

Performance Measuring in Communities of Practice: A Method and Case Study

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Abstract—Project organizations generally do not know how to stimulate knowledge sharing. Besides, the implementation of a knowledge management system to stimulate knowledge sharing often fails. Literature shows that there are several techniques to measure communities of practice, individual, and organizational performance. But which technique should be used? Although discussed by several authors, there is still not yet a generic method that can be used to efficiently implement knowledge management interventions. In this paper, a method to measure community of practice performance is developed and validated. The measuring method provides an indication of how a community of practice is functioning at a certain moment. On the other hand there is no valid proof that KM interventions have a positive effect on a community of practice. Therefore more validation is needed. Also, some limitations of the research and suggestions for further research are given.

Keywords; communities of practice, knowledge management, KM performance, knowledge network analysis, interventions, knowledge sharing.

I. INTRODUCTION

Project organizations experience the problem of knowledge drain within their organisation. Knowledge can be gathered from colleagues through communities of practice. A community of practice (CoP) is a group of people informally bound together by shared expertise and passion for a joint enterprise [1]. Joint enterprise in this context means that a group wants to accomplish something on an on-going basis. Employees are part of several CoPs, especially when they fulfil a job at a customer. Those employees share knowledge with employees of a customer company, but often do not share their knowledge with their direct colleagues. To prevent knowledge drain within the organization, employees should share knowledge with their direct colleagues. Therefore, CoPs should be stimulated and facilitated within any project organization. With an instrument that measures CoPs it is possible to introduce Knowledge Management (KM) interventions that improve knowledge sharing. KM interventions are defined as all tools and activities that are related to KM that aim to improve KM performance in the organization. Besides the stimulation and facilitation of CoPs, the implemented KM interventions must be evaluated to ensure that the KM interventions actually increase knowledge sharing.

In the next section the problem is described in more detail. Besides, the research questions and the practical and scientific triggers are provided. Section three is about the related

literature, which consists of several ways to measure, stimulate and facilitate CoPs, and KM performance. The model, which is developed to measure CoPs, KM facilities, and KM performance, is described in section four. The method to measure the effect of KM interventions on CoPs and KM performance is described in section five. The method consists of all aspects described in section four. In section six the case study is described, which validates the method described in section five. The discussion and conclusions are given in sections seven and eight.

II. PROBLEM STATEMENT AND RESEARCH METHOD

First of all KM must be defined. Jashapara [36] defines KM as the “effective learning process associated with exploration, exploitation and sharing of human knowledge (tacit and explicit) that use appropriate technology and cultural environments to enhance an organization’s intellectual capital and performance”. A CoP creates an environment that supports knowledge sharing [4]. Therefore, an increasing number of organizations are adopting CoPs as part of their KM strategy [5]. Several authors agree that CoPs can improve organizational performance [2, 4, 6, 7]. Organizational performance comprises the actual business outcomes of an organization as measured against its intended business outcomes [2]. Besides, CoPs can be facilitated and developed by implementing KM interventions [8]. In spite of organizational performance, individual performance can be influenced by KM interventions [3]. Individual performance is a function of skills and know-how, personal job satisfaction, sense of belonging, professional reputation, and personal productivity [3]. In literature several methods are available that measure CoPs [4, 9, 10]. On the other hand, it is essential for managers to know what benefit an implementation has concerning KM performance. For an implementation of KM, intervention benefits should be elicited. In short, in literature there is no generic method available that measures the effect of a KM intervention on CoPs and KM performance. KM performance is a combination of individual and organizational performance, which focuses on KM [2, 3].

From a practical point of view, managers want to know what effect an investment has. So, when KM interventions are implemented, they want to know what effects such an implementation has. Besides, managers are always seeking effective policies that encourage employees to share their knowledge with others in an organization [11]. When knowledge is shared the productivity of the employees within

an organization increases. For instance when new employees enter the organization, these employees do not exactly know what knowledge is available within the organization. If they do know what knowledge is available, they do not know where this knowledge can be found or even who possesses the knowledge. When an employee does know where to find certain knowledge, he can be much more productive. Furthermore, it has been proven that knowledge sharing is a precious intangible resource that is key to competitive advantage [12]. So, besides the scientific trigger, there is a practical trigger for measuring the effect of KM interventions on CoPs and KM performance.

Both triggers result in the following research question:

What effect do KM interventions have on CoPs and KM performance?

To answer the research question, the question is separated into four sub questions:

- How can CoPs be identified in an organization?
- How can KM performance be measured?
- What effect does implementation of KM interventions have on CoPs?
- What effect does implementation of KM interventions have on KM performance within an organization?

The first two questions are answered by doing an extensive literature study on CoPs and KM performance. It is studied how CoPs can be identified, stimulated and facilitated. Furthermore, the different aspects of KM performance, which consists of individual and organizational performance, are elicited. The last two questions are answered by doing a case study. The case study consists of two analyses, being analyses of the situations pre and post implementation of KM interventions. Between the implementation of KM interventions and the second analysis, a period of two months gives employees the time to get used to the KM interventions. The difference between the two analyses shows the effect of the implementation of KM interventions on CoPs and KM performance.

III. RELATED WORK

There are various ways to measure CoPs and KM performance.

