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Using Seci To Improve Teachers' Pedagogical Content Knowledge

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Abstract: Pedagogical Content Knowledge (PCK) is a form of knowledge that has a big role in determining the success of the teaching and learning process in the classroom. Teachers in one school tend to have different levels of PCK, depending on each teacher's background knowledge and experience. Previous professional teacher development schemes in Indonesia have been held in a way that emphasises the teacher's individual learning aspects, were held separately between different teaching subjects (such as through a Mandatory Regional Teacher Meetings based on subject matters, known as "MGMP" in Indonesia), and has a lack of documented reports about the impact of that training on teaching. This study offers an alternative way to improve teachers' PCK using the knowledge creation approach. This study used the SECI model to design a procedure to facilitate teachers from the same school to share, externalise, combine, and internalise other teachers' PCK for their own teaching practice. The procedures of this study have addressed several problems that are found in previous attempts of using PCK in an educational setting. This study found that one cycle of the SECI model could improve teachers' PCK ($F(2, 40) = 68{,}963$, $p < 0{,}05$) and has the potential to close the gap between teachers' PCK levels. Further research on an iterative SECI model to improve PCK with a longer timeframe and that evaluates factors that might affect the SECI process is needed to explore the potential of creating a shared perspective of PCK among teachers and create a contextual standard for a school as an educational institution. Exploratory research regarding teachers' natural knowledge sharing and knowledge acquisition is also offered.

Keywords: Pedagogical Content Knowledge, Knowledge Creation, SECI, Teacher, quasi-experiment

1. Introduction

The teacher's instruction is one of several important aspects that influence students' learning experience in the classroom. When capable teachers teach, students have a better learning experience and improve their learning achievements (Ballard and Bates, 2008). One of the many ways to improve teacher's teaching practice is by improving teachers' knowledge. After reviewing many formulations of teacher's knowledge, Shulman (1987) proposed that the knowledge that determines the success of teaching is pedagogical content knowledge (PCK).

Shulman initially proposed PCK in the late 1980s as a critique of the way stakeholders saw teachers and education. A teacher's competency was seen either by their pedagogical knowledge or their content knowledge, not both. However, it is argued that more often than not, the combination of both is what determines the success of teaching in the classroom. Shulman (1986; 1987) argued that the factor that determines the success of teaching is the combination of content knowledge and pedagogical knowledge.

Thirty years after its introduction, PCK has been accepted, argued, researched, and developed by other researchers. Research has found that PCK positively affects student's learning (Hayden and Eades Baird, 2018), can be used to create a more holistic way to view teachers' practice (Hanuscin, Lee and Akerson, 2011), and helps to understand and develop teachers' competence (Sperandeo-Mineo, et al., 2010). The acceptance of PCK in the academic field also led to many developments of PCK that often involve several aspects such as knowledge about students, assessments, and curriculum knowledge (Fernandez, 2014; Gess-Newsome, 1999). PCK has also been stated as the only type of teacher knowledge that appears to have an impact on teachers' instruction (Guerriero, 2013).

However, one of the authors of this study has found from his experience in managing a boarding school and training teachers in South Kalimantan, Indonesia, that teacher's PCK still needs improvement. Some teachers do not seem to recognise, respond, or adapt to the students' educational needs in their own classroom. This is aligned with a study conducted by Georgiou (2008), who found that some teachers make assumptions about their students. When teachers are detached from the classroom, teaching becomes ineffective (Käpylä, Heikkinen and Asunta, 2009).

In the author's school, there are many teachers with various levels of knowledge and expertise in teaching, or in short, PCK quality. This is aligned with a report by Sumaryanta, Mardapi, Sugiman and Herawan (2018) about

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the quality of teacher's teaching competence in Indonesia. In the context of teaching improvement, there have been several efforts, before this study, that have been implemented in the author's school to develop a shared standard of teaching between teachers, such as through independent group learning, subject-based group sharing (MGMP) and focus group discussion (FGD) among teachers. These were typical of the professional teacher development scheme that is commonly held in schools in Indonesia (Rahman, 2019). Within these activities, evaluations to check the improvement of a teacher's competence were rarely held. There has also been no attempt to document the meeting; when peer-sharing was conducted, there was no structure of sharing being implemented. No one really knows what teachers have learned from the groups, and it is almost impossible for the school to track the progress of the knowledge of teachers. In Rahman's report (2019), one of the principals stated that even the teachers who are often engaged in many professional teacher development schemes do not show any significant teaching improvement. The principal in this report is not the only one who saw this problem. Similar problems occurred in the author's school. The author did not find any significant change, even after two years of actively supporting teachers to engage in professional improvement activities. This lack of improvement of quality and shared teaching quality between teachers' PCK is not good for the students, the school or teachers.

Closing this gap and making sure that everyone improves is imperative. The authors seek an alternative way to solve this problem by looking at the knowledge management field. Although the education world has been exposed to various learning methods, and teachers have adopted various learning activities, very little research involves knowledge management or knowledge creation concepts. Knowledge creation offers a different perspective on acquiring knowledge and is rarely incorporated in the education field. The authors' search in ERIC, the largest education database, yielded 5,624 search results for "Teacher Professional Development", whereas when the search term is altered to "Teacher Professional Development" AND "Knowledge Management" only 11 results were available. This result is alarming because it seems that teacher's professional development rarely considers knowledge management as a way to improve teachers' competence and affirms that teacher development has only been evaluating this problem from a learning perspective (Bredeson, 2002; Rahman, 2019). The authors were interested in considering this problem from a different perspective that reviews not only the teachers' individual learning but also how the organisational setting could help the process of acquiring knowledge from other professionals in the same work setting. This is the different take that knowledge management offers to teachers' improvement.

According to Leibowitz (2005), knowledge management includes sharing and leveraging knowledge, both externally and internally. It is a process of creating value from an organisation's intangible assets, such as employee knowledge. According to Love, Fong and Irani (2005), knowledge management is the process of acquiring, refining, storing, and sharing knowledge within an organisation. Knowledge management has also been defined by different labels. However, the following similarities can be found in most definitions: there must be some knowledge that can be acquired or created, and that knowledge can be shared with others through various media (Haapalainen and Mäkiranta, 2013).

From knowledge management, the breadth of knowledge creation concept emerged. Knowledge creation differs from learning in that knowledge creation refers to a set of social practices that advance the state of knowledge within a community over time (Paavola, Lipponen and Hakkarainen, 2004). The study of knowledge creation that is most influential was by Nonaka, who develop the SECI model. According to Nonaka (1994), knowledge could be created by sharing knowledge within an organisation through a process of socialisation, externalisation, combination, and internalisation, which Nonaka called the SECI model. Knowledge creation in this sense is similar to learning, but it differed in that it emphasised the process of how knowledge is created within an organisation, rather than on one individual. It refers to a set of social practices that advance the state of knowledge within a community over time (Paavola, Lipponen and Hakkarainen, 2004).

As there was a necessity to introduce the concept of PCK to teachers, this study aims to innovate the ways teachers improve their knowledge. PCK is a knowledge that develops as teacher build knowledge and experience in teaching. In a school, teachers are the practitioners of teaching, and they tend to possess different levels of PCK (Chan and Yung, 2018). The SECI model is a knowledge creation model that is the optimal system for organisational knowledge creation, where people generate knowledge from each other. With this setting, the SECI model could be an alternative for teachers to improve their PCK. This study investigated if the SECI model could improve a teacher's PCK. Then, this study designed an instrument which consists of a procedure on how to run the SECI process. And this instrument is the novelty of this study.

In the following literature review section, this article first discusses PCK as the knowledge of teachers that needs to be improved, followed by a discussion on the SECI model and how it has been used (or not used) in the education field.

2. Literature review

2.1 Pedagogical Content Knowledge

PCK is the form of knowledge that teachers use to organise a classroom and to ensure the achievement of teaching goals (Shulman, 1987). When it was introduced by Shulman for the first time, PCK was described as the combination of two forms of knowledge: content knowledge and general pedagogical knowledge. Content knowledge refers to knowledge about the subject matter from an academic perspective. This is the knowledge that is to be taught in the classroom. It includes the teachers' breadth and depth of the knowledge of the teaching subject, regardless of whether it will be taught in the classroom. Meanwhile, pedagogical knowledge refers to general knowledge about teaching, such as how to instruct the class or the teaching model used in class. This also includes the various theories about learning that teachers acquire during teacher training or after teaching for a period of time (Shulman, 1987; Carlsen, 1999; Gess-Newsome, 1999). The combination of both types of knowledge results in PCK: the teacher's mastery of how to decide what is the most representative materials (of a certain topic) to teach and the best way to teach it to students. Teachers' mastery of PCK developed differently depending on their experiences of teaching practice (Sumaryanta, et al., 2018).

Over time, the concept of PCK has become more complex than when it was introduced. For example, Carlsen (1999) made further elaboration on the construct of PCK. He expanded PCK to include not only content knowledge and general pedagogical knowledge but also involve contextual knowledge, knowledge about students, and other forms of knowledge. These forms of knowledge are supposed to be the construct of pedagogical knowledge and content knowledge separately. Similar thoughts have been shared among other researchers who study PCK. Another model was proposed by Morine-Dershimer and Kent (1999), who conceptualised PCK as a more complex interrelation between various forms of knowledge. In their concept, PCK is constructed from various forms of knowledge, as shown below.

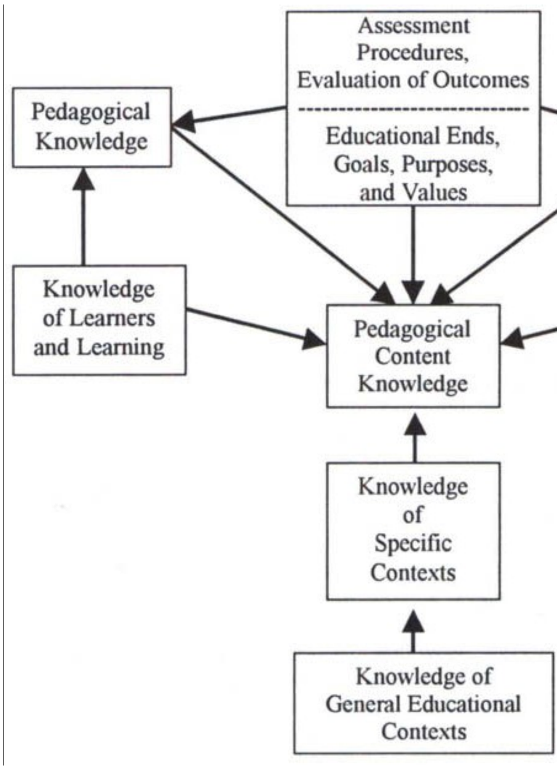

Figure 1: Interpretation of PCK by Morine-Dershimer and Kent (1999)

The above image shows that there are seven aspects that directly or indirectly affect teachers' PCK: pedagogical knowledge; content knowledge; knowledge of learners and learning; curriculum knowledge; assessment procedures; evaluation outcomes — educational ends, goals, purposes and values; knowledge of specific contexts; and knowledge of general educational contexts. The interconnected knowledge that contributes to pedagogical content knowledge demonstrates the richness of the concept. Some of these aspects are changeable depending on the situation, such as knowledge about learners and learning or curriculum knowledge. Teachers should improve and update their information to ensure that they are aware of recent developments in every aspect of PCK. Teachers are expected to be life-long learners who update their knowledge to keep up with new demands and needs as the education system evolves (Impedovo, 2016).

This recent development is deemed necessary because Morine-Dershimer and Kent found that the concept of PCK has been widely accepted in the education field. This acceptance is an opportunity to expand the construct of PCK further. Morine-Dershimer and Kent (1999) argued that the classroom itself is a complex context that the teacher needs to fully understand before they can adjust their practice accordingly. The aspects of this model can be explained as follows:

- Content knowledge is knowledge about the subject matter that needs to be taught. Teachers should have deep and wide content knowledge, as these are the materials that they teach to students. It enables the teacher to comprehensively teach the subject matter.
- Pedagogical knowledge is knowledge about teaching. This knowledge is developed over time through many teaching experiences and by acquiring declarative knowledge about teachings, such as theories of learning, learning models, and psychology of learning.
- Curriculum knowledge refers to the knowledge that is related to understanding the nature of the current curriculum implemented in the teacher's school— the content and the demand of education as designed in the curriculum. It also includes the teacher's ability to design their own curriculum.
- Knowledge of the learner and learning are the forms of knowledge that correspond closely to one another. Knowledge about the learner focuses on the students' condition, such as their prior knowledge, social upbringing, interests, and learning style. Learning focuses on the various factors that could influence learning, such as learning models and learning styles.
- Knowledge regarding assessments and goals from this model is comprised of assessment procedures, evaluation outcomes, educational ends, goals, purposes, and values. Assessment procedures are comprised of knowledge about the various kinds of assessments in education, such as portfolios and multiple choice. Evaluation outcomes are the knowledge about the way the evaluation results are used. Educational ends, goals, purposes, and values are the knowledge regarding the various aspects that education is expected to contribute, from the classroom scale (e.g. students' understanding of content knowledge) to the national or even worldwide scale (e.g. national education goals).
- Knowledge of specific contexts refers to knowledge about events that happened in the world with which students are familiar that could aid students in making connections between their own experiences and the content knowledge they obtain in learning activities.
- Knowledge of the general educational context is the knowledge of general information that supports and has become the environment in which education takes place. This includes knowledge such as school management, national philosophies and classroom situations (Alimuddin, Tjakraatmadja and Ghazali, 2020)

2.2 SECI Model

Nonaka (1994) proposed his concept of knowledge creation to explain knowledge and its role within organisations (Nonaka, 1991; 1994). This concept was developed as Nonaka acknowledged that each employee must have their own best practice in the company. In this case, professional teachers are no exception. By sharing knowledge with one another, it is expected that teachers will be able to create new knowledge that will help them to improve their PCK.

His formulation of knowledge creation developed into the SECI model. In this model, there are four steps of knowledge conversion that lead to an individual's knowledge creation: socialisation, externalisation, combination, and internalisation (Nonaka, 1994). Each step represents different modes of conversion (Figure 2).

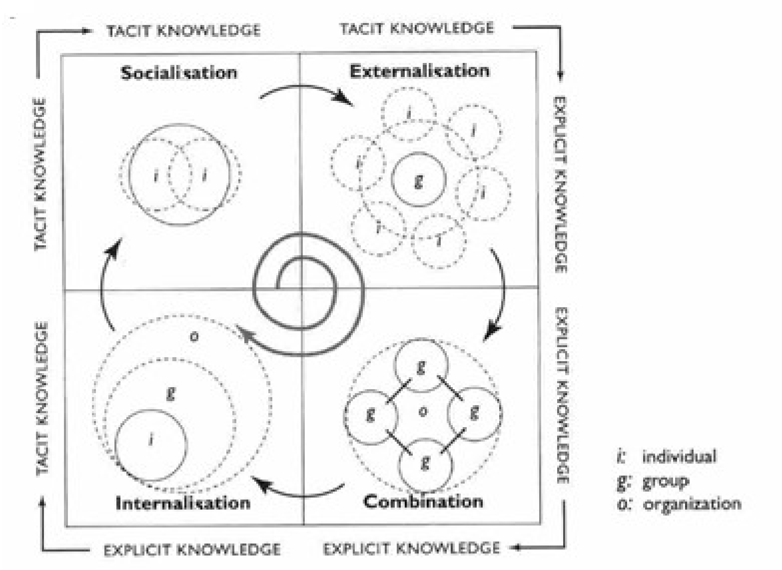

Figure 2: Interaction within the SECI Model. Reprinted from Nonaka & Konno (1998)

- Socialisation: the conversion of tacit knowledge from one person to another through hands-on experience.
- Externalisation: a process where one converts his/her tacit knowledge into explicit knowledge by trying to explicitly explain what they do.
- Combination: the conversion of the explicit knowledge acquired to a more complex and systematic explicit knowledge based on explicit knowledge sharing.
- Internalisation: a process where explicit knowledge from outside is converted to an internal and tacit knowledge.

The SECI model allowed companies to store their employees' knowledge and transfer it between one another. It aims to ensure that most of the knowledge within companies could be acquired by everyone, allowing the company to formulate the best practices from everyone's various knowledge. To do so, tacit knowledge should be converted to explicit knowledge. The conversion occurs through discussions, dialogues, or experience sharing. In the SECI model, this process can be found in the *externalisation* step. This is also the strength of the SECI model. However, when introducing the concept of SECI in his early writing Nonaka did not either provide deep explanation or emphasize the externalization phase (Gourlay, 2006)

In his SECI framework, each step represents how information is used and stored by individuals in the organisation and in the organisation itself. For example, employees externalise their various experiences to share with other employees. The information is then internalised and becomes the knowledge of other employees. Meanwhile, this knowledge could also be compiled in the form of a handbook or written guidance as a reference for future employees. Using Nonaka's SECI model as a framework for knowledge creation in an organisation will facilitate individuals to receive various information for their individual knowledge creation and for the organisation's knowledge creation (Nonaka, 2005).

One important aspect of the SECI model is that it thrives when applied in an organisational setting. When the SECI model is applied within organisations, it can provide a supportive environment where members of the group share their knowledge through any of the knowledge conversion modes. When conversion is conducted continuously in an organisation, it will become a never-ending circular process of knowledge creation for both the individual and the organisation (Nonaka, 1994).

In short, the SECI model departed from the traditional way of knowledge transfer, which has been heavily criticised, and mitigated possible problems that often occur during the learning process. It is structured and provides a clear framework for implementation, giving participants an active role in their learning, which is expected in adult learning (Angelo, 1993).

2.3 Using SECI to Improve Teachers' PCK

The concept of knowledge creation was first introduced in the organisation field. This means that any other form of organisation, including education, could also try to adapt knowledge creation into their field. However, searches in educational databases, such as ERIC, suggest that the implementation of knowledge management in the education field is limited.

An initial search of the term "Knowledge Management" in ERIC, the largest education database, yielded only 2,247 results. The top result was research about an agriculture research institution followed by other results that are less connected with compulsory schooling such as high school or elementary school. This alarming result led the researcher to inspect the descriptor list and choose "Knowledge Management". The descriptor led to a smaller number of articles, only 1,489, showing the same list of articles from the previous search. When the researchers searched for "knowledge management" and "school", it yielded more specific results that are connected to the implementation of knowledge management in formal schools; however, the number of articles became even lower, only 485. The results for "knowledge management" and "teacher" yielded only 440. Table 1 outlines the attempts the researcher conducted to check literature for this study.

Table 1: Search results from 2 different database

No	Search Terms/Keywords	Numbers of article in ERIC (educational database)	Numbers of article in ABI/INFORM (management database)
1	Knowledge Management	2247	Omitted for obvious reason
2	"knowledge management" and "school"	485	35,889
3	"knowledge management" and "teacher"	445	4,479
4	"knowledge creation" and "school"	167	14.064
5	"knowledge creation" and "teacher"	170	2097
6	SECI	15	Omitted for obvious reason
7	"SECI" and "Teacher"	5	146

A contrast could be seen when the search was conducted in the ABI/INFORM database, one of several large databases about the management field. For the same term, ABI/INFORM yielded many results, except for the last keywords, "SECI" and "teacher", where there were significantly fewer results. When compared, the amount of articles from both ERIC and ABI/INFORM search results were still small. Furthermore, when the authors examined all 5 article in ERIC and 146 article in ABI/INFORM search results, there were only a few articles that actually discuss the SECI model in a school setting for teachers' improvement. The authors used Google Scholar to search for relevant articles that were not already indexed in both databases.

From those limited sources, there are a few notable articles that highlighted the use and importance of the SECI model when implemented in an education setting. Some of those studies used the SECI model to facilitate education related to the Virtual Learning Environment (VLE). Hosseini (2011) reported that employing the SECI framework for the VLE could create an integrated and systematised path for knowledge creation. He used SECI's conversion modes as pedagogical steps in the VLE. He reported that the SECI model helps to make teachers' knowledge creation are practical and sequenced. Participants could also be more attentive to each step of knowledge conversion rather than allow it to occur in the background or unconsciously. However, he also reported that not all modes of conversion have been carried out effectively by the participants.

Similar findings could be seen in another VLE related study by Joia (2002). He reported the use of the SECI model as a methodology to implement training for unqualified in-service teachers in Brazil's rural areas. He tried to measure the strengths of all modes of conversion in the SECI model during the training. Similar to Hosseini's findings, the results indicated that the SECI model helped teachers in their practice, but not all modes of conversion were performed well. For example, the socialisation and internalisation processes tended to be more successful compared to combination and externalisation.

Another study that used the SECI framework is by Tee and Lee (2011). They combined problem-based learning (PBL) with the SECI framework to improve teachers' technological pedagogical content knowledge (TPACK). In their study, PBL, combined with the SECI model, improved teachers' TPACK. However, in their study, the program lasted for 12 weeks. This long period gives teachers enough time to shift their problems, from blaming students for lack of participation in class to reviewing their own teaching mistakes.

These previous studies tend to discuss the SECI model in a qualitative manner. While in the Tee and Lee (2011) study, although they used the SECI framework, this was not the only framework they used to improve teachers' PCK. Previous study also found several problems in the implementation of the SECI model for in-service teacher training, such as in Joia (2002). The problem lies with syllabi that are considered to be "too difficult" for teachers and a lack of grounded teaching materials, which make it difficult for teachers to relate with what is being taught in training. Another problem is related to the structure of the training scheme, where the training is held for months, and the need for teachers to visit different classrooms from different schools. Teachers need time outside of their teaching schedule to conduct their visits, and there is a lack of coordination between the teachers and the education department that manages the programme to ensure that visitations run smoothly. In the method section, the authors in this study demonstrate that several of these problems are addressed.

The discussion regarding the SECI model cannot be separated from its root, Polanyi's concept of tacit knowledge. Polanyi (1967) argued that, other than explicit knowledge, which is knowledge that can be delivered through verbal communication and has been linked with know-what, humans also have tacit knowledge. Tacit knowledge is the knowledge that is hard to articulate and has been linked with one's know-how. PCK, as Shulman (1986, 1987) argued, requires teachers to have knowledge about what to teach and how to teach. Even earlier conceptions of PCK argued that those are not the only aspects of PCK (Morine-Dershimer and Kent, 1999). That knowledge is acquired by teachers after their experience of teaching. This is similar to Polanyi's conception of tacit and explicit knowledge. Not only do teachers need to have theoretical knowledge about teaching and what to teach, but they also must be able to deliver it in the classroom. Some teachers might have the same educational background, but their teaching experiences in the years to come may be different depending on their experiential context (Shulman, 1987; Chan and Yung, 2018). This shows that the nature of PCK and the mechanism of knowledge conversion in the SECI model corresponds to one another. This article proposes to use the SECI model as a treatment for teachers to improve their PCK.

This study also adds another novelty to this academic niche. In a later section, the authors elaborate on the process of SECI treatment to improve teachers' PCK. The authors found that there was a lack of a directive process in previous studies to guide other stakeholders in the step-to-step implementation of the SECI model to improve teachers' PCK.

3. Research method

An empirical study on the implementation of the SECI model to improve PCK was conducted. The preparation for the study and the analysis was conducted during 2018 for six months in Indonesia. To test whether the SECI model could improve teachers' PCK, we created a quasi-experimental research design, as shown in the following table.

Table 2: Quasi-Experimental Research Design

Treatment Group	*M*	O	*X*	O
Control Group	*M*	O	*C*	O

M in this design means that the subjects in each group are matched because the subject cannot be randomly assigned to the control and treatment group. O signifies the test that was given to the participants. The treatment group received a test before the treatment (pre-test), treatment (X), and a test after the treatment (post-test). The control group also received pre-test and post-test at the same time with the treatment group, but without receiving any treatments (C).

Two groups of teachers from two different schools were involved in this research. One group was the treatment group and the other was the control group. Each group had a total of 20 teachers each. The grouping was decided based on the teachers' teaching institutions.

Eight open-ended questions were prepared as the pre-test and post-test to measure PCK. The instrument was created in a way that allowed teachers to reflect on how they implemented their PCK in a classroom setting, as seen in Table 3. The instrument was validated by experts.

Table 3: Questions to evaluate teacher's concept of PCK

No	PCK	Question
1	Knowledge of specific context	What is the context that you often use to deliver your subject matter?
2	All PCK components	What are the problems that you usually face during teaching?
3	Educational ends, goals, purposes, values; content knowledge; knowledge of specific contexts	Can you interpret the context that you use in your teaching practice? Explain.
4	All PCK components	What are your considerations when you brought a new perspective on that subject matter?
5	All PCK components	What are the conditions or situations that have helped or impeded you during your teaching practice?
6	All PCK components	What are the instructions that you used to deliver your teaching?
7	Assessments, procedures, and evaluation of outcomes	How do you know whether your teaching practice has been a success or failure?
8	All PCK components	What have been the successes or failures in that teaching practice? Moreover, what did you/would you do when failures occurred/occur?

Source: (Alimuddin, Tjakraatmadja and Ghazali, 2020)

The teachers' answers were evaluated by selected assessors using a rubric and scored. The assessors have experience in teaching as teachers in the same school and grading teacher's performance as assessor teams from the as part of the school's teacher evaluation team. There are five categories within the rubric. Each category was assigned with a score. The scoring system is similar to a Likert scale but with different numerical values. Instead of using the 1–5 or 0–4 range, this research used the 0–1 range with 0.25 intervals. This system was chosen based on the idea that 1 represents a holistic mastery of PCK. Any answer that demonstrates a lack of understanding of PCK would be scored lower than 1, with 0 as the lowest score.

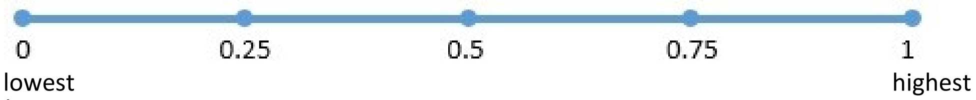

Figure 3: Rubric scoring system

The rubric provides guides for the assessor to determine whether all aspects of PCK that are related to the questions have been considered by the teachers. This is to ensure that the assessor can give an appropriate score (Stevens & Levi, 2005). The benefit of using a rubric is that it can be used to measure the answers created from a complex thinking process (Anderson, 1998; Stevens & Levi, 2005). As demonstrated in the literature review, PCK has a dense structure. Teachers need to have the freedom to externalise it in the form of writing. It is not possible to observe PCK generally if using other forms of assessment, such as multiple-choice tests. In multiple-choice tests, questions tend to encourage rote learning of information, where participants are directed towards a specific context and there is only one right answer. A universal instrument is not an ideal situation to learn about teachers' PCK. Table 4 shows an example of the details that could be captured by a rubric scoring system.

Table 4: Example of a 5-scale rubric

Question	0	0.25	0.5	0.75	1
What is the context that you often use to deliver your subject matter?	The teacher is not able to provide any aspect needed to create a context in teaching (*).	The teacher is able to provide 1 to 2 aspects needed to create a context in teaching (*).	The teacher is able to provide 3 to 4 aspects needed to create a context in teaching (*).	The teacher is able to provide 5 to 6 aspects needed to create a context in teaching (*).	The teacher is able to provide 7 to 8 aspects needed to create a context in teaching (*).

*context in teaching includes, but not limited to: situations, actors, objects, activities, interactions between actors and objects, descriptive aspects (time, place, and distance), changes or consequence (after the interaction), statement that leads to the connection between necessary aspects that were used to discuss learning concepts

After teachers' pre-tests and post-tests, answers were scored using the rubric. These scores were tabulated and then analysed using ANCOVA in SPSS.

3.1 The SECI Procedure in the Treatment

A session of knowledge creation was conducted in the educational institution that was chosen as the experiment group. The researchers created a systematic and detailed procedure for teachers to engage in the SECI process throughout the session. The session was conducted over four consecutive days. The first day, the teachers were introduced by facilitators to the concept of PCK, knowledge creation, and the SECI model. A demonstration was also carried out by the facilitators to illustrate the implementation of the SECI model on teachers' PCK. This lesson was given as an introductory task before participants used the SECI model to improve PCK the next day

The second day, the teacher was asked to form a group of four people. Each teacher in this group was guided by worksheets to engage in the socialisation and externalisation processes from the SECI model. In the socialisation phase, teachers worked on worksheet 1, and they were asked to watch a video of their teaching practice that had been recorded beforehand and make comments about their practice. After they finished making comments for the improvement of their own practice, the teachers moved on to worksheet 2.

During the externalisation phase, teachers were asked to take their own worksheet 1 and look at worksheet 2. Any comments that they found useful for their own teaching practice from worksheet 2 were to be written down on worksheet 1.

The combination phase and internalisation phase took place on the third day. In the combination phase, the trainers only gave teachers their worksheet 1 that they completed the day before. They each read each other's worksheet 1 that already had teaching two types of comments: the owner's comments and the comments about others' teaching practices that they thought might improve their teaching. Next, they were asked to write down what they learned from each other's notes in worksheet 1 on their own worksheet 1.
The last phase was the internalisation phase. Teachers were given a new worksheet 1. They were asked to re-watch their own video and write their comments on worksheet 1.

Table 5: Question in worksheets for the SECI treatment

Worksheet	Total worksheets/person	Question/Task
Worksheet 1	One worksheet	Watch your teaching video. Take notes and comment on your teaching practice.
Worksheet 2	Three worksheets	Watch other teachers' videos (three teachers). Write down comments, criticisms, and advice on those practices separately.

Researchers in this study expected that after the treatment, the teachers' awareness of what happened in their classroom would increase. This would be indicated by the comparison between their answers on worksheet 1 on the second day and the third day.

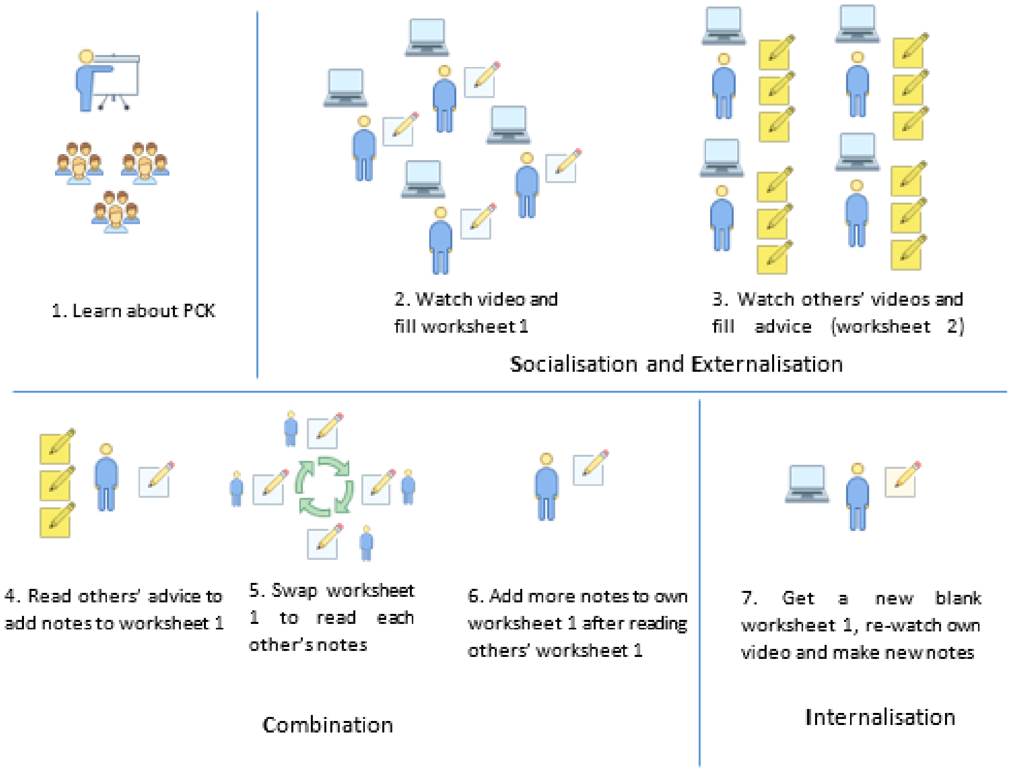

Figure 4: SECI treatment procedure

4. Results

Table 6 presents the means between the treatment group and the control group. There are differences between the control group's average post-test score and the treatment group's average post-test score.

Table 6: Average score for each group

Dependent Variable: Post-test

Treatment	Mean	Std. Deviation	N
SECI	3.9250	.91443	20
without SECI	1.3250	.48054	20
Total	2.6250	1.50107	40

The data of the teachers' test results also show that all teachers improved their PCK, as seen in Figure 5.

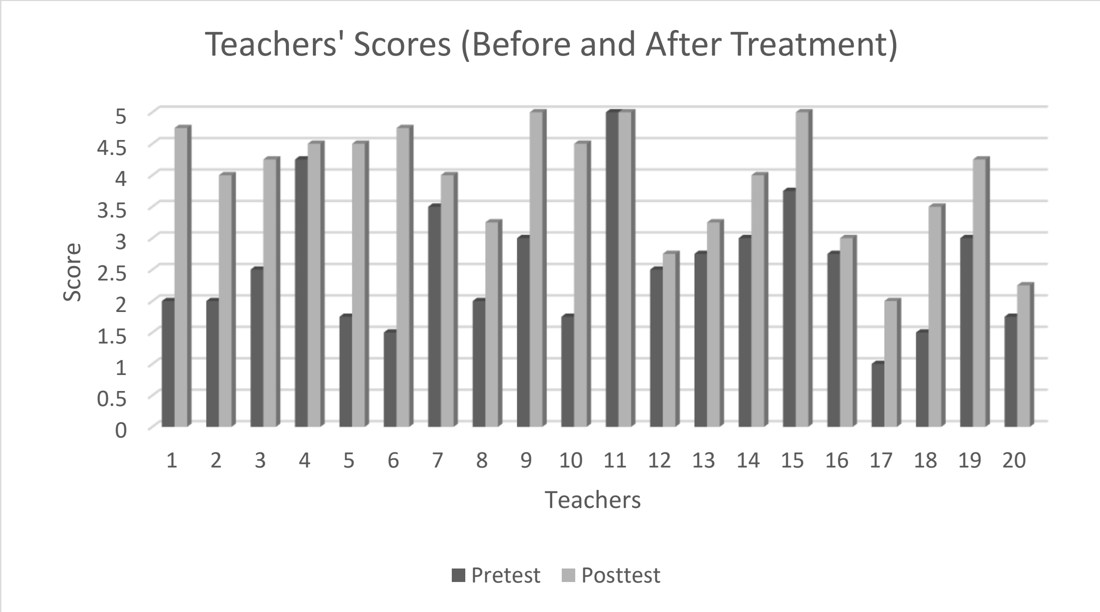

Figure 5: Graph of teachers' scores before and after the SECI treatment

The same data were analysed to check whether any significant difference existed within the data. Table 7 presents the ANCOVA test results. The ANCOVA analysis shows that there was a significant effect of the treatment on the participants' post-test results [$F(2, 40) = 68.963$, $p < .05$]. The partial eta square for the post-test indicates that the improvement of teachers' PCK, as a result of the SECI model, was as much as 65.1%. However, it could also be seen from Table 7 that 26% of the teachers' PCK improvement was also due to the participants' initial knowledge (pre-test effect on the post-test score has been removed by the ANCOVA analysis).

Table 7: Tests of between-subjects effects

Dependent Variable: Post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	72.882[a]	2	36.441	89.926	.000	.829
Intercept	17.122	1	17.122	42.254	.000	.533
Pre-test	5.282	1	5.282	13.033	.001	.260
Treatment	27.946	1	27.946	68.963	.000	.651
Error	14.993	37	.405			
Total	363.500	40				
Corrected Total	87.875	39				

Note: R Squared =.829 (Adjusted R Squared = .820)

This result implies that the SECI model can improve teachers' PCK. However, it is also important to acknowledge that participants' initial knowledge also contributes to a small extent to this improvement.

5. Discussion

This research is aimed at implementing an alternative approach to improve teachers' PCK. This study proposed to approach it from knowledge creation perspective using the SECI model. The researchers equated teachers with employees of a company that have unique skills and contextual knowledge of their practice. There have been few reports on the utilisation of the SECI model for professional teacher development; however, this approach has been successfully implemented to improve employee work in other fields, such as IT (Rodrigues, Gayathri and Rao, 2006), banking (Easa, 2012) and construction (Eliufoo, 2008).

This study found that the SECI model could significantly improve teachers' PCK [$F(2, 40) = 68.963$, $p < .05$]. This improvement is aligned with previous research conducted by Joia (2002), who found that the SECI model helped teachers in their teaching practice. This research also aligned with findings from Tee and Lee (2011) who combined PBL with the SECI model to improve teachers' TPACK, and demonstrated that even without combining with PBL, the SECI model could improve teachers' PCK.

Several problems in previous studies, such as Joia (2002), have also been addressed in this study, as demonstrated in the procedures of the SECI treatment. In this study, the teachers did not use a syllabus of teaching theories, but instead, they were asked to look at their own teaching and other teachers' videos. Teachers in the treatment group came from the same school, so the videos they watched had a familiar context and even similar problems. When teachers made notes about other teachers' practices, they shared their PCK in a written form and was expected to notice something that the other teachers did not notice because they were occupied with their teaching perspective. In the combination process, using the worksheets filled with comments and advice, all the teachers reviewed the same problem (the video) through different teachers' perspectives. During the internalisation process, teachers could internalise those new perspectives to their future practice by projecting what they would do differently compared to their previous practice.

The new knowledge and advice from watching other teachers' practice could even be used as a reference for each teacher's future practice if they happened to have the chance to teach the same class and face the same problem. This SECI dynamic is still related to different PCK that teachers have. Different teachers tend to notice different things and have different sensitivities to teaching (Chan and Yung, 2018). This is the tacit knowledge that is transferred during the SECI process. Thus, teachers are not confused with a new context that they are not familiar with, and they are not dragged into problems that they might never face. This latter point also addresses another problem that Joia spotted in his study, where teachers were expected to go to different schools to observe other teachers who teach different classes in different schools.

In this study, since all teachers came from the same school, the SECI process could be conducted in a less time-consuming way. This study's setting made the SECI process more effective because teachers could focus on the problem without needing much time to familiarise themselves with the context. The SECI model is a knowledge creation process that is developed for employees from the same organisation (Nonaka, 1994), and this study mimics that organisation setting well. Teachers also did not have to take extra time to visit other schools to participate in the SECI process.

This study also took a different route than the study by Tee and Lee (2011). It directly asked teachers to reflect on their teaching practice. In PCK, there are eight aspects for which teachers need to have knowledge and awareness. One of those is teachers' knowledge about learning and learners. The procedure bypasses the process of teachers blaming the student (the outcome of the socialisation phase in the few initial weeks of the SECI model in the Tee and Lee study) and asks teachers to directly focus their attention on the actual teaching, such as whether the teacher has a good sense of the students' attention and learning process and whether their teaching strategy corresponds to the problems in the classroom (teaching materials, curriculum needs, etc.). By asking teachers to be aware of other teachers' use of PCK as they teach, the SECI process could be more effective because teachers were focused on a situation that they could change on their own.

Further analysis of the results can be seen in Figure 5, which presents the teachers' PCK scores. This graph shows that it is possible for teachers to improve their PCK and get closer to other teachers' levels of PCK. For example, teacher 8, who initially had a low PCK score, improved his PCK score and had a score closer to those of teachers 7 and 15 from before the treatment. Although it could also be seen that teachers 7 and 15 have also improved their PCK, it should be noted that this study was only conducted in a single cycle of the SECI treatment. Other interesting data could also be seen in teachers 1, 5, and 10, who started with low scores and more than doubled their initial score. This is unlike teacher 20, who showed only a small improvement compared to teacher 2, even though they had roughly the same initial score. Another interesting result could be seen from teachers 16, 17, and 18. Teacher 17 had one of the lowest initial scores and did not improve as much as the other teachers. Meanwhile, teacher 16 had a higher score before the treatment, yet he did not experience a significant change in his post-test score. Teacher 18 had a lower score before the treatment but experienced a larger score increase. These results correspond to the eta square value in table 7, which shows that, although the teachers' initial knowledge (measured by their pre-test score) affected the post-test scores ($F = 13{,}033$, $p<0{,}05$), the effect of the teachers' initial knowledge was low (26%). Several data, such as that from teachers 12, 13 and 16, who only had a small increase in their PCK score, highlighted the need to investigate further as to whether factors that might pose as barriers to knowledge creation could be found within this setting, such employees unwillingness to participate in knowledge sharing (due to various reasons as reported by Razi, Karim and Mohamed (2015), Razmerita, Krichner and Nielsen (2016) and Albers et. al. (2018)

6. Conclusion, limitation, and recommendation for further research

Each teacher has different levels of PCK. During their career, they have developed their PCK, but they still need to improve it. At the beginning of this article, the authors addressed that the knowledge management perspective, especially the knowledge creation approach for teachers' professional development, is rarely used in the education setting. This study offered a different perspective by showing that knowledge creation, specifically the SECI model, could be used to improve teachers' PCK. SECI process in this study allows teachers to create a shared perspective about PCK, improve their PCK, and close the knowledge gaps between teachers. If teachers could familiarise themselves with the SECI procedures, they can have a shared PCK, and the school might be able to set certain standards according to its needs. Professional teacher training is no longer an individual pursuit but rather a collaborative effort within the organisation to improve teaching quality. However, further research is needed.

The limitation of this study is that it has not investigated further each SECI mode separately. This study does not show the variety of challenges or difficulties that the participants had during the process. Carried out this way, the study could not provide deeper insights into each SECI knowledge conversion process separately. Since there are four modes of knowledge conversion in SECI, there are still plenty of aspects that need to be explored, especially considering previous research in education indicates that some knowledge conversion steps are not as effective as others (Joia, 2002; Hosseini, 2011). Besides that, further research should also be conducted on the following subjects: First, a further investigation could evaluate whether a continuous PCK cycle (more than one session) is able to result in a bigger impact on teachers' PCK. For example, whether it could close the gap even further if the teachers have become used to the SECI procedure, or in a condition where the teachers are able to do SECI naturally in the work setting. Second, a grounded and longitudinal study could be conducted on certain groups of teachers to assess their natural knowledge sharing process (without the SECI model). This could be followed by a survey study to investigate teachers' habits in acquiring knowledge. Another study could be conducted with the participants of this study to investigate their experiences in using the SECI model as well as their previous experiences in acquiring knowledge (before using the SECI model). These studies are needed to obtain a more holistic understanding of this subject.

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The Effects of Organizational Absorptive Capacity, Professional Experience and Training over the Use of Sales Force Automation

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Abstract: This research brings out the impact of training and professional experience on organizational absorptive capacity and the use of Sales Force Automation (SFA). A quantitative study was conducted on a sample of 186 medical sales representatives who work in the pharmaceutical industry. The method of structural equations based on the PLS approach and linear regression have been deployed for data analysis. The results reveal a positive impact of the training over organizational absorptive capacity (potential absorptive capacity and realized absorptive capacity) and the use of SFA as well as a positive impact of professional experience on organizational absorptive capacity. Furthermore, the organizational absorptive capacity has a positive influence on the use of the SFA. This study contributes to the literature on SFA use by examining the role of training, professional experience, realized and potential absorptive capacities in the SFA use. This research is appropriate for managers of pharmaceutical companies who constantly seek to improve the use of SFA technologies. Thus, the staff of these companies is more likely to perform their duties in a way that promotes their realized and potential absorptive capacities and the best use of SFA through continuous training for inexperienced and experienced salespeople.

Keywords: SFA use, organizational absorptive capacity, training, professional experience, potential absorptive capacity, realized absorptive capacity, North Africa

1. Introduction

In an increasingly competitive market, the introduction of information and communication technologies (ICT) into business enterprises have made Sales Force Automation (SFA) systems fatal business devices, in which organizations regularly invest despite the high cost of implementation (Román and Rodríguez, 2015 ; Sanakulov, Kalliomaa and Karjaluoto, 2018).

Sales Force Automation is part of Customer Relationship Management (CRM) systems and consists of supplying sellers with management tools to assist them in their prospecting procedures. It also helps companies to collect, manage, store and share knowledge to develop a lasting relationship with customers (Boujena and Merunka, 2008; Upadhyay et al., 2018).

Companies acquire immense human and financial resources to equip their sales forces with information technology (Román and Rodríguez, 2015). Yet, Sleep et al. (2020) and Sanakulov, Kalliomaa and Karjaluoto (2018) argue that increased use of SFA systems does not continually lead to increased productivity and work efficiency. In fact, both Gartner and Standish Group claim that 75% of SFA projects fail (Bernoux and Gagnon, 2008). According to these Groups, there are several difficulties encountered when implementing a Sales Force Automation solution: resistance to change, the quality of use of the SFA and the difficulty in benefits provided by such a solution. As a result, the deployment of the SFA is a difficult and complex task that must be taken seriously. It is, then, necessary to understand why some organizations manage to use SFA tools and why others fail (Sanakulov, Kalliomaa and Karjaluoto, 2018).

The current hypothesis reveals that the failures of the SFA systems that endure arise from the fact that organizational changes are considered with a deterministic approach to technology. This is a recurring debate that has drawn the attention of researchers by opposing two types of determinism: technological determinism and organizational determinism. Technological determinism considers that technology has an impact on organizations insofar as it contributes to improving the efficiency of organizations and organizational mechanisms. Indeed, if the technology is properly implemented, it will impose itself intrinsically on the organization and on the stakeholders. Organizational determinism, on the other hand, stipulates that the diffusion of technologies depends on the characteristics of the organizations in which they are used and that the

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characteristics of the organization appear as a constraint to the introduced technologies (Leonardi and Jackson, 2004).

The majority of research on SFA systems is based on the deterministic approach (technological and organizational) and focuses on three key themes: SFA adoption by the sales forces (Larpsiri and Speece, 2004; Sinisalo, Karjaluoto and Saraniemi, 2015; Sanakulov, Kalliomaa and Karjaluoto, 2018), SFA impact on the organization (Sinisalo, Karjaluoto and Saraniemi, 2015; Román and Rodríguez, 2015; Wang et al., 2017) and the determinants of adoption and use of SFA (Sinisalo, Karjaluoto and Saraniemi, 2015; Cascio, Mariadoss and Mouri, 2010 ; Upadhyay et al., 2018). These works have been based on the deterministic approach that focuses on explaining individual reactions and behaviors with the implementation of a new technology as well as its impact on the organization. On the one hand, this approach has focused on enumerating the determinants of the acceptance and adoption of the SFA among the actors of the organization, more precisely the sellers and this is according to a linear diagram which is mainly inspired by acceptance models (TAM1, TAM2) (Davis, 1989). On the other hand, it has focused on the study of the positive (productivity, creativity, efficiency) (Cascio, Mariadoss and Mouri, 2010, Wang et al., 2017) or negative implications of the SFA on employers and employees (Sinisalo, Karjaluoto and Saraniemi, 2015).

However, despite the difference in their results, these research works, which have been based on the deterministic approach, had one thing in common: the analytical approach adopted was of a causal type; that means it attempts to establish a link between the antecedents or the consequences of adopting the SFA. The technological determinism adopted by the majority of research works on SFA systems (e.g. Sinisalo, Karjaluoto and Saraniemi, 2015; Román and Rodríguez, 2015 ; Wang et al., 2017) has been well criticized for not calling into question the relevance of the factors of success.

Thereby, the understanding of the logic of using the SFA thus requires to break with the technological deterministic approach and to adopt organizational determinism which considers that human actors and the organizational context are taken into account (Barley 1990; Orlikowski, 1992) and the relational approach by integrating the Knowledge Management (KM) more particularly organizational absorptive capacity which involves the incorporation, retention and distribution of knowledge (Cohen and Levinthal, 1990).

As an alternative to this deterministic approach, the relational approach based on knowledge management aims to focus on the link rather than people and makes it possible to understand how employees interpret and share knowledge. It assumes that people act in relation to each other and that individual autonomy can only be relative. It emphasizes interaction, communication, relationships and knowledge sharing among staff members to succeed in using technologies. (Stadler, Fullagar and Reid, 2014)

In this research, we are simultaneously in the organizational determinism approach and in the relational approach based on knowledge management. In fact, organizations invest considerable sums to acquire a Sales Force Automation system, but they do not properly use their systems to gain customer knowledge. Indeed, Khodakarami and Lahouti (2013) stated that SFAs are generally underexploited, especially with regard to creating customer knowledge. External knowledge has become a primary source of competitive advantage. To ensure their sustainability, organizations must « *recognize the value of new, external information, assimilate it, and apply it to commercial ends*" (Cohen et Levinthal, 1990, p.128), namely the organizational absorption capacity. According to Chaudhary (2019, p.3) *"An organization's absorptive capacity is not resident in any single individual, but depends on the link across a mosaic of individual capabilities"*, it requires organizational factors such as training and professional experience to help make individual knowledge more understandable.

The choice of this topic is primarily justified, first, despite the importance of the use of technology in sales jobs; empirical research on the use of SFA is quite limited (Sanakulov, Kalliomaa and Karjaluoto, 2018). The SFA use and organizational absorptive capacity are two considerable areas, but their links remain insufficiently dealt with at the academic level. Organizational absorptive capacity has largely fascinated knowledge management researchers (Wu et al., 2019), but not sales force automation research. Second, the majority of early research uses absorptive capacity as an unidimensional concept (e.g. Cohen and Levinthal, 1990), while recent research examines its sub-dimensions, potential and realized absorptive capacities (Ahmed et al., 2019 ; Chaudhary, 2019 ; Muraliraj et al., 2019). However, as far as it is known, there is no research that examined the relationship between organizational absorptive capacity and SFA use through potential absorptive capacity and realized absorptive capacity. Third, the results are different in the effects of training on information and communication technologies (ICT) use. In fact, in the area of SFA use, training is accepted as an important driver of successful SFA use (e.g. Singh, Manrai and Manrai, 2015; Jantan and Honeycutt, 2013 ; Kodwani and Prashar, 2019). Other researchers such as Salopek (2009) have observed that many salespeople find training ineffective or less useful for a better use of technology. Fourth, professional experience has received little attention in ICT research specifically SFA systems. In doing so, we fill an important gap in the literature by examining the antecedents of SFA use in pharmaceutical firms which are non-R&D-intensive service firms.

Tunisia is a particularly interesting example of developing countries in North Africa. The use of SFA in developing countries is comparatively lower than in most developed countries (Román and Rodríguez, 2015). This research is particularly necessary in a context of African developing countries such as Tunisia, where companies in the pharmaceutical sector adopt less ICT than companies from developed Western countries.

This article focuses on the use of SFA to the detriment of the largely dominant concepts of adoption and acceptance in previous research works (Cascio et al., 2010, Wang et al., 2017), and its relation with the organizational absorptive capacity and its determinants such as training and professional experience. Thus, this research tries to answer this question: To what extent do training, professional experience and organizational absorptive capacity influence the use of the SFA? This study examines the role of training and professional experience on potential and realized absorptive capacity and on SFA use. In addition, this study also investigates the direct impact of each dimension of organizational absorptive capacity on SFA use.

Section 2 of this article presents a cross-referencing of previous research on the use of the SFA in the light of the organizational deterministic approach and relational approach based on knowledge management. Then, it explains the hypotheses and the conceptual model. Section 3 develops the research methodology. Section 4 presents the analysis of the data while the discussion appears in sections 5. Section 6 presents the conclusion by highlighting the theoretical and managerial contributions, the limitations of the study and possible directions for future research.

2. Theoretical background

2.1 The use of the SFA in the light of the organizational deterministic approach

The concept of Sales Force Automation has been conceptualized by Lambin and De Moerloose (2012) as an effective solution to optimize salespersons' activities with their customers. It is often adopted by businesses to improve customer service, better guide salespeople, improve sales force productivity, and ensure the best sales management decisions.

Baker and Delpechitre (2013, p.278) presented SFA as “computer software and relational database technologies created to support sales activities in the field”. Sinisalo, Karjaluoto and Saraniemi (2015) state that SFA is therefore part of a company's CRM (Customer Relationship Management) and is generally the first function (the others being marketing and customer service) that is automated using CRM technology. Jelinek (2013, p.637) has defined it as “the set of technological tools making it possible to better equip a sales and marketing organization to practice CRM”. Sleep et al. (2020) have defined SFA as a technological tool that helps organizations manage the sales function by collecting and storing customer data such as demographic data, purchase history, needs and wishes, etc.

Although SFA has been defined in various ways, the common thread of all these definitions is that the application of SFA technology helps to support the sales function thus enabling better execution of sales tasks in an organization (Upadhyay et al., 2018).

Research that focuses on the use of the SFA in the light of the organizational deterministic approach, states that the SFA use depends on the characteristics of the organizations. In this context, Serdagolu (2009) shows that there are relations between the use of the SFA and its antecedents. This is inspired by the value chain and the model of acceptance of the technology (Davis, 1989). Serdaroglu (2009) identified determinants that affect the use of SFA: perceived usefulness, perceived ease of use, supervisor support, enabling conditions, computer system self-efficiency, use of the SFA team and control of SFA technology from supervisors. He presents the use of the SFA as a two-dimensional concept: the SFA is a customer relationship management tool and an internal coordination tool for teams within the organization. The first dimension includes processes such as managing business contacts as well as understanding customer needs, organizing activities such as scheduling sales' calls, preparation for the a visit, presentation of sales pitch while overcoming objections and continuing to serve the customer after the sale (Widmier et al, 2005). The second dimension allows internal coordination between the members of the company in relation to the management of information concerning the sales activities of the team and the training to be provided. In this way, the sales persons exchange information daily with each other while communicating the results of their activities to their management.

Central elements of SFA acceptance can be grouped into three categories, namely: organizational factors (training, managers' commitment), individual factors (personality traits, age, attitude and professional experience) and social factors (the role of social norms, peer usage). In this sense, Upadhyay et al. (2018) enumerated the direct and indirect influencers of use of sales technology, they claimed that attitude and peer usage have a direct effect on the use of sales technology. Pullig, Maxham and Hair (2002) showed that managers' commitment to the use of SFA tools is the key to a successful organizational change and that training helps sales persons to better understand the operation and use of SFA. Keillor, Bashaw and Pettijohn (1997) have demonstrated that age and professional experience can influence the process of accepting and using SFA tools.

2.2 The use of the SFA in the light of the relational approach based on knowledge management

Research that focuses on the use of the SFA in the light of the relational approach based on knowledge management states that there is a close relationship between CRM and knowledge management, this relationship is materialized through the transfer of knowledge, held by sellers, to other stakeholders in the company and to customers (Boujena and Merunka, 2008). Thus, the transverse system of the CRM type is dedicated to sellers to facilitate the accumulation, processing and sharing of customer knowledge, both tacit and explicit.

Migdadi (2020) states that knowledge management enables successful CRM of which SFA is a part since CRM processes are based on large amounts of knowledge to identify and track customers and then satisfy and retain them. Thus, companies would have to develop CKM (Customer Knowledge Management) capacities to properly manage the knowledge coming from customers. Customer knowledge will be a valuable and scarce asset for these companies to adapt to rapidly changing customer needs. In the same way, Tseng (2016, p.204) asserts that *"knowledge management the objective of which is the acquisition, dissemination and use of knowledge will be the cornerstone for the successful use of a CRM, since it allows the organization to have a global view of customers".*

According to Chua and Banerjee (2013, p.614), the continuous evolution of customer needs and wishes has led to a paradigm shift in knowledge management towards a dynamic customer-centered approach. He claimed that *"CKM (customer Knowledge Management) enables to positively affect CRM practices by facilitating the acquisition and continuous updating of knowledge on customer needs, motivations and behavior, as well as the application of this knowledge to improve CRM practices".* Tseng (2016, p.205) asserts that *"companies rely on good knowledge management to improve CRM practices through a better understanding of customer needs by providing personalized information and increasing interaction between companies and their customers".* Hasanian, Chong and Gan, (2015) also indicated that customer relations cannot take place without knowledge management since CRM processes are based on large amounts of knowledge. Knowledge management facilitates the sharing, creation and storage of knowledge thus it promotes the functioning of CRM.

There is very little research, as far as it is known, that addresses the relationship between SFA and KM but since SFA is part of CRM, we assume that there is a relationship between the SFA and KM. The capacities in terms of knowledge management are important pre-requisites in the implementation of an SFA. To be effective and productive, the SFA must have both explicit and tacit knowledge at the same time in order to be properly managed by the sellers. As far as it is known, only the research by Hunter and Perreault Jr. (2007) have examined the notion of using the SFA by relying on the theory of organizational learning and knowledge management. They defined the concept of using the SFA in three dimensions: access to information, its analysis and its communication. Access to information provides details on the possibility available to the sales force to obtain information related to the accomplishment of its sales work and the complaints related to it. Information analysis is translated into the ability of the sales force to synthesize information. As for the communication of information, it reflects the ability of sellers to share information between contributors.

2.3 Research Framework and Hypotheses

2.3.1 Effects of Training and Professional Experience on Organizational Absorptive Capacity and the Use of SFA

Muraliraj et al. (2019) asserted that companies must foster organizational absorptive capacities to cope with the turbulence of the business world and to survive in dynamic environments. Cohen and Levinthal (1990, p.130) were the first authors to develop the notion of absorptive capacity. They defined it as *"the aptitude of a firm to recognize the value of new information, to assimilate and to apply it for commercial purposes".* Three dimensions can be retained: the valorization of external knowledge, its assimilation and its application for commercial purposes. Zahra and George (2002) used this definition to describe organizational absorptive capacity as a dynamic capacity and multidimensional construct, and they defined it as a *"set of organizational routines through which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability"* (Zahra and George, 2002, p. 186). They propose four dimensions that are grouped into two categories, namely the potential absorptive capacity (PACAP: the ability of the company not only to acquire external knowledge but also to assimilate it) and the realized absorptive capacity (RACAP: the organization's capacity to transform and exploit knowledge). According to Albort-Morant et al. (2018), PACAP and RACAP are distinct capabilities that need to be managed separately because they allow differential outcomes to gain competitive advantage.

Ahmed et al. (2019) state that the majority of research examining organizational absorptive capacity has taken it as an unidimensional concept, regardless of the differences between realized and potential absorptive capacity. Questioning the determinants of absorptive capacity without differentiating between its types can be risky and even misleading. In addition, research on the relationship between three concepts training, organizational absorptive capacity and SFA use is scarce.

Murovec and Prodan (2009) consider that training is a determining variable that affects the use of the SFA. Sellers' training is subject to ongoing development and learning programs that provide sellers with the skills and knowledge they need. Chen and Huang (2009) show that human resource management practices (such as training) are positively related to knowledge managment.

Kodwani and Prashar (2019) state that the existing literature on training states that it remains a major concern for managers. Singh, Manrai and Manrai (2015) advocated the need for empirical work which explores the relationship between training and SFA use given the importance of the effectiveness of sales training. Thus, training is also an important factor in the development of sales work while using information technologies according to Cron et al. (2005). Indeed, sellers attend courses to improve their skills, and this is done through online training sessions. Cron et al. (2005) show that training contributes to the improvement of the use of SFA.

Kodwani and Prashar (2019) state that effective sales training improves knowledge and skill levels of sales managers. As a result, organizations invest immensely in terms of time, resources and effort to train their sales executives for better SFA use.

Thus, the hypotheses H1, H2, H2.1 and H2.2 are presented as follows:

H1. Training has a positive influence on organizational absorptive capacity.

H2. The training positively influences the use of SFA.

H2.1. The training positively influences the use of the SFA as a customer relationship management tool.

H2.2. The training positively influences the use of the SFA as a tool for internal coordination among stakeholders.

Few researches deal with professional experience and even with the relationship between professional experience and SFA use. As far as it is known, two little bit old studies have dealt with this relationship. Keillor, Bashaw and Pettijohn (1997) examined the relationship between sellers' work experience and their perception of technology. They found that less experienced salespeople are more resistant to the use of technology. Deng, Doll and Cao (2008) state that internal factors can influence knowledge management, which are the category of study, the type of position held in the company, as well as the professional experience within the company. Thus the hypotheses H3, H4, H4.1 and H4.2 are presented:

H3. Professional experience positively influences organizational absorptive capacity.

H4. Professional experience positively influences the use of SFA.

H4.1. Professional experience positively influences the use of the SFA as a customer relationship management tool.
H4.2. Professional experience positively influences the use of the SFA as a tool for internal coordination among stakeholders.

2.3.2 Effects of Absorptive Capacity on the Use of SFA

Cohen and Levinthal (1990) suggest that a firm with a large absorptive capacity makes the use of technology more attractive through the organization's contributors. Zahra and George (2002) made a reconceptualization of the organizational absorptive capacity different from that of Cohen and Levinthal (1990) by identifying two dimensions, namely the potential absorption capacity and the realized absorption capacity.

The Potential absorptive capacity is related to exploratory learning or the acquisition of external knowledge. It is the ability to assess the interest of external knowledge (Chaudhary, 2019); it is made up of knowledge acquisition and assimilation capacities. According to Ahmed et al. (2019), knowledge acquisition is the ability of companies to recognize and obtain important information from external sources for the proper functioning of the organization. Knowledge assimilation is the company's ability to interpret and process the knowledge obtained. Chaudhary and Batra (2018) claim that once organizations acquire potential absorptive capacity, this latter positively affects the use of ICTs.

The Realized absorptive capacity is defined as the organizational capacity to transform and exploit knowledge. Knowledge transformation is defined as *"firm's ability to develop and refine routines that facilitate combining existing knowledge"* (Zahra and George, 2002, p.187) with new external knowledge. According to Chaudhary (2019), transformation supports companies to combine external knowledge with existing knowledge in order to properly use technologies. Finally, the exploitation of knowledge is based on the application and implementation of acquired, assimilated and transformed knowledge (Ahmed et al., 2019), thus linking them to positive uses of technologies (Xie, Zou and Qi, 2018).

Hence, the following hypotheses: H5, H5.1 and H5.2.
H5. Organizational absorptive capacity positively influences the use of SFA.
H5.1 Organizational absorptive capacity positively influences the use of the SFA as a customer relationship management tool.
H5.2 Organizational absorptive capacity positively influences the use of the SFA as an internal coordination tool among stakeholders.

Figure 1 shows the assumptions and presents the research model.

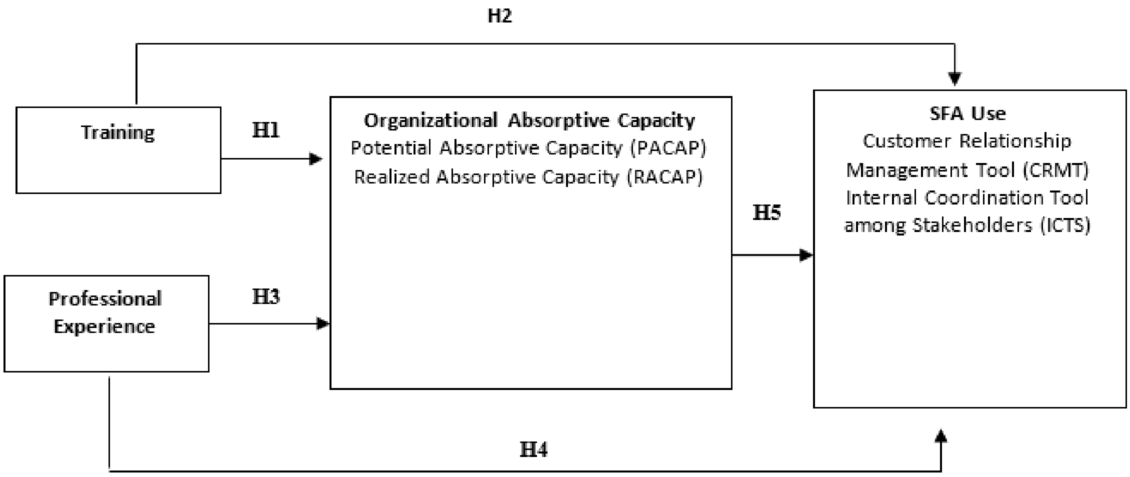

Figure 1: Research model

3. Methodology

3.1 Sample and data collection

The data collection has lasted six months during which the authors used a questionnaire handed directly to respondents or sent electronically by email. The authors chose the sample based on the "snowball" method to select medical sales representatives working in companies operating in the pharmaceutical sector and located in Tunisia. Tunisia is a country in North Africa located on the Mediterranean coast.

The choice of the pharmaceutical sector is justified by the fact that SFA system facilitates the working tasks of the medical sales representatives during their visits to pharmacies for example. This is why it is essential for the medical sales representatives to have a simple and intuitive tool that facilitates commercial activity.

The sample is made up of 186 medical sales representatives, 84 men and 102 women, aged between 36 and 45 years old. The choice of medical sales representatives is justified by the paramount role of the medical visitor in the pharmaceutical industry, which has a primary responsibility at the level information.

We chose the snowball sampling method, because we evaluate the target population, namely medical representatives, who are a bit special and geographically dispersed over Tunisia. In addition, we believe that the number of medical representatives in Tunisia is low. Around 4000 medical representatives are available throughout the national territory in January 2019 (http://recruter.tn/delegue-medical-un-metier-difficile-mais-valorisant. 2020.10.20)

3.2 Measurement instruments

All variables were measured using a Likert scale ranging from 1 (strongly disagree) to 1 (strongly agree). Table 1 shows the measurement scales.

3.3 Validation of measurement instruments

The exploratory factor analysis using the SPSS 18.0 software has allowed the refinement of the measurement scales. An exploratory factor analysis, the type of which is principal component analysis and Cronbach's alpha reliability analysis are deployed to test factor saturation. Table 1 details the principal component analysis of each dimension and presents the results of these analyses and proves that the Kaiser-Meyer-Olkin (KMO) measurements indicate the relevance of the factor solution for all the dimensions obtained. In addition, the Barlett specificity test is significant (P = 0.000) for all dimensions, which confirms the existence of a non-zero inter-item matrix. In addition, the quality of representation of the indicators is good since they have values higher than or equal to 0.5. Finally, the Alpha Index values are considered satisfactory and acceptable since they are above the minimum threshold of 0.6. These results prove that the reliability of the dimensions is checked.

Table 1 shows the results of the exploratory factor analysis.

Table 1: Results of exploratory studies

Ite ms	Factors	Eigenvalue
The Training (Chen and Huang, 2009)(KMO=0.648; ⍰=0.768)		
TR_1: Availability of formal training activities (i.e. after a degree/ a diploma).	0.602	
TR_2: Availability of training policies and global training programs (a training program covering several aspects, e.g. pharmaceuticals, languages, negotiation techniques, etc.).	0.632	3.380
TR_3: Availability of training for newly hired personnel.	0.703	

Items	Factors	Eigenvalue
TR_4: Availability of training for developing problem solving skills.	0.637	
The Organizational Absorptive Capacity (Flatten et al, 2011)		
Potential Absorptive Capacity (PACAP) (KMO=0.648; ⍰=0.768)		
Acquisition		
ACQU_1: To look for relevant information about our industry is an everyday matter in our business.	0.872	
ACQU_2: Our management system encourages employees to use sources of information related to our sector.	0.861	
ACQU_3: Our management system expects employees to process information that are not part of our sector (outside the sector).	0.794	2.234
Assimilation		
ASS_1: In our company, ideas and concepts are communicated in between departments.	0.658	
ASS_2: Our management system emphasizes interdepartmental support for problem solving.	0.762	
ASS_3: In our company, there is a fast information flow (that is, if aservice obtains important information, it quickly communicates it to all the other services or departments).	0.871	3.345
ASS_4:Our management system periodically requires interdepartmental meetings to exchange new developments, issues and achievements	0.734	
Realized Absorptive Capacity (RACAP) (KMO=0.516 ; ⍰=0.842)		
Transformation		
TRAN_1: Our employees are able to structure and use the collected knowledge.	0.855	
TRAN_2: Our employees are used to assimilating new acquaintances	0.777	

Ite ms	Factors	Eigenvalue
as well as preparing them for other purposes and making them available.		
TRAN_3: Our employees succeed in linking existing knowledge with new corporate inspirations.	0.803	6.634
TRAN_4: Our employees are able to apply the newly acquired knowledge in their practical work.	0.600	
Exploitation		
EXPL_1: Our management system supports the development of pharmaceutical laboratory projects.	0.807	
EXPL_2: Our laboratory takes technology into consideration and adapts it to new knowledge.	0.866	3.456
EXPL_3: Our laboratory is able to work more efficiently by adopting new technologies.	0.699	
***The use of SFA* (Serdagolu, 2009)**		
A customer relationship management tool (KMO=0.637, =0.748)		
CRMT_1: To serve customers in a more creative way (e.g. the use of computers by salespeople to improve problem-solving skills).	0.602	
CRMT_2: To improve the quality of service offered to prescribers.	0.609	6.456
CRMT_3: To identify the most profitable customers from the list of potential customers (prospects).	0.718	
CRMT_4: To plan sales activities (e.g. sales number, phone calls per day).	0.476	
An internal coordination tool among the stakeholders of the company		
(KMO=0.641, =0.820)		

Items	Factors	Eigenvalue
ICTS_1:To receive information from my director (manager, supervisor)	0.637	3.345
ICTS_2: To provide information to my director (manager, supervisor)	0.74	
ICTS_3: To report travel expenses to the head office.	-	-
ICTS_4: To learn about our existing products and new products	0.582	
ICTS_5: To coordinate activities with members of my team.	0.719	

4. Results and analysis

Two statistical methods, namely the simple linear regression method and the structural equation method, were used to test the research model. On the one hand, the linear regression method aims to test the relationships between training, organizational absorptive capacity and use of the SFA. On the other hand, it aims to test the relationships between professional experience, the organizational absorptive capacity and the use of the SFA. Regarding the structural equations method, the authors chose the Partial Least Square (PLS) method to study the relationship between the organizational absorptive capacity and SFA use. This method is considered pertinent to this research since the conceptual model includes a formative construct, namely the use of the SFA.

4.1 Effects of Training on the Organizational Absorptive Capacity and the Use of the SFA

To test the hypotheses H1, H2.1 and H2.2, the simple linear regression method was used by applying the two tests: the "ANOVA" test which makes it possible to test the existence or the absence of the model and the tests of Student "t" that allow the study of the significance of the coefficients of the regression equation. The results obtained are shown in Table 2. We opted for linear regression since the training variable is a qualitative variable. According to Carricano and Poujol (2008), ANOVA consists in testing the effect of a qualitative variable, it is training in our study on a quantitative variable.

Table 2: Summary of the validation of assumptions about the effects of training on the organizational absorptive capacity and the use of the SFA.

Hypotheses	Indicators	Validation
H1. Training has a positive influence on organizational absorptive capacity.	β=0.916 p=0.000 t=32.078	Supported
H2.1. The training positively influences the use of the SFA as a customer relationship management tool.	β=0.337 p=0.000 t=4.859	Supported
H2.2. The training positively influences the use of the SFA as a tool for internal coordination among stakeholders.	β=0.249 p=0.000 t=3.490	Supported

4.2 Effects of professional experience on the organizational absorptive capacity and the use of SFA

To test hypotheses H3, H4.1 and H4.2, ANOVA tests (analysis of variance) were used. The results have showed a significant difference of risk at 5% for the organizational absorptive capacity. Indeed, the organizational absorptive capacity depends on experience. In addition, the average results show that medical sales representatives with 4 to 10 years of experience contribute more to organizational absorptive capacity. This age range has the highest and least dispersed average with a standard deviation of 0.8 (see Appendix 1). Hypothesis H3 is then accepted.

The results of the ANOVA Test revealed a non-significant difference for the use of SFA as an internal coordination tool between stakeholders and the use of SFA as a CRM tool. Indeed, Fisher's test is not significant for the variable "use of SFA as an internal coordination tool among stakeholders", i.e. p = 0.341 superior than 5% and the variable "use of SFA as customer relationship management tool'', i.e. p = 0.143 superior than 5%. On the other hand, the variance-based average comparison test is not significant because the probability level is higher than 0.5 for both dimensions, namely the use of the SFA as a management tool of the customer relationship and the use of the SFA as an internal coordination tool among stakeholders (see Appendix 1). The results of the hypothesis test prove that hypothesis H4 is invalid since H4.1 and H4.2 are disproved.

4.3 Effects of the organizational absorptive capacity on the use of SFA.

The approach of Hair et al. (2014) was adopted to test the predictive validity of the relationship between the organizational absorptive capacity and use of the SFA. This approach involves two steps, namely the specification and validation of the measurement model and the specification and validation of the structural model.

Therefore, the structural model has two measurement models, namely the organizational absorptive capacity measurement model (a third-order reflexive construct) and the SFA use measurement model (a second-order formative construct). In order to evaluate the measurement model, several validation criteria, derived from the PLS method, are used. These criteria differ according to the nature of the construct. In this sense, for a reflective construct, the composite reliability (CR), the convergent validity [average variance extracted AVE (Average Variance Extracted)] and the discriminant validity [cross-correlation (cross loading) (Chin, Henseler and Wang 2010) and criterion of Fornell-larker] are studied. Concerning the formative construct, the quality of the indexes at the level of the construct (the nomological validity and the content validity) and at the level of the indicator [significance of the weights: VIF (variance inflation factor)] are checked. The results from PLS prove that the validity of first-order reflective constructs, namely acquisition, assimilation, transformation and exploitation is acceptable. Given the internal coherence of the scales, the convergent validity and the discriminant validity are satisfactory.

The organizational absorptive capacity is a reflective first-order and reflexive second-order construct. The construct of potential absorptive capacity encompasses two dimensions, acquisition and assimilation. As for the realized absorptive capacity, this one includes two dimensions: transformation and exploitation. The authors have found that the construct of the potential and realized absorptive capacity has the following loadings: acquisition (0.34), assimilation (0.983), transformation (0.306), and exploitation (0.964). The authors have retained the two dimensions of acquisition and transformation, relying on Murovec and Prodan (2009). Despite the weakness of these two dimensions, the authors find that the composite reliability (CR) of the construct "the potential absorptive capacity" is 0.722, a value exceeding the theoretical threshold of 0.7 (Gefen, Straub and Boudreau, 2000). It is the same for the realized absorptive capacity where the composite reliability CR is 0.524. The convergent validity of the potential absorptive capacity has been considered sufficient. Indeed, the AVE is 0.505, just above the threshold of 0.500 (Fornell and Larcker, 1981). It is the same for the realized absorptive capacity where the AVE is 0.524.

Regarding the discriminant validity, the square validity of the AVEs of the latent constructs, namely the potential absorptive capacity and the realized absorptive capacity have values of 0.711 and 0.724 respectively. The value of Potential Absorptive Capacity (PACAP) is higher than its correlation with other non-diagonal variables. Similarly, the latent variable "realized absorptive capacity" proves that the square root of the AVE is higher than the value of the correlation with the other constructs (VAVE = 0.724) (see Appendix 1). Similarly, the results show that organizational absorptive capacity is a third-order reflective concept. Indeed, the realized absorptive capacity has a loading of 0.852 and the potential absorptive capacity has a loading of 0.819. In addition, the loadings have values above the threshold promoted by the literature, i.e. 0.5 (Chin, Henseler and Wang, 2010). The composite reliability (CR) of the construct organizational absorptive capacity is 0.630 so it is above the threshold of 0.6. Being 0.5011, the convergent validity of the organizational absorptive capacity is sufficient for the estimation of the AVE, since it is above 0.500 (Fornell and Larker, 1981). Concerning the discriminant validity, the results prove that the square roots of the AVEs of the latent construct "the organizational absorptive capacity" have a value of 0.600. This result indicates a value higher than the correlation of the organizational absorptive capacity (CAP) with the other variables that are off diagonal (see Appendix 1). Figure 2 explains the measurement model of third-order organizational absorptive capacity.

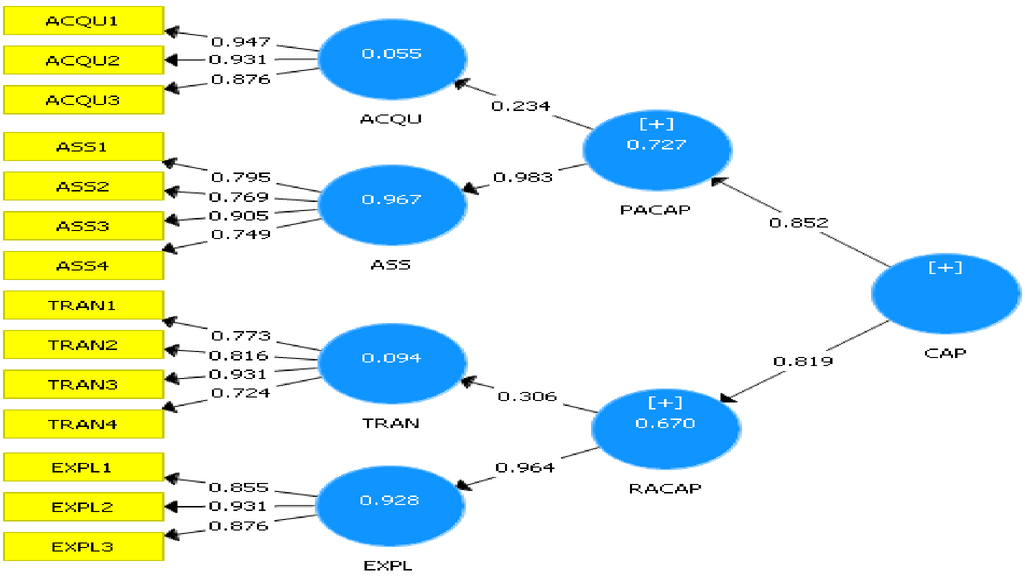

Figure 2: The measurement model of third-order organizational absorptive capacity

Concerning the concept of the use of the SFA, it is a second-order formative concept (Serdagolu, 2009). Table 3 presents the results of the first-order formative constructs, namely the use of the SFA as a customer relationship management tool and as a tool for internal coordination among stakeholders.

Table 3: Results of confirmatory analysis of first-order formative constructs: the use of SFA as a customer relationship management tool and as a tool for internal coordination among stakeholders.

latent variables	indicators	VIF	weight	t-test
Customer Relationship Management Tool (CRMT)	CRMT1	1.563	0.211	4.530
	CRMT2	1.569	0.251	4.190
	CRMT3	1.838	0.981	17.843
	CRMT4	1.516	0.300	3.427
Internal Coordination Tool among Stakeholders (ICTS)	ICTS1	1.719	0.867	10.918
	ICTS2	2.867	0.716	4.992
	ICTS4	1.682	0.499	3.700
	ICTS5	3.098	0.221	4.094

It should be noted that there is no problem of multicollinearity since the VIF values are higher than 1 and lower than 10. In addition, the results show that all weights have higher order values than 0.2 and therefore the contribution of each formative indicator in the latent variance is satisfactory. To estimate the formative construct, it is necessary to ensure the external validity of the index (Lacroux, 2011). The value of the relationship between ICTS and CRMT did not exceed 0.5, it is not very strong and it could not reach 0.6 as indicated by Roussel, Durrieu and Campoy (2002) and therefore it will be sufficient to adopt a first-order structure and the use of SFA construct as an internal coordination tool among stakeholders and as a customer relationship management tool. The study of the structural model and the hypotheses of the research were carried out by evaluating the values of the coefficient of determination R^2 (explained variance), the structural coefficients and the statistics t. Indeed, R2 and structural coefficients indicate the strengths and meanings of relations, while t-statistics and errors indicate the power of the influence of the variable. Following an estimation by the Boostrap procedure (Gefen, Straub, and Boudreau, 2000), the R2 values are higher than the minimum value recommended in the literature (0.19) (Chin, Henseler and Wang, 2010). In this sense, the R2 of the global model is 0.511, that is, the structural model has a satisfactory explanatory power of 51.1%

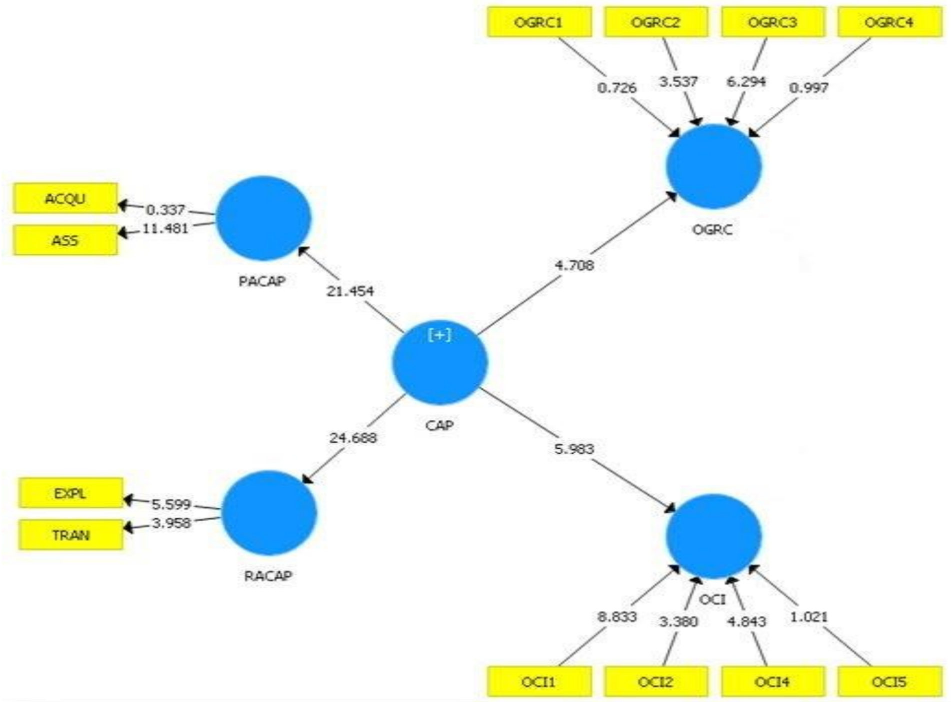

Figure 3: Structural model

Added to that, Stone-Geisser's Q2 fit index is analyzed (Geisser 1974, Stone 1974) to ensure the overall validity of the structural model. This indicator is used to assess the overall relevance of the model. The values of Q2 must be higher than or equal to zero. The Q2 indicator assesses the overall relevance of the model. Table 4 presents the values of the explained variance of model of dependent variables as well as the Stone-Geisser Q2 calculation.

Table 4: The results for the explained variance R^2 and Q^2 of Stone-Geisser

Dimensions	R^2	sted R^2	Q^2(=1-SSE/SSO)
Customer Relationship Management Tool (CRMT)	0,417	0,416	0,130
Internal Coordination Tool among Stakeholders (ICTS)	0,352	0,351	0,048
Organizational Absorptive Capacity	0,423	0,422	-
Potential Absorptive Capacity (PACAP)	0,631	0,630	0,306
Realized Absorptive Capacity (RACAP)	0,713	0,712	0,338

On the one hand, the results of the direct relationships between, the organizational absorptive capacity, the use of the SFA as a customer relationship management tool (H5.1) and on the other hand, the organizational absorptive capacity and the use of the SFA as an internal coordination tool among stakeholders (H5.2) are shown in table 5.

Table 5: The significance of the structural coefficients

Hypotheses	Path coefficient	t-statistic	P-value	Signs
CAP _ICTS	0.564	5.983	0.000	+
CAP_CRMT	0.513	4.708	0.000	+

These results prove that all the structural coefficients are significant and positively valid for the tested hypotheses, and this is applicable for all the structural relations. Hypotheses H5, H5.1 and H5.2 are accepted.

5. Discussion

The first tested hypothesis states the positive influence of training on the organizational absorptive capacity. This result converges with the work of Prodan and Ostermann (2009), Murovec and Prodan (2009) and Ahmed et al. (2019), who support the idea that the strategic practices of human resources, the training of which, positively affects the ability of the company to acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capacity. This means that a well-trained workforce facilitates the identification and the interpretation of external knowledge, the combination of existing knowledge with external knowledge and the implementation of acquired, transformed and assimilated knowledge for a best SFA use.

The test of the second hypothesis, which defends the positive effect of the training on the use of the SFA, as an internal coordination tool among stakeholders and as a customer relationship management tool has been validated. This is proved by the improvement of salespeople's skills following their participation in the training sessions offered to them. This result joins the work of Ling and Nasurdin (2010), Cron et al. (2005) and Kodwani and Prashar (2019) who highlight the existence of a significant relationship between training and the use of SFA. Thus training has become an influential factor of SFA use, it motivates staff to learn and transfer their learning for the sake of using SFA system.

The third hypothesis postulating a positive impact of professional experience on organizational absorptive capacity was, unsurprisingly, confirmed. Indeed, the most experienced players are able to detect knowledge and exploit it for commercial purposes faster than others. This result is consistent with the work of Lane, koka and Pathak, (2006), who prove that experience has a positive effect on the organizational absorptive capacity. Thus the staff with a high degree of professional experience feel a sense of being committed to recognizing and obtaining knowledge from external sources, to interpret, incorporate and personalize it in the procedures and structures of the company.

The test of the fourth hypothesis proves that professional experience, negatively rather than positively, affects the use of the SFA as a customer relationship management tool and as a tool for internal coordination among stakeholders. The rejection of hypothesis H4.1 can be explained by the fact that, there is prior research (e.g. Abdolvand and Farzaneh, 2013; Johnson, Barksdale Jr. and Boles, 2001) which reveals that professional experience of salespeople does not positively impact the use of CRM (and thus SFA) applications. The reason for this is that experienced salespeople consider their contact list a personal asset and are resistant to turn it over to the organization. Normally, one of the drivers for an organization to implement an SFA system is to convert the Human Capital of the salespeople into Structural Capital of the organization, which leads to a loss of power of the experienced salesperson (Griffiths, 2011, p.186). Similarly, the rejection of hypothesis H4.2 can be explained by the fact, there is prior research (e.g. Poujol, 2009) that seems to support that there is always a tendency to consume more than to contribute to a knowledge repository as is the case of an SFA system for lead management and internal coordination. Young inexperienced professionals see more value in these knowledge repositories while the experienced professionals feel that they 'do not need it' because they know their business and thus find an asymmetry: they contribute to the repository more than they get out of it. In order to get them to use the system and contribute to it, there needs to be some sort of external incentive (Griffiths, 2011, p.213).

Finally, the last hypothesis, which emphasizes that organizational absorptive capacity has a positive influence on the use of the SFA as a customer relationship management tool and as a tool for internal coordination among stakeholders, has also revealed the significance of the relationship. Indeed, this result goes hand in hand with the work of Cohen and Levinthal (1990) and Noblet and Simon (2010) who prove that a high level of absorptive capacity favors, at best, the exploitation of ICT tools by companies. In this sense, these authors argue that companies that have an ability to detect external knowledge to mobilize information technology better. This mobilization of technologies facilitates the communication between the players of the enterprise and contributes to the development of a durable relation with the customers. The result of this last hypothesis is consistent with the work of Zahra and George (2002) and Wu et al. (2019) who prove that the company that develops a great capacity for assimilation, acquisition, transformation and exploitation of knowledge will have greater capacity to use technologies. This result leads to the following conclusion: firms that have a high potential absorptive capacity, i.e. the ability of the enterprise to detect and absorb external knowledge using the processes deployed by the enterprise, and a significant realized absorptive capacity, that is, the ability to combine existing knowledge and new knowledge for transformation and exploitation; all these factors have a better ability to mobilize and use technological tools of SFA type.

6. Conclusion

This research shows that training and professional experience have a positive influence on the organizational absorptive capacity and the use of the SFA and that the organizational absorptive capacity in turn positively influences the use of the SFA.

On the theoretical level, this research simultaneously links the deterministic approach and the relational approach based on knowledge management, to study in depth the determinants of the use of the SFA more precisely the training, the professional experience and the organizational absorptive capacity. The contribution of this research to the existing literature, in particular on SFA use, can be justified in two ways. First, the study empirically examines how training and professional experience influence potential and realized absorptive capacities, respectively. It provides new insight into the combined effect of absorptive capacity, training and professional experience on SFA use. Second, this research helps to develop an understanding of how salespersons acquire, assimilate, transform and exploit external knowledge for a better SFA use in a pharmaceutical context and in a country (like Tunisia, North Africa) where these potential and realized absorptive capacities are little dealt with in the previous literature.

From a managerial point of view, this research could be relevant for pharmaceutical laboratory managers, who are constantly seeking to improve the use CRM tools of SFA type through a better understanding of the determinants that may affect this use. In this sense, a pharmaceutical laboratory must have the ability to detect external knowledge and apply it for better use of SFA tools. In addition, a better understanding of how training and professional experience interact on organizational absorptive capacity and use of the SFA can help pharmaceutical companies determine what steps need to be taken to improve the use of the SFA.

This research immensely helps owners and managers of companies in the pharmaceutical industry to carry out ongoing training for new and inexperienced and experienced salespeople to improve their abilities to acquire, assimilate, transform and exploit external knowledge and consequently the use of SFA. Continuous training and professional experience are no longer considered an option but rather a requirement; therefore pharmaceutical companies must plan and / or manage strategies for the implementation of regular training for their staff in order to appropriate absorptive capacity and SFA use.

Nevertheless, the current research presents certain limits, which opens horizons, to complete it. First of all, the current research was unable to deeply and comprehensively address the interaction between CRM systems of SFA type and the three types of customer knowledge "knowledge about customer"," knowledge from customer "and "knowledge for customer". In addition, the choice of the field of the pharmaceutical industry may be simplistic in regards with the lessons and conclusions drawn in terms of inferential statistics. Other elements could be taken into account by the researchers in their subsequent research, so it would be relevant to study the consequences of the use of the SFA on the salespeople's performance and on the quality of service provided to the end customers in the industrial environment. It would also be wise to carry out comparative studies between companies in various sectors in the use of SFA tools.

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Appendix 1: "SMART PLS Version 3" outputs

Table 1: Correlation matrix of first-order reflexive variables

	ACQUI	ASS	EXPL	TRANS
ACQUI	**0.918**			
ASS	0.055	**0.807**		
EXPL	-0.105	0.375	**0.888**	
TRANS	0.056	0.198	0.041	**0.815**

Table 2: Correlation of second-order constructs (potential organizational absorptive capacity and realized absorptive capacity) with the use of SFA

	PACAP	RACAP	ICTS	CRMT
PACAP	0.711		0.400	0.492
RACAP	0,408	0,724	0.528	0.353
ICTS	0,831	0,844	0.600	
CRMT			0.476	

Table 3: Correlation of third-order construct with the use of the SFA as a CRM tool and internal coordination tool among members

	CAP	ICTS	CRMT
CAP	0.600	-	-
ICTS	0.564	-	-
CRMT	0.513	0.467	-

Table 4: Correlation matrix of the use of the SFA as a CRM tool and as a tool for internal coordination among stakeholders

	CAP	ICTS	CRMT	PACAP	RACAP
CAP	1,000				
ICTS	0,564	1,000			
CRMT	0,513	**0,467**	1,000		
PACAP	0,831	0,400	0,492	1,000	
RACAP	0,844	0,528	0,353	0,408	1,000

Antecedents of Knowledge Sharing Behaviour in the Public Sector

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Abstract : This qualitative study investigated antecedents of knowledge sharing in the public sector. Basing on the theory of planned behaviour and literature review, three antecedents guided the conceptualization of the study namely; employee attitudes, subjective or social norms and perceived behaviour control. Data from the 19 in-depth interviews were thematically analyzed. Findings revealed that employee attitudes towards knowledge sharing in the public sector were both positive and negative. While the theory of planned behaviour focuses on the attitudes of knowledge givers, it emerged that the knowledge seekers' attitudes mattered as well. Subjective norms were prevalent in meetings, teams, job rotation as well as in the Communities of Practice (CoP). The finding that Communities of Practice were disconnected in terms of knowledge sharing emerged surprising because we had not envisaged it since previous studies have not investigated it. Perceived behaviour control was modified by scanty organizational resources as well as incentives and policies. The study proposes knowledge sharing model for both practitioners and researchers.

Keywords: Knowledge sharing, attitudes, subjective norms, perceived behaviour control, Community of Practice

1. Introduction

Knowledge sharing is conceptualised as the process of accessing knowledge for application in solving work related problems (Christensen, 2007). Knowledge sharing relates to the provision of task related skills, experiences, abilities and expertise to help workers solve problems, develop new ideas, or implement policies or procedures (Wang and Noe, 2010; OECD, 2015).

Although the public sector is endowed with the knowledge resource (Cong and Pandya, 2003; Turyahikayo, 2018; Davenport and Prusak, 1998), evidence shows that such knowledge is not adequately shared to enhance decision making, solving of task related problems and improved service delivery (Caruso, 2017; Wamitu, 2016; Furlich, 2016). While we acknowledge the fact that knowledge should be shared so as to be meaningful (Oghavvemi, Sharabati, Paramanathan and Rahin, 2017; Kalani and Kamrani, 2017) it is noted that previous studies have not investigated fully the antecedents of knowledge sharing behaviour in the public sector. There are limited studies regarding the antecedents of knowledge sharing behaviour within the sector. A few quantitative studies have focused on knowledge sharing practices in the public sector organisations (Amayah 2013; Parka, et al, 2014; Sensuse, Cahyaningsih and Wibowo, 2015; Aerts and Haezendonck, 2017). There are a few, if any, qualitative studies focusing on the antecedents of knowledge sharing behaviour in the public sector. Consequently, the absence of qualitative studies has, to some extent, hindered the emergence of new knowledge regarding the factors that drive knowledge sharing behaviour in the sector. Yet, without understanding the antecedents of knowledge sharing behaviour in the public sector, we cannot satisfactorily propose appropriate knowledge sharing strategies for the sector. The current qualitative study addresses this gap by examining antecedents of knowledge sharing behaviour in the public sector using the theory of planned behaviour. The research question addressed in this study is; What are the antecedents of knowledge sharing behaviour in the public sector? The purpose of this qualitative study is to attempt to seek answers to the research question.

2. Theoretical framework and Literature Review

Previous studies have indicated that knowledge sharing largely depends on individual behaviour (Kuo and Young, 2008) driven by attitudes towards behaviour, subjective norms, perceived behavioral control (Punniyamoorthy and Asumptha, 2019) and intentions (Wang and Noe, 2010). These antecedents of knowledge sharing behaviour are conceptualized in Ajzen's (1985) theory of planned behaviour.

The Theory of Planned Behaviour (TPB) was propounded by Ajzen, (1985) who assumed that the intention to behave in a certain manner results from; a) an individuals' attitude towards the behaviour, b) their subjective norