 298–318. https://doi.org/10.1016/j.leaqua.2007.04.002

Yang, C.-W. (2008). The Relationships Among Leadership Styles, Entrepreneurial Orientation, and Business Performance. *Managing Global Transitions, 6*(3), 257–275.