Arora [13] uses a balance scorecard approach to improve KM within an organization. The approach gives managers the ability to measure the performance of their KM strategy. Andriessen [14] identified over thirty methods that value or measure intangibles. He believes that intellectual capital improves organizational performance. Sparrowe et al. [15] did a field study, involving 190 employees, on the relation between social networks and the performance of individuals and groups. Individual job performance was positively related to centrality in the advice network. Social capital is seen as a connection between CoPs and Organizational Performance [2]. Social capital can be measured in several ways. Narayan & Cassidy [16] compared five studies that measure social capital. Cummings and Cross [17] studied the structural properties of

work groups and their consequences for KM performance. One of the conclusions of this study is that greater hierarchical structure of the group will be negatively related to group performance. Smits and de Moor [18] measure KM effectiveness in CoPs. With help of key performance indicators the evolution of KM practices can be assessed and guided. Gongla and Rizutto [19] researched the evolvement of CoPs over a period of five years. Based on these findings they constructed a framework that consists of five stages and the different lines of business. This way an organization knows how to get their lines of business to the next stage and therefore knows how to support growth and the development of CoPs. Probst and Borzillo [10] researched why communities of practice succeed and why they fail. They propose in their paper a CoP governance model, which is a normative tool that encapsulates issues raised by the literature on governance. The model is based on ten successful governance mechanisms that can also be seen as KM interventions. However, those mechanisms are already encapsulated by the approach of Smith & McKeen [8].

To create an environment that supports knowledge sharing, Smith & McKeen [8] state that the first step is to identify CoPs and the second step is facilitating and developing the CoP. Besides, Smith & McKeen [8] distinguish some points of advice to create effective CoPs.

1) *Identify CoPs*

Grootveld [9] did research on the advantages and disadvantages of the different ways to measure CoPs. He distinguished four CoP measurement types; activity indexes, storytelling, result survey and network analysis.

a) *Activity indexes*

Activity indexes focus on knowledge transfers between people through a knowledge system and are therefore measured like an online community. Change in statistics like unique visitors, page views, etc. indicate the change of a CoP. Therefore, activity indexes are measured like an online community [20]. A disadvantage of activity indexes is that the focus is only on knowledge transfers through a knowledge system. Face-to-face meetings and informal contacts, for instance, are not taken into account.

b) *Storytelling*

Storytelling focuses on members who tell stories about the benefits they achieved by participating in the community. Smith & McKeen [9] distinguish two approaches; bottom-up and top down. The bottom up approach identifies what community activities take place and then tries to understand the effect they might have had on business performance. The top down approach identifies what kind of knowledge an organization needs and then starts investigating what communities do to achieve this knowledge. A disadvantage of storytelling is that when employees do not see the importance of a story, they would not tell that story and certain results remain undiscovered.

c) *Result survey*

Result survey uses a set of predefined questions to which a score can be assigned. Survey questions asked to the members of a CoP give insight in the results of the community. An

advantage is that such CoP measurement type gives a comprehensive overview of potential community benefits. A disadvantage is that there is no prioritization of benefits that are most crucial for the company or stakeholders.

d) Network analysis

Both network analyses, push network analysis as well as pull network analysis, give insight into the structural properties of the networks of which a CoP consists. Social Network Analysis (SNA) is the basis of this technique. SNA elicit the structural patterns of social relationships in the network. Based on SNA, Knowledge Network Analysis (KNA) is developed [4]. KNA does not focus on the social relationships, but on the richness of knowledge transfers between employees.

2) Facilitate and develop CoPs

CoPs can be collated with a garden, the respond to attention that respects their nature. "You can't tug on a cornstalk to make it grow faster or taller... you can however, till the soil, pull out the weeds, add water, and ensure... proper nutrients." [1]. To consider best way to facilitate CoPs, the results of the technique of [4] are combined with the findings of Smith & McKeen [8] and the KITS project [21].

According to Smith & McKeen [8] CoP facilitation consists of three general areas in which organizations can provide support to a CoP; management, technical infrastructure, and culture.

a) Management

Managers have to create environments, reinforce norms, and help set expectations [8]. It is another role they must fulfil next to making strategic decisions. Managers must encourage employees to participate in a CoP, and become a member of a KM tool. Lesser & Storck [2] state that social capital creates an environment in which employees can safely share their knowledge.

b) Technical Infrastructure

The use of technology alone is not enough to facilitate a CoP, a supportive technical infrastructure is therefore critical [8]. If employees are not motivated to share knowledge, they are not motivated to use tools facilitating knowledge sharing. The following elements support the technical infrastructure:

- Local practitioner support
- An enterprise-wide library and web-access
- Conversational technology
- Collaborative technology

Tools which make it easy to connect with, contribute to, and access the community

c) Culture

The need for a culture which supports communities, learning and knowledge sharing is considered a critical success factor by both practitioners and researchers [8]. McElroy [22] agrees with this statement and presents in his paper an epistemological theory of sustainability. The theory answers the question what a learning system must be like in order to be effective, beneficial and sustainable and leads to an

improvement of the KM performance. Van Reijns et al. [23] validate the new KM claim of McElroy [22] in his paper. As a result of the validation can be said that the corporate sustainability yields a higher KM performance, but the KM performance of innovation does not improve. According to Smith & McKeen [8] some of the areas where culture can be made more supportive of communities include:

- Build enough background contexts to enable people to better understand each other
- Use multiple forums to share knowledge
- Give people time
- Provide for face to face meetings

These areas have an overlap with the approach of Lesser & Storck [2]. Building enough background context is strongly related to the common context dimension of social capital. When every CoP member knows the background of other members they can understand each other more easily. Besides, the use of forums to share knowledge strongly relates to the connections dimension. Forums increase the ability to make connections with other CoP members.

3) Making CoPs work

There are several ways to make CoPs work. Smith & McKeen [8] distinguish seven points of advice to create effective CoPs. The points, which have an overlap with other approaches, are described below.

a) Understand the Hurdles

Some researchers believe it is unrealistic to expect knowledge to flow through organizations, because people's time and energy are limited and they will choose to do what they believe will give them the most return on these scarce resources [24]. Therefore it is sometimes difficult to motivate employees to actually participate in CoPs. According to Harding & Pawar [25] another hurdle is the fear for know-how sharing. Individuals might fear losing an expert status within the company. These are just some of the hurdles, off course there can be several other hurdles to make CoPs work.

b) Make knowledge easy to use

Community space needs to be familiar and easy to move around in [8]. Employees do not have plenty of time to understand knowledge. For instance, when a new tool is developed by someone he must write an easy to use manual for that tool. If the manual is not easy to use it is difficult for others to understand how the tool works, so they would not use the tool.

c) Measure value

Every member of a CoP struggles with the need to demonstrate the value of their organization's CoPs to senior management [8]. An example to demonstrate the value of CoPs to the employees and the management is this paper. Results of the paper give an indication of the value of CoPs for an organization and give advice how to increase that value.

d) Develop trust

Levin et al. [26] state that it is trust that leads to effective knowledge sharing. The importance of trust is also supported

by Nahapiet & Ghoshal [27]. They distinguish four components in the relational dimension and one of these components is trust. Trust involves the predictability of another person's actions in a given situation, whereas identification refers to the process whereby individuals see themselves as united with another person or set of individuals [2]. For instance, when two colleagues know each other only by mailing, trust will be low. When those colleagues also have face-to-face meetings trust will be higher and employees are more willing to share knowledge. Therefore trust needs to be developed. In the study of Millen & Fontaine [3] only half of the respondents think that trust improves organizational performance, which indicates that employees do not realize what role trust has in improving organizational performance.

e) *Establish coordinating roles*

To ensure that CoPs work effectively a number of coordinating roles have to be established [8]. Smith & McKeen [8] distinguishes the following roles.

- **Sponsor** - A senior manager who communicates the company's support for the CoP and helps remove any barriers which obstruct community progress.
- **Champion** - The chief organizer of events and communications for the CoP.
- **Facilitator** - The person who clarifies information and helps keep discussions on topic.
- **Practice leader** - The acknowledged leader of a CoP.
- **Infomediaries** – Librarians, knowledge managers, or researchers that filter information.

f) *Motivate people*

There must be incentives for individuals to participate in CoPs. For instance, a reward system can motivate employees, or a contest of *knowledge sharer of the quarter* can motivate employees. In other words, employees must be intrinsically and extrinsically motivated to share knowledge. However, Hendriks [28] concluded that ICT has a negative influence on the motivation of people, because people prefer face-to-face meetings, which further supports the fact that knowledge sharing cannot be improved only by implementing a tool.

g) *Monitor evolution*

The understanding and practice surrounding CoPs is evolving continually [8, 19, and 29]. Therefore, it is essential that knowledge managers monitor both research and practice to consider what others are doing [8].

This research fulfils different gaps in existing literature. First of all the KNA technique of Helms [4] is extended with the pull network. In the KNA technique of Helms [4] only the push network is elicited. So, to measure a pull network new bottlenecks are formulated which focus on a pull network. On the other hand, an instrument is developed to measure KM performance. There are several ways to measure individual and organizational performance, but now there is an instrument that relates the performance with KM. Both measurement instruments are part of a method to measure the effect of KM interventions on CoPs and KM performance. Besides, this

method can be used as a guide to increase knowledge sharing within an organization.

IV. THEORETICAL FRAMEWORK

Based on the literature study and the research question, a model is developed which indicates how the different measurement instruments relate to each other.

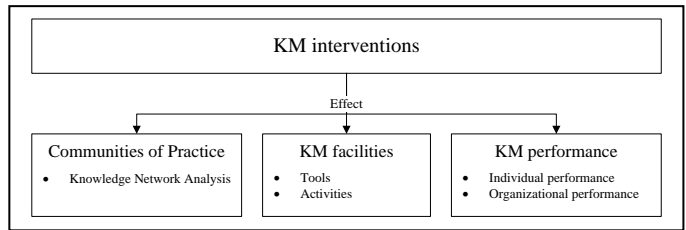


Figure 1. Figure 1. Visualisation of the research project

According to the model KM interventions affect three aspects. In the next paragraphs for each aspect is described how the effects are measured.

A. *CoP measurement*

The first challenge is not to create a CoP, but to simply find existing ones and make them visible to CoP members and the rest of the organization [30]. Grootveld [9] did research on the advantages and disadvantages of several CoP measurement types. Based on his research and the literature study described above, the KNA technique of Helms [4] is employed for measuring the CoP. In figure 2 below is shown what different aspects are part of KNA.

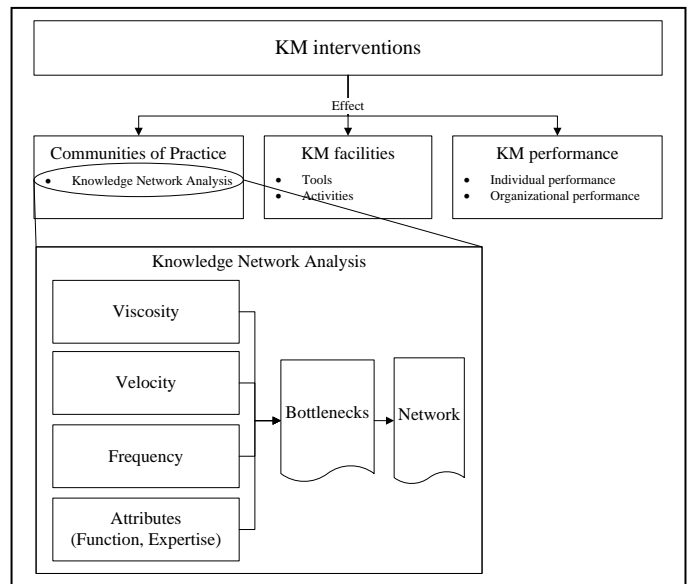


Figure 2. CoP measurement

CoP measurement can be separated into the measurement of a push and a pull network. Push networks focus on the development of employees' professional skills [4]. One way to ensure this development is to make knowledge transfer more effective, which can be done by improving the richness of knowledge transfers. Another word for the richness of knowledge transfers is viscosity. Pull networks focus on the reaction time of knowledge requests, which is also a way to

make knowledge transfer more effective [9]. Another word for reaction time in this context is velocity.

To identify the push network the KNA technique of Helms [4] is used. Next to the viscosity, in addition the frequency of knowledge transfers and two attributes are taken into account. The frequency indicates how often a knowledge transfer appears. The attributes distinguish employees with different functions and expertise levels. Based on the technique of Helms [4] some bottlenecks for the push network are elicited. Also, these bottlenecks are the basis of the bottlenecks of the pull network, which were not formulated by the technique of Helms [4] yet. With help of these bottlenecks the push and the pull network are identified.

B. KM facilities measurement

Based on literature study and the findings of Grootveld [9] KM facilities measurement is separated into KM tool measurement and KM activity measurement. For measurement of the tool, activity indexes are used. In figure 3 below is shown what different aspects are part of the KM facilities measurement.

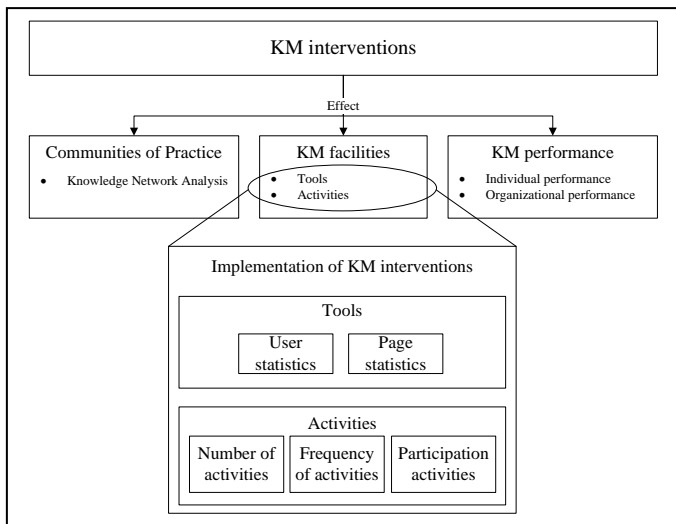


Figure 3. KM facilities measurement

A KM tool is measured like an online community [20]. One of the disadvantages of activity indexes is that face-to-face meetings are not taken into account. Therefore, KM tool measurement like Cothrel's [20] is extended with KM activities measurement. For such measurement literature of Lock Lee [31] and Andriessen [14] is used. KM activities measurement is based on the number, frequency and participation of the listed activities.

C. KM performance measurement

Dignum & Tick [38] state that organizational performance is partly dependent on individual performance. Therefore KM performance measurement is separated into individual and organizational performance. In figure 4 on the right is shown what different aspects of individual and organizational performance are part of the KM performance measurement.

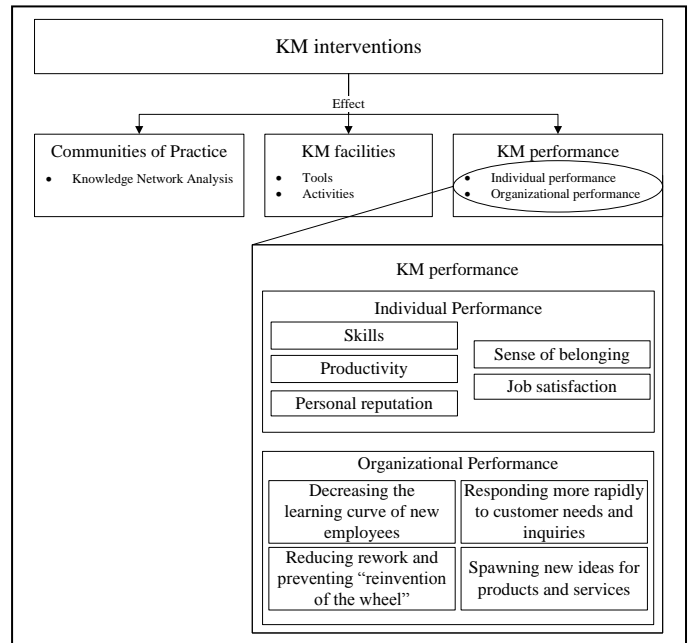


Figure 4. KM performance measurement

1) Individual performance

The measurement of individual performance is based on Millen & Fontaine [3], who measure individual performance using five aspects; skills and know-how, personal job satisfaction, sense of belonging, professional reputation, and personal productivity. Furthermore, Van Reijssen et al. [23] measure group performance by calculating the average perceived job performance of all employees in the network. The job performance score is inspired by Sparrow et al. [15], who did a field study, involving 190 employees, on the relation between social networks and the performance of individuals and groups. On the other hand Teigland [32] explores the relationships between participation in networks of practice, centrality, and individual. The combination of those papers resulted into ten statements that measure the effect of KM interventions on individual performance.

2) Organizational performance

The measurement of organizational performance is based on a paper of Lesser & Storck [2], who developed a theory where business outcomes are coupled with social capital. Social capital is separated into three dimensions; connections, relationships and common context. On the other hand, there are four business outcomes; decreasing the learning curve of new employees, responding more rapidly to customer needs and inquiries, reducing rework and "re-invention of the wheel" and, spawning of new ideas for products and services. The linkage between social capital and business outcomes resulted into twelve statements that measure the effect of KM interventions on organizational performance.

V. METHOD TO MEASURE THE EFFECT OF KM INTERVENTIONS

There is already an overview of possible KM interventions available [21]. The overall objective of the KITS project is to develop and evaluate a learning environment that comprises an educationally supported, distributed business game in the domain of KM. Smith and McKeen [8] focus in their paper on

facilitating CoPs, which is supported by management, technical infrastructure and culture. Those three aspects have an overlap with three categories of the interventions described by the KITS Project [21]; implementation of organizational changes, implementation of ICT, and co-operation of employees and departments. Management can be compared with the implementation of organizational changes, because the management within an organization mainly focus on making organizational changes. An example of an organizational change is to introduce an apprenticeship system where less experienced employees learn from experienced employees. The technical infrastructure aspect of the approach of Smith & McKeen [8] is in line with the implementation of ICT category of the KITS Project [21]. For instance, the implementation of an enterprise content management system (e-CMS), where employees can codify their knowledge. When knowledge is codified, individual knowledge is transformed into organizational performance [35]. The co-operation of employees and departments category of the KITS Project [21] has overlap with the culture aspect of Smith and McKeen [8]. When there is an informal culture with short lines between management and executive employees, the barrier to share knowledge is low. For instance, a discussion on an e-CMS takes place because people have the same interests. It can be a manager, but also an executive employee who replies, so this way the formal barrier between a manager and executive employee is taken away. The other categories do not have an overlap with the approach of Smith & McKeen [8], so are less important.

To measure the effect of KM interventions on CoPs and KM performance, a method is developed using meta-modelling. Meta-models are expressed in Process Delivery Diagrams (PDD) [33]. A PDD consist of two parts, the process view and the deliverable view. The process view is based on a UML activity diagram and the deliverable view is based on a UML class diagram [34]. For reasons of brevity the diagrams could not be included in the paper. A textual description follows.

The method consists of four main phases; analyse current situation, implement interventions, analyse situation after implementation and measure the effect of implemented interventions.

A. Analyze current situation

The analysis of the current situation is divided into two parts; CoP measurement and KM facilities measurement. Both measurements are done separately from each other at the same time. Based on both measurements an advice is given to implement new or adapt old KM interventions that stimulate knowledge sharing within the organization.

B. Implement interventions

Together with the managers is decided which of the advised KM interventions are actually implemented within the organization. Furthermore an implementation plan is made how the KM interventions should be implemented. Based on the implementation plan the KM interventions are implemented.

C. Analyze situation after implementation

The second analysis is done like the analysis of the current situation. The only difference is that in the second analysis KM performance is also measured. The reason why KM performance is only measured during the second analysis is because this way the implemented KM interventions can be linked to the KM performance. This measurement is done parallel to the other measurements.

D. Measure the effect of implemented interventions

The differences between the situation before and after the implementation measure the effect of the implemented KM interventions on CoPs and KM performance. When, for instance, after the implementation of some KM interventions more people transfer their knowledge or people transfer their knowledge more frequently, it is concluded that these KM interventions had a positive effect on CoPs. Concerning KM performance, the employees are specifically asked which implemented KM interventions contribute to a better KM performance.

VI. CASE STUDY: CAESAR GROUP

To validate the method a case study is conducted at Caesar Group. Caesar Group is an ICT service provider, which focuses on consultancy and projects. The project organization has around 300 employees and has two locations. There are seven expertises within Caesar Group; Microsoft, Oracle, Java, Progress, Infrastructure, Process optimization, and Business Intelligence. The case study is done within “Expertisecentrum Progress”. The case study consists of the implemented KM interventions and the result analysis.

A. Implemented KM interventions

Based on the paper of Smith & McKeen [8] the KM interventions are separated into different aspects. Per aspect the KM interventions are mentioned.

1) Technology

First of all a team site within the e-CMS environment is set up. The site contains an area where news items concerning the CoP are posted. Secondly, an area where documents can be shared is set up. There is also a discussion area where employees can discuss problems, give tips and tricks concerning their expertise or can post ideas for a small research assignment. Besides this discussion area there is also an area where research assignments are posted, which are of organizational value. More about these assignments can be found later in this section. Furthermore, there is an area to list useful links. Last but not least there is an area where a photo is posted of the knowledge sharer of the quarter.

When items are added in the different areas all the employees of “Expertisecentrum Progress” receive a mail, so that they are triggered to continuously visit the team site. Besides, to monitor the quality of the shared documents and the discussion items a plug-in is installed. This plug-in makes it possible to vote each item and provide them with comments.

2) Motivation

To motivate employees to become an active team site user all employees of “Expertisecentrum Progress” can declare half

an hour every week, on knowledge sharing. In that half an hour employees should visit the team site and they are asked to share their knowledge via the site. When employees choose to declare this half an hour it will be checked what is done to share their knowledge. Employees who have the status “available” have to declare at least four hours on knowledge sharing within their contract hours.

As mentioned earlier there is a possibility to post ideas for a research question. To motivate employees to solve relevant research assignments is chosen to reward a solution with an amount of UV-hours. UV-hours are hours that can be used for a day off. All ideas are filtered by the technology manager, who separates the ideas that can be of organizational value. After first filtering the coordinating team, technology manager, manager operation, secretariat and a sales employee, decide which questions can be solved for UV-hours.

Furthermore employees will be rewarded when they share their knowledge. The intrinsic motivator is the photo on the team site, an honourable announcement during the quarterly employee meeting and in the newsletter. The extrinsic motivator is a present. To choose this knowledge sharer of the quarter the amount in combination with the quality of what knowledge is shared is taken into account. To measure the quality, voting and comments of colleagues on shared documents on the team site is used and also the opinion of one manager is taken into account.

3) Develop trust

There are already meetings organization broad and department meetings once a quarter. Such meetings always consist of three subjects like actual problems, new technologies, etc. The attendance of these meetings varies with the subjects, but are mostly well visited. Therefore is not chosen to organize more face-to-face meetings, because these current meetings should be sufficient.

4) Value of CoP

The value of the CoP and the KM interventions, which support the CoP, are described in the newsletter and are presented to the management of Caesar Group.

5) Establish coordinating roles

The roles described in section three are assigned to different employees of the Caesar Group. The operations manager fulfils the sponsor role and the technology manager fulfils the Infomediaries role. The researcher fulfils the facilitator and practice leader role.

6) Monitor evolution

CoPs and KM performance should be monitored every quarter or half year. The researcher is responsible for the next measurements and the evolution of the CoPs and KM performance for the next six months.

B. Result analysis

The results of the case study are described in the following paragraphs.

1) CoP measurement

The results of the CoP measurement are separated in the results of the push network and the results of the pull network.

First the results, i.e., the differences in findings between the two measurements of the push network, are described. After the implementation of KM interventions instead of seven now nine employees have a connection to a colleague. The two new employees are both active members of the team site. It appears that the implementation of KM interventions has had a positive effect on the in-degree of less experienced employees. The brokerage roles of the employees also changed. There are three roles distinguished; gatekeeper, representative and liaison. A gatekeeper is someone who controls access of outsiders to the group, a representative is someone who acts as the contact point or representative of one group to another, and a liaison is someone who brokers a relation between two groups and is not part of either. Instead of being a representative the technology manager is now a gatekeeper. The operations manager is still the most important representative. There was no liaison, but after the implementation the liaison role is fulfilled by one person. These are the only differences that are caused by the KM interventions concerning the pull network and are shown in the table below.

TABLE I. PUSH NETWORK RESULTS

| <i>Aspect</i> | <i>Situation before KM interventions</i> | <i>Situation after KM interventions</i> |
|---------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Less experienced employees who receive knowledge from experts | 7 | 9 |
| People who are not connected to any colleagues | 12 | 8 |
| Brokerage roles | Operations manager is most important gatekeeper | Technology manager is most important gatekeeper |
| Brokerage roles | Liaison role is not fulfilled | Liaison role is fulfilled by one person |

Also, the bottlenecks concerning the pull network resulted in some changes. A positive change is that one employee was not able to learn from his colleagues, but now has two in-degree connections with high velocity. Especially one connection can be seen as a result of the implementation of KM interventions, because both employees are active users of the team site. Besides, the total number of employees with a reach out above 20 is increased from 15 till 21. The increase of the reach out is not directly derived from a bottleneck, however it is a remarkable change. These are the only differences that are caused by the KM interventions in regards to the pull network and are shown in the table below.

TABLE II. PULL NETWORK RESULTS

| <i>Aspect</i> | <i>Situation before KM interventions</i> | <i>Situation after KM interventions</i> |
|-------------------------------------|------------------------------------------|-----------------------------------------|
| Employees with an out-degree | 12 | 13 |
| Employees with a reach out above 20 | 15 | 21 |

2) KM facilities measurement

The statistics of the “Expertisecentrum Progress” team site show that instead of ten employees now 28 of 42 employees of

“Expertisecentrum Progress” use an e-CMS. In this case study SharePoint is chosen as e-CMS.

Twelve of these 28 e-CMS users actively use the team site, which means that they have already shared knowledge using an e-CMS. The other 16 employees only read the team site, so they only receive knowledge instead of share their knowledge. Out of the twelve employees who are active on the team site, only six employees frequently post new knowledge. Besides, the top ten users visit the team site at least 38 times a month with a maximum of 276 times a month. In other words, the top ten users on average visit the team site more frequently than once a day. The top ten most visited pages vary from eight times a month till 1191 times a month. These statistics indicate that postings are viewed and/or used by colleagues. An e-CMS has a feature that enables a user to share their personal background information. The use of such a feature indicates in what way background information is shared with colleagues. The amount of employees who use their personal site is raised from three to eleven employees. Of course, to make it easy to find experts with specific skills everyone should use the personal page feature.

3) KM performance measurement

The KM performance survey consists of 22 statements. A seven-point Likert scale indicates how much employees agree with the statements.

The individual items per benefit are merged into a group result, which represents in what way the employees agree that the implementation positively influences the benefits concerning individual performance. A result above four means a positive influence and a result below four means a negative influence. In the table below a global overview of the results of the analysis concerning individual performance is given.

TABLE III. INDIVIDUAL PERFORMANCE RESULTS

| <i>Benefit</i> | <i>Group result</i> |
|---------------------|---------------------|
| Skills | 4,27 |
| Productivity | 4,33 |
| Personal reputation | 3,77 |
| Job satisfaction | 4 |
| Sense of belonging | 4,68 |

Concerning organizational performance the individual items are merged into a group result, which represents in what way the employees agree that the implementation positively influences the business outcomes. A result above the value four means a positive influence and a result below four means a negative influence. In the table below a global overview of the results of the analysis concerning organizational performance is given.

TABLE IV. ORGANIZATIONAL PERFORMANCE RESULTS

| <i>Business Outcome</i> | <i>Group result</i> |
|---------------------------------------|---------------------|
| Decrease learning curve | 3,81 |
| Increase customer responsiveness | 4,15 |
| Reduce rework and prevent reinvention | 4,49 |
| Increase innovation | 4,13 |

As can be seen in table III, sense of belonging has the highest value. It means that most employees agree that the KM interventions have a positive effect on the sense of belonging. On the other hand the KM interventions do not have a positive effect on personal reputation. As can be seen in table IV, reduce rework has the highest value. It means that most employees agree that the KM interventions have a positive effect on reducing rework. On the other hand the KM interventions do not have a positive effect on decreasing the learning curve.

VII. DISCUSSION

In this section the limitations of this paper and its validity are discussed. Both lead to some points for further research.

A. Limitations

The developed method creates scientific and practical value when it can be used within all project organizations. Before the method can be generalized some limitations have to be tackled, however.

The survey used for CoP measurement is filled in twice by the employees. The second time 16 of 42 employees handed in exactly the same results as the first analysis. The question remains whether the respondents took enough time to fill in the survey the second time. It could mean that there are no changes, but it could also mean that they did not want to spend time on the second survey. Besides, changes in the composition of project groups at a customer have influence on the network. Ten out of 42 employees now have a different customer than they did during the first network analysis.

Furthermore, in this economic time, employees have to be productive and therefore do not want to ‘waste’ time on knowledge sharing when they are hired by a customer. Desouza [12] agrees that in the current economic times, when cost cutting seems to be an overarching concern for most organizations in order to show profitability, knowledge sharing initiatives might suffer.

In this paper the assumption was made that every employee has access to Internet and the e-CMS, but during the research it was discovered this was not the case.

Another reason why there are still too many employees who do not efficiently share their knowledge could be that the value of the team site is still too low. The value of a KM tool increases when more knowledge can be found by employees with such a KM tool. At the moment, too little knowledge is shared and that shared knowledge is often too specific. An employee only uses the site when there is knowledge shared which is useful for him. At the moment the chance that useful knowledge can be found on the team site is too low. Therefore, the usage of the team site can also be too low.

On the other hand, KM interventions have a positive effect on KM performance. However, a strange result in the KM performance measurement is the personal reputation aspect. Personal reputation is part of the individual performance as well as organizational performance. Concerning individual performance employees disagree that the KM interventions positively influence personal reputation, but on the other hand concerning organizational performance these employees agree

that the KM interventions positively influence personal reputation. Maybe this has something to do with the fear to share something what is not (fully) correct. In other words employees are vulnerable; at least they think they are vulnerable. So, to take these thoughts away it is an idea that employees are also rewarded when they share knowledge what is not (fully) correct. In short it is important that trust is created within the organization.

Another way to develop trust is organize more face-to-face meetings. Related to this aspect is also the sense of belonging. Interviews with employees resulted in the fact that they see their customer as their employer. A KM tool improves the sense of belonging, so that way such a KM tool can also improve trust. A disadvantage is that development of trust takes time, so it cannot be measured in two months. Furthermore, it is also obvious that concerning the organizational performance the KM interventions do not have any positive effect on the common context dimension of social capital. Probably the reason for this is that there is not much knowledge of common context shared on the team site yet. The shared knowledge has a limited target group, for instance a problem that appears only at a specific customer.

B. Validity

The validity is separated into construct, internal, external, and experimental validity. In the sub paragraphs each aspect is described.

1) Construct validity

The survey to analyse the knowledge networks is adapted, because the original form was time consuming for respondents. Therefore the survey is adjusted and dispersed within a Microsoft Excel file. In the new form is now asked what the most important manner of receiving knowledge is, instead of all manners of receiving knowledge. Besides, the KM facilities measurement verifies if the KM interventions are implemented correctly, as they were intended.

2) Internal validity

Grootveld [9] already validated CoP measurement by doing a case study at DHV. KM performance measurement is based on literature study and some expert interviews. In literature no validation by case studies of such KM performance measurement is found. So, KM performance measurement should be validated by doing more case studies. Besides, the network analyses before and after the implementation of KM interventions must be measured identically to ensure that the effect does not derive from differences in execution of the analysis. Furthermore, a minimum of 90% response is required for the KNA technique, because otherwise there are knowledge transfers missing in the network visualization.

3) External validity

The used research method is validated by the case study within Caesar Group, which focuses mainly on knowledge sharing within the organization. The improvement of knowledge sharing is measured by the effect of KM interventions on CoPs, and KM performance. Further research at different organizations must be done to generalize the method. Distinction can be made by the size, location and branch of the organization. To validate if the results differ

when a different tool is used, the same research must be done, with another KM tool. The time between the implementation of KM interventions and the second analysis was two months. Improving knowledge sharing needs a change in the culture of an organization. Such a change needs a longer period than two months to be measurable. Therefore a third analysis after half a year should be done. In further research the time between the KM interventions and the second analysis has to be longer than two months.

4) Experimental validity

The research should be repeated within a different organization with the same conditions. Then can be elicited if there are some situational aspects that influence the result. For instance, one of the possible outcomes could be that the economic situation has influence on the results.

VIII. CONCLUSIONS

The research question is answered by the four sub questions.

A. How can CoPs be identified in an organisation?

In short, there are various ways to measure CoPs. Grootveld [9] did research on what the benefits of each way are and chose to use an extension of the KNA technique of Helms [4] for measuring CoPs. Literature shows overlap with the CoP measurement instrument of Grootveld [9], which is why that instrument was chosen.

B. What effect does the implementation of KM interventions have on CoPs?

The answer is based on a comparison between the network analyses before and after the implementation of KM interventions.

1) Push network conclusion

A closer look shows some differences that are probably a result of the implementation of KM interventions. However, the changes are too minimal to conclude that the implementation of KM interventions has a positive effect on the push network of a CoP.

2) Pull network conclusion

The results show only one small positive difference that is probably a result of the implementation of KM interventions. Besides concerning the connectedness and responsiveness only negative changes took place. So, the change is too minimal to conclude that the implementation of KM interventions has a positive effect on the pull network of a CoP.

3) CoP conclusion

Based on these findings concerning the push and pull networks the question can be answered. There is hardly any difference between the push and pull networks before and after the implementation. So, in the case study, the implementation of a KM tool has no or minimal positive effect on CoPs.

C. How can KM performance be measured?

In short, there are several ways to measure KM performance. In this paper is chosen to combine the methods of Lesser & Storck [2], Millen & Fontaine [3], and van Reijssen et al. [23]. The first two methods focus mainly on individual

performance and the last method focuses on organizational performance.

D. What effect does the implementation of KM interventions have on CoPs?

The answer is based on the results of the KM performance survey.

1) Individual performance conclusion

The employees of “Expertisecentrum Progress” agree that the implementation of KM interventions, like an e-CMS, positively influences individual performance. Individual performance is measured with ten items distributed over five benefits. The employees agree that the implementation of KM interventions positively influences three of five benefits directly; skills, productivity and sense of belonging. Personal reputation is not positively influenced by the implementation and the employees are neutral concerning job satisfaction.

2) Organizational performance conclusion

The employees of “Expertisecentrum Progress” also agree that the implementation of KM interventions, like an e-CMS, positively influences organizational performance. Organizational performance is measured with twelve items distributed over four business outcomes. The employees agree that the implementation positively influences three of four business outcomes; Increase customer responsiveness, reduce rework and prevent re-invention and increase innovation. The decrease in the learning curve is not positively influenced by the implementation.

When organizational performance is not measured by business outcomes, but by social capital dimensions it is obvious that the common context dimension is not supported by the implementation of KM interventions. Probably, the reason for this is that there is not much knowledge of common context shared yet. The connections and relationships dimensions are both positively influenced.

3) KM performance conclusion

Based on findings concerning the individual and organizational performance the question can be answered. The implementation of KM interventions has a positive effect on KM performance. Concerning individual performance the positive influence on skills and productivity is considered most important, because those aspects are of value to the individual and to the organization. Concerning organizational performance the prevention of rework and reinvention is most important, because it saves most time and money compared to the other business outcomes.

E. What effect does the implementation of KM interventions have on CoPs and KM performance?

In this paper, KM interventions have no effect on CoPs and a positive effect on KM performance. With an extensive network analysis the CoPs are measured before and after the KM interventions. The network analysis show only small differences and only a few differences are the result of the KM interventions. Therefore is concluded that the implementation of KM interventions have no effect on CoPs. However, the implementation apparently has a positive effect on the KM performance. Individual performance is measured by five

aspects; skills, productivity, personal reputation, job satisfaction, sense of belonging. Skills, productivity and sense of belonging are positively influenced by the KM interventions. Personal reputation is the only aspect that is not positively influenced. Organizational performance is measured by four aspects; Decrease learning curve, increase customer responsiveness, reduce rework and prevent re-invention, and increase innovation. All aspects except decrease of learning curve are positively influenced by the implementation of the KM interventions. The common context dimension of social capital however is not yet influenced by the KM interventions.

In this paper a method to measure CoP performance is developed and validated. The measuring method gives a good indication of how a CoP is functioning at a certain moment. On the other hand there is no valid proof that KM interventions, like the implementation of an e-CMS with corresponding activities to stimulate the use of such a tool, have a positive effect on a CoP. Therefore more validation is needed.

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