The Influence of Organizational Factors on Inter-team Knowledge Sharing Effectiveness in Agile Environments

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Abstract

Agile software development is known by focusing on interaction among team members to share knowledge. However, little guidance is provided to encourage interaction across agile teams. Based on a preliminary conceptual model, this paper examines influencing factors, such as organizational strategy, and communication flow and channels, regarding inter-team knowledge sharing (KS) effectiveness in agile environments. We analyze the characteristics and the influence of the mentioned factors through a survey research method. Data was gathered from seven Brazilian agile software organizations. We employed statistical analysis techniques, e.g., structural equation modeling and cross-table analysis, to analyze the results. Within the surveyed companies, organizational strategy reflects on moderate commitment towards knowledge. KS practices are carried out to an acceptable standard. Extensive communication flow and the use of several channels denote that agile companies are also fostering interaction across teams. We found strong relationship between these factors and the companies' experience on agile methods. As companies continue on an agile adoption program, they growingly focus on long-term goals and consider knowledge as strategic resource. However, they still need to improve strategy alignment to all organization levels. Thus, we recommend that agile companies consider these factors when striving on this endeavor.

1. Introduction

Agile methods stimulate significant intra-team knowledge sharing (KS) through face-to-face interactions [1]. However, they provide little recommendations about coping with inter-team KS, which is fundamental in creating organizational knowledge [2].

Inter-team KS[1] in agile software development still needs more research [3] [4]. The approaches presented in literature are few and classified as codification and personalization strategies [5]. The codification strategies correspond to make knowledge explicit through the use of tools and collaboration platforms [4] [6] [7]. The personalization strategies encompass spaces to foster interaction between people [8], communities of practice in skill circles [9] [10], rotation of professionals [11], technical presentations [12] and Scrum of scrums [13].

1.1. Preliminary conceptual model

A grounded theory study was previously conducted to investigate inter-team KS effectiveness in agile software organizations [14]. The emerging theory indicates that such organizations also deal with inter-team knowledge sharing by applying practices to foster social interactions. The practices adopted have a well-defined description and classification according to specific purposes, such as leveling knowledge. Practices adopted by most of the studied agile companies were face-to-face conversations in the workspace environment, collective informative workspaces, rotation among teams, collective meetings, pair programming between different teams, technical presentations, marathons and coding dojos.

Organizational conditions (e.g., culture) and stimuli (e.g., problem-situations) are influencing factors that empower or hinder inter-team knowledge sharing. The effectiveness of inter-team knowledge sharing practices consists of the following four components. The level of purpose achievement is the extent to which the reason for sharing knowledge is accomplished. The frequency is the periodicity at which the practice is performed in the organization. The level of formalization is the degree of institutionalization of the practice in the organization,

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[1] This means KS among agile teams of the organization.

[2] The *ComputerWorld* magazine's criteria consider

and reassessment is whether and how often the practice is evaluated by the organization.

This preliminary theory was the first step towards understanding this topic in agile organizations. However, such theory did not provide the main characteristics of conditions found in agile contexts.

1.2. Research motivations and overview

As the influencing factors determine the achievement of inter-team knowledge sharing effectiveness, in this study we chose to examine organizational strategy, communication flow and its channels. The main motivations of this study are to understand the characteristics of these factors in favorable agile contexts, and to analyze if these positively influence KS across teams. This understanding may improve guidance on the organizational knowledge creation in agile environments and its consequent organizational competitiveness. We employed a survey [15] in seven Brazilian agile companies, which employ inter-team knowledge sharing and provide favorable conditions for KS to happen and obtained 57 responses.

Organizational strategy seems to reflect on moderate commitment towards knowledge, i.e., the organizations show quite clear notion of the importance of knowledge to carry out KS practices without demanding excessive investment and resources. This might suggest that agile companies should also consider establishing a consistent and aggressive KS strategy as a way to transform their businesses and become more competitive in the long-term. The communication flow and extensive use of channels denote that agile companies are also dealing with tacit knowledge across teams through face-to-face conversations, collective meetings and use of common tools.

The paper is organized as follows: in Section 2, the factors influencing inter-team knowledge sharing effectiveness are presented. Section 3 explains the survey research method. Section 4 describes the results. Section 5 articulates the results with existing studies and Section 6 presents the conclusions and further research.

2. Survey research approach

We chose to examine organizational strategy, and communication flow and channels, because they are management-related factors. Therefore our research questions are: *What are the characteristics of organizational strategy, and communication flow and channels in favorable agile environments? And what is*

the influence of these factors on inter-team knowledge sharing effectiveness? To answer these questions, we employed a survey research [15] on seven Brazilian agile organizations from February to June 2012.

2.1. Research constructs

Figure 1 illustrates the relationships among the research variables that are in the ellipses connected by the arrows and the variables' properties, in the rectangles. Effectiveness (EF) is the dependent variable being predicted or explained by the set of independent variables that compose the Organizational Conditions (OC), which are Organizational Strategy (OS), and Communication Flow and Channels (FC).
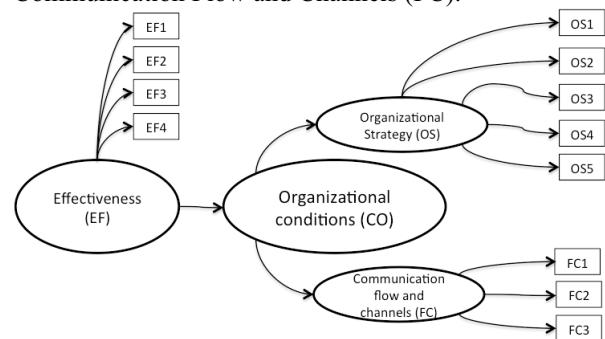

Figure 1. Research construct's overview.

Table 1 presents the research constructs used to validate the research constructs through the description of independent and dependent variables and its properties.

Table 1. Research variables and properties

Organizational strategy (OS)
OS1. The employees' knowledge is recognized by everyone in the organization as a strategic resource.
OS2. The strategy followed by the organization is widely communicated at all organizational levels.
OS3. The organization promotes a shared vision as a mean of conducting business through the values, mission and goals.
OS4. Teams are not only focused on the short term, i.e., frequent and quick deliveries, but also in the long-term strategies of the organization.
OS5. The organization's strategic posture provides a context for knowledge sharing and learning.

Communication flow and channels (FC)
FC1. The communication is effective among agile teams.
FC2. There is great incentive for communication in the organization.
FC3. There is extensive use of communication channels in the organization.

Inter-team knowledge sharing effectiveness (EF)
EF1. The knowledge sharing across teams in the organization is effective and totally achieves its purpose.
EF2. The practices adopted for sharing knowledge across

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teams have appropriate frequency.
EF3. The practices adopted for sharing knowledge across teams are widely known (formalized) in the organization.
EF4. The practices adopted for sharing knowledge across teams are periodically reassessed.

2.2. Population and sample

The population of this study represents Brazilian organizations that adopt agile methods, share knowledge across teams and have a favorable KS context. According to [16], a favorable context means organizational climate based on respect, mutual trust, willingness to help others and commitment.

The following criteria was established for the sample: (1) organizations that have not participated in the previous study [17]; (2) organizations that claim to adopt agile methods for at least two years and their representativeness in the Brazilian agile community by attending, lecturing, and organizing events; (3) organizations that have more than one agile team; (4) organizations that apply practices for sharing knowledge across teams; (5) organizations with favorable conditions for knowledge sharing. This latter criterion was reached by selecting organizations from the *ComputerWorld* 2011 ranking[2] considered by the participants as great places to work in the Brazilian IT domain. We selected organizations from this ranking, because they evaluate responses from employees regarding behaviors of credibility, respect and fairness, and levels of expressed pride and camaraderie in the workplace[3].

Within these criteria, our sample comprises 57 respondents in different positions and roles from 7 organizations (from A to G) of different sizes and business domains that are described in Table 2. The first column lists the representation of each company by letter; following is the interval size of their software development department; the third column represents the number of people who integrates agile teams per company; the fourth column shows the total of people who answered the survey; the subsequent column presents the respondents' rate; then we provide the number of excluded responses per company, concerning incomplete responses; and lastly the number of valid responses.

[2] The *ComputerWorld* magazine's criteria consider behaviors of credibility, respect and fairness, and levels of expressed pride and camaraderie in the workplace.
[3] The ranking evaluation criteria are detailed in www.greatplacetowork.com.br/melhores-empresas/sobre-a-inscricao-nas-nossas-listas/como-voce-sera-avaliado. This link, however, is in Portuguese.

Table 2. Research sample

Org.	Interval size	Total	Resp.	Resp.' rate	Excl. resp.	Valid resp.
A	>250	60	15	25%	3	**12**
B	21-50	15	4	26,66 %	0	**4**
C	51-100	29	10	34,48%	2	**8**
D	51-100	60	4	6,67%	0	**4**
E	51-100	12	7	58,33%	1	**6**
F	101-250	40	19	47,5%	6	**13**
G	101-250	20	10	50%	0	**10**
	Total	**236**	**69**	**29%**	**12**	**57**

Regarding the respondents' characteristics, the majority of participants are developers (50.8%), team leaders (21%) and project managers (12.2%), other positions (15.7%) correspond to software architects, designers, development managers and top managers.

About the respondents' experience with agile methods, most participants have less than 2 years experience (46.4%), experience between 2 and 4 years (42.9%) and between 4 and 6 years (10.7%).

Figure 2 shows the companies' experience on agile methods comprising agile teams. Most companies have between 2 and 4 years (68%), followed by companies with experience between 4 and 6 years (21%).
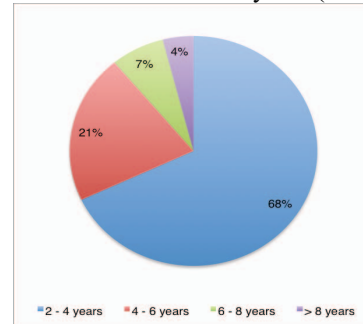

Figure 2. Companies' experience on agile methods.

2.3. Data collection

The survey data collection was performed through a questionnaire divided into five sections: (1) respondent's profile, (2) company profile, (3) assertions about organizational conditions and stimuli, (4) practices for inter-team knowledge sharing and (5) assertions about the effectiveness of the process. The questions of the first and the second sections were based on the VersionOne's agile methods state of practice questionnaire[4]. The other sections were based on [14] and [17]. This questionnaire covers all aspects of the conceptual model, but in this study only two

[4] The VersionOne questionnaire is available at: versionone.com/state_of_agile_development_survey/10

factors were examined. The questionnaire was built in March 2012. After that, it was implemented in the online survey tool called SurveyMonkey[5].

The respondents' opinions to the assertions were expressed by a 5-point Likert scale, in which '1' means "total disagreement" and '5' means "total agreement". We also included the option "neither agree nor disagree" in case of missing respondent's opinion.

Upon the conclusion of the questionnaire, we conducted a pilot data collection to identify inconsistencies, improvements and average time for questionnaire completion. The pilot questionnaire was sent to seven professionals from agile companies and academic institutions in Fortaleza, Brazil. The pilot took place during the week commencing on March 23th, 2012. Data gathered in this step also helped us to verify the suitability of the statistical tests chosen for analyzing the data and the statistical tool called R[6]. After corrections made to improve the understanding of the questions and assertions, we created a new version of the questionnaire, which was sent to seven different companies. The data collection period was set between April 1st and May 25th.

2.4. Data analysis techniques

First, we verified the reliability between the variables' properties through the Cronbach's alpha index. Then we analyzed the validity of the properties according to their constructs through confirmatory factor analysis (CFA) with the Pearson correlation coefficient [18].

Next, we explained the relationship between the constructs (dependent and independent variables) with structural equation modeling [19]. Lastly, we made a cross-table analysis with chi-square test to evaluate the correlation among the constructs and company experience on agile methods [18].

2.5. Threats to validity

This study presents a threat to external validity [20], because our sample is not considered representative. The empirical findings are based on data from Brazil. Although the country shares many characteristics with other emerging economies in terms of technology development, managerial practices and market conditions, this may also limit the generalizability of our findings. However, our intention

was not to generalize, but to answer the research questions and encourage further data collection.

Companies in this research had more than 2 years of experience in agile methods. In addition, these companies also give special attention to their organizational conditions. Therefore, the findings may not be applicable for companies with little experience in agile methods and with an unfavorable context.

As Runeson and Höst [20] state, when the researcher is investigating whether one factor affects an investigated factor, there is a risk that the investigated factor is also affected by a third factor. They argue that if the researcher is not aware of the third factor and/or does not know to what extent it affects the investigated factor, there is a threat to internal validity. In this study, we did not consider to analyze the intricate relationship of the examined factors, such as the use of communication tools influencing the organizational strategy to knowledge sharing. We also did not analyze the influence of other factors, such as the management style and the organizational culture, since we selected companies with favorable context to knowledge sharing.

3. Results

In this section, we present the results gathered by the statistical analysis techniques described in the subsections below.

3.1. Data reliability

Cronbach's alpha is used to analyze the reliability of the survey, taking into account the size of the sample and the relationship among the properties (items) [21]. Table 3 presents the research factors and the related Cronbach's alpha.

Table 3. Internal consistency estimate

Construct	Nº of items	Aver-age	Std dev	Cronbach's alpha
Strategy	5	4,287	0,779	**0,855**
Communication flow and channels	3	4,233	0,761	**0,851**
Effectiveness	4	3,627	1,109	**0,899**

The indexes reached values greater than 0.7, which denotes high reliability. The column "N° of items" represents the properties that are related to the independent and dependent variables. By testing the data reliability, we can perform a validation of the research constructs, and consequently analyze the level of dependence between the research variables.

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3.2. Descriptive Statistics

Regarding the strategy variable (Figure 3), most responses to the OS1 and OS3 were "totally agree", which may suggest that strategy towards knowledge is a concern for the surveyed companies.

However, properties OS2, OS4 and OS5 pointed to partial agreement, which may represent a difficulty of the surveyed agile organizations on putting the knowledge strategy into practice. Further data collection may confirm this finding.

Properties FC1, FC2, and FC3 presented partial agreement, followed by total agreement (Figure 4). The massive responses might be related to the companies' experience on agile methods. Such relationship is analyzed later in this section.
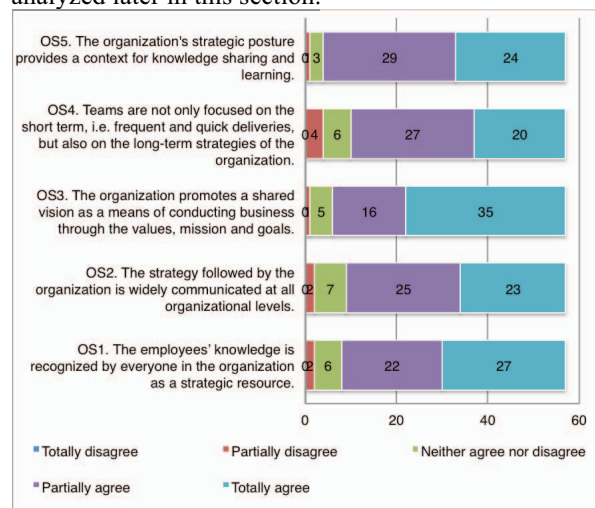

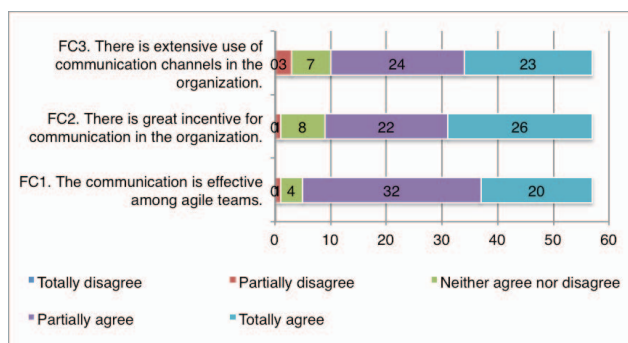**Figure 3. Responses to OS properties.**

Figure 4. Responses to FC properties.

Figure 5 presents the main communication channels used by the companies. In this case, face-to-face communication is the most used communication channel among agile teams, followed by meetings and

the use of common tools. These suggest that in co-located teams, the most used channels are the ones that foster interaction among agile teams' members.

3.3. Confirmatory factor analysis

Confirmatory Factor Analysis (CFA) is the analysis of variables, in order to decipher the factor structure underlying a set of related data [29]. CFA analyzes the relationship between a set of indicators and a set of factors. Thus, we employed this analysis to identify the relationship between dependent variables and its related properties, and to empower the validation of the variables of the research constructs under analysis.

Table 4 presents the CFA results for each property factor and their dependency degree. CFA values greater than 0.3 indicate a relationship between the variable and its properties.
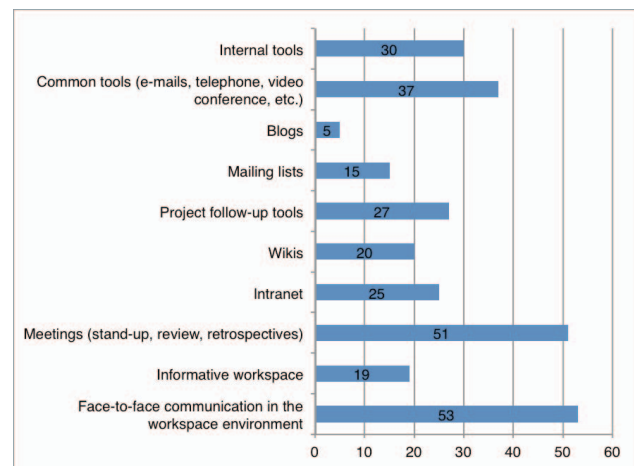
Figure 5. Communication channels adopted.

Table 4. Data validity with CFA

Property	OS	FC	EF
1	0,479	**0,550**	**0,764**
2	0,456	**0,740**	**0,938**
3	**0,665**	**0,685**	**0,845**
4	**0,545**		**0,781**
5	**0,582**		

3.4. Structural equation modeling

This analysis, in conjunction with the analysis of covariance between the dependent and independent variables, was employed to confirm the constructs' influence on the model and to answer the research question.

Table 5 presents the SEM coefficients for each pair of dependent and independent variables. According to

[18], the variance index must be higher or equal than 0.5. The coefficients meeting this value are outlined in boldface. Only strategy's coefficient was found below the expected value, but very close to it.

Table 5. Influence of the constructs with SEM

| Construct | Effectiveness | | | |
	Coefficient	Std error	z-value	Pr(>|z|)
Strategy	0,493	0,118	4,177	3,040
Communication flow and channels	**0,687**	0,089	7,737	1,019

Each coefficient has a statistical significance in the model (`z-value`), which is used to test whether the factors have statistically significant relations within the model [22]. Thus we have:

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z-value = Coefficient / Standard Error
```

The standard errors (`Std Error`) in the table present moderate values, then low influence in the calculation of the value of `|z|` is noted. Excessively large or small values may mean several problems such as poorly specified model or small sample size [21].

The influence of a given factor within the model is accepted only when the coefficient and the `z-value` are greater than 0.5 and 1.96, respectively [22]. In our case, the values were close to expectations and their `z-value` were higher than the expected.

The calculated indexes show that the relationship between dependent and independent variables may be standardized. Consequently, the higher the variables' coefficient, the greater their impact on knowledge sharing effectiveness. Thus, an important relationship between communication flow and channels and inter-team KS effectiveness was noted, since the coefficient and `z-value` were the highest.

`Pr(>|z|)` represents the probability of a random variable having an extreme value in relation to the observed value, if the hypothesis is true. If `Pr` is less than or equal to `z-value`, then we reject the null hypothesis and conclude the alternate hypothesis is true. If `Pr` is greater than the `z-value`, then we fail to reject the null hypothesis and conclude that the null is plausible. `Pr` for strategy and communication variables is less than their `z-values`, so the null hypothesis is discarded and the hypothesis is true.

3.5. Cross-table analysis between the factors and company experience on agile methods

In this subsection we present Pearson's Chi-Square values ($\chi 2$) for the association between the influencing factors and the company experience on agile methods.

The significant relationships were highlighted in boldface and consist of values higher than 7.7 with 3 degrees of freedom (`df`) and significance probabilities (ρ) from 0.01 (significant) to 0.0001 (very significant).

3.5.1. Organizational Strategy. Table 6 presents such associations. According to the research sample results, there may be very significant association between the recognition of knowledge as strategic resource and company experience on agile methods (higher than 19). There may be significant association between the transparency of the strategic orientation to the employees and company experience on agile methods (higher than 27). Also, there may be significant association between the provision of a context to share knowledge and learn, and company experience on agile methods (higher than 27).

However, there may not be significant association between the communication of the strategic orientation at all levels and company experience on agile methods, since we only got significance for responses related to "neither agree nor disagree". Likewise, there may not be significant association between the establishment of long-term strategies and company experience on agile methods.

These results might suggest that maturity on agile methods does not mean to have a clear and consistent strategic orientation to inter-team KS. Further data collection may confirm or refute these associations.

3.5.2. Communication. Table 7 presents this association. According to the index results, there may be very significant association between communication efficiency and experience on agile methods (higher than 12). We also notice very significant association between great incentive for communication and experience on agile methods (higher than 13.69). Likewise, we found very significant association between the extensive use of communication channels and experience on agile methods (higher than 15.78). This might suggest that the more the company gets mature on agile methods, the more the communication is improved, which impacts on inter-team KS.

Table 8 presents the association between the communication channels and company experience on agile methods. There may be very significant associations for face-to-face communication in the workspace environment ($\chi 2=51.8$), meetings ($\chi 2=47.3$), common tools ($\chi 2=38.6$), wikis ($\chi 2=17.2$), mailing lists ($\chi 2=15.1$), project follow-up tools ($\chi 2=14$), and intranet ($\chi 2=13.9$). There may also be significant associations for internal tools ($\chi 2=25.7$) and informative workspace ($\chi 2=7.7$).

4. Discussion

In this section we explain the results gathered from the statistical analysis techniques with related work.

4.1. Organizational strategy

Strategy represents the organizational intentions to achieving its goals within a changing and competitive environment [23]. This factor plays an important role in the KS process, because strategy influences the adoption of KS approaches within the company's routine operations to achieve long-term goals.

Table 6. Association between strategy and company experience on agile methods

Organizational strategy	Likert scale	Company experience on agile methods										χ^2	df
		> 8 years		6 - 8 years		4 - 6 years		2 - 4 years		Total			
		n	%	n	%	n	%	n	%	n	%		
The employees' knowledge is recognized by everyone in the organization as a strategic resource.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	1	8.3	1	2.5	2	3.5	2	3
	Neither agree nor disagree	0	0	0	0	1	8.3	5	12.8	6	10.5	11.33	3
	Partially agree	0	0	2	50	3	25	**17**	**43.5**	22	38.5	32.90**	3
	Totally agree	**2**	**100**	**2**	**50**	**7**	**58.3**	16	41	27	47.3	19.37**	3
The strategy followed by the organization is widely communicated at all organizational levels.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	1	8.3	1	2.5	2	3.5	2	3
	Neither agree nor disagree	0	0	0	0	1	8.3	6	15.3	7	12.2	**14.14***	**3**
	Partially agree	0	0	**2**	**50**	**7**	**58.3**	16	41	25	43.8	24.44	**3**
	Totally agree	**2**	**100**	**2**	**50**	3	25	16	41	23	40.3	24.47	**3**
The organization promotes a shared vision as a means of conducting business through the values, mission and goals.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	1	8.3	0	0	1	1.7	3	3
	Neither agree nor disagree	0	0	0	0	1	8.3	4	10.2	5	8.7	8.6	**3**
	Partially agree	0	0	1	25	2	16.6	13	33.3	16	28	**27.5***	**3**
	Totally agree	**2**	**100**	**3**	**75**	**8**	**66.6**	**22**	**56.4**	35	61.4	**29.11***	**3**
Teams are not only focused on the short term, i.e. frequent and quick deliveries, but also on the long-term strategies of the organization.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	1	8.3	3	7.6	4	7	6	3
	Neither agree nor disagree	0	0	0	0	1	8.3	5	12.8	6	10.5	11.33	**3**
	Partially agree	**1**	**50**	**4**	**100**	5	41.6	17	43.5	27	47.3	22.03	**3**
	Totally agree	**1**	**50**	0	0	5	41.6	14	35.8	20	35	24.4	**3**
The organization's strategic posture provides a context for knowledge sharing and learning.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	0	0	1	2.5	1	1.7	3	3
	Neither agree nor disagree	0	0	0	0	0	0	3	7.6	3	5.2	9	**3**
	Partially agree	**1**	**50**	**3**	**75**	**6**	**50**	**19**	**48.7**	29	50.8	**27.13***	**3**
	Totally agree	**1**	**50**	1	25	**6**	**50**	16	41	24	42.1	25	**3**

N = 57   Significance levels: *** ρ < 0.0001 ** ρ < 0.001 * ρ < 0.01

Table 7. Association between communication and company experience on agile methods

Communication	Likert scale	Company experience on agile methods										χ^2	df
		> 8 years		6 - 8 years		4 - 6 years		2 - 4 years		Total			
		n	%	n	%	n	%	n	%	n	%		
The communication is effective among agile teams.	Totally disagree	0	0	0	0	0	**0**	0	0	0	0	-	-
	Partially disagree	0	0	0	0	0	**0**	1	2.6	1	1.8	3	3
	Neither agree nor disagree	0	0	0	0	0	0	4	10.3	4	7.0	**12****	3
	Partially agree	**1**	**50**	**3**	**75**	**6**	**50**	**22**	**56.4**	32	56.1	**34.3****	3
	Totally agree	**1**	**50**	1	25	**6**	**50**	12	30.8	20	35.1	**16.4****	3
There is great incentive for communication in the organization.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	0	0	1	2.6	1	1.8	3	3
	Neither agree nor disagree	0	0	0	0	1	8.3	7	18	8	14	**17****	**3**
	Partially agree	0	0	1	25	4	33.3	17	43.5	22	38.6	**33.64****	**3**
	Totally agree	**2**	**100**	**3**	**75**	**7**	**58.4**	14	35.9	26	45.6	**13.69****	**3**

There is extensive use of communication channels in the organization.	Totally disagree	0	0	0	0	0	0	0	0	0	0	-	-
	Partially disagree	0	0	0	0	1	8.3	2	5.1	3	5.3	3.67	3
	Neither agree nor disagree	0	0	0	0	0	0	7	17.9	7	12.3	**21*****	**3**
	Partially agree	**1**	**50**	**2**	**50**	4	33.3	17	43.6	24	42	**27.67****	**3**
	Totally agree	**1**	**50**	**2**	**50**	7	58.4	13	33.3	23	40.4	**15.78****	**3**

N = 57   Significance levels: *** ρ < 0.0001 ** ρ < 0.001 * ρ < 0.01

Table 8. Association between communication channels and company experience on agile methods

Communication channels	Company experience on agile methods						
	> 8 years	6 - 8 years	4 - 6 years	2 - 4 years	Total	χ^2	df
Face-to-face communication in the workspace environment	2	4	12	35	53	**51.8***	3
Informative workspace	1	3	6	9	19	**7.7***	3
Meetings (stand-up, review, retrospectives)	2	4	12	33	51	**47.3***	3
Intranet	1	3	8	13	25	**13.9****	3
Wikis	0	1	8	11	20	**17.2***	3
Project follow-up tools	2	2	10	13	27	**14****	3
Mailing lists	0	2	3	10	15	**15.1****	3
Blogs	0	0	2	3	5	5.4	3
Common tools (e-mails, telephone, video conference, etc.)	1	3	8	25	37	**38.6***	3
Internal tools	2	2	7	19	30	**25.7***	3

N = 53   Significance levels: *** ρ < 0.0001 ** ρ < 0.001 * ρ < 0.01

Recent studies declare that an effective KS initiative relies on a coordinated and coherent strategic orientation to build dynamic capabilities over time [16] [24] [25]. We found that the more mature the company is on agile methods, the more the knowledge is acknowledged as a strategic resource.

Concerning the OS1 property, the majority of the respondents within the sample "totally agree" with this assertion, followed by "partially agree" opinions. We also found a CFA result of 0.479 close to the expected limit value, which may imply that OS1 fits the model.

About the OS2 property, most respondents "partially agree" with this assertion, which is followed by "totally agree" responses. Even in companies concerned about providing a good organizational context, there is still a difficulty in spreading strategic orientations to the whole company. The CFA result of 0.456, which is below the limit, is still inconclusive. However, it might suggest that the wide communication of the organizational strategy is considered a challenge for the surveyed companies. This result might be related to the types of knowledge strategy employed by the companies, which are passive, inconsistent, moderate and proactive [25]. Within our sample, the companies tend to apply a moderate knowledge strategy.

These authors posit that the lack of a consistent and aggressive knowledge strategy might affect the organization's willingness to communicate their strategies. Von Krogh et al. [26] state that it is also related to the company business domain. Choo and Alvarenga [27] explain that the communication of the company's strategy is fundamental to organizational success. A further study should consider cross-table analysis between organizational strategy and business domain to understand this relationship in this context.

The OS3 property is totally agreed by most of the respondents and reached a good CFA coefficient. We also found very significant association between OS3 and the companies' experience on agile methods, which suggest that maturity on agile methods enhance a shared knowledge vision within the company.

Regarding the OS4 property, most respondents partially agree with this assertion. We did not find significant associations between OS4 and companies' experience on agile methods. This might be related to the misconception that agile methods are only focused on short deliveries to customers [28]. However, as this author posits, it is necessary to also extend agility from basic software delivery to continuous delivery. This means creating long-term and flexible organizational strategies in order to transform the businesses through reducing technical debt, creating innovation, and fostering improvement initiatives.

On the OS5 property, most respondents "partially agree" with this assertion, even in the selected companies that are being considered as good places to work. This is similar to findings of other studies that relate the difficulty in sustaining an enabling context for KS [27] and the need for energizing the *ba* [26].

4.2. Communication flow and channels

Every organization works through communication processes. The communication process flows from the source to the receiver resulting in transference and comprehension of a meaning [29]. In a certain way, the communication process is inherent to KS, because both start from a source that intends to transmit a message (or knowledge); then the codification of the message (or the conversion of the knowledge) takes place; so the recipient decodes the message; and lastly the recipient provides feedback, which means the recognition of the transmitted message. In addition, the knowledge sharing process is only effective if the recipient can absorb the content of the message (knowledge) and make use of it [30].

With the SEM coefficient we found a positive influence of this factor on the inter-team knowledge sharing effectiveness. However, regarding the FC1 property, most respondents "partially agree" with this assertion, which denotes that communication across teams is still a concern.

On the FC2 property, the companies under study are concerned about stimulating communication through several incentives. The CFA result of 0.740 implies this correlation. This result is also supported by [31].

About FC3 property, the results are similar to the findings of other studies that state the use of rich ways of communication as an important aspect for tacit knowledge transfer [16] [31] [32].

The companies' experience on agile methods implies that this maturity impact on better communication among teams. Hooff and Ridder [34] posit that a constructive communication climate positively influence knowledge sharing. Teams communication is strengthened by agile practices [33]. Other authors state that personal interactions can be considered the richest channels, since they foster mutual and immediate feedback, and use multiple forms of communication, such as a demonstration of personal skills and body language [34].

Another finding is that some channels even with few responses presented a very significant association with company experience on agile methods, such as Wiki, mailing lists, project follow-up tools, and intranet which may imply that mature agile companies are making more use of tools for sharing knowledge across teams. Blogs were at the bottom of the list with 5 responses, which is surprising because several agile practitioners pride themselves on their blogging[7]. Only further studies would provide an explanation about this. For collocated teams the face-to-face

communication is still possible, however for distributed teams in different locations is inevitable to have more use tools [35]. Joia and Lemos [31] state that means of communication classified as low in richness are more appropriate for sharing information or explicit knowledge.

5. Conclusions

This paper examines the influence of organizational strategy, and communication flow and channels on inter-team KS effectiveness. Although the sample is not considered very representative, the results indicate a positive relationship between these factors and inter-team KS effectiveness.

Within our sample, organizational strategy tends to be characterized as moderate towards knowledge. Communication flow and channels denote that agile companies also foster personal interaction across teams through face-to-face conversations, collective meetings and use of common tools.

According to our sample, companies should consider creating a consistent organizational strategy and applying extensive communication, when striving on this path. Further data collection should be considered to improve decision on adjustments and generalizability of our findings.

Finally, KS in agile and non-agile software organizations is an emergent research field, therefore as a further study, it is important to extend this survey also to non-agile software organizations to understand and compare their organizational conditions influencing KS initiatives.

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7. References

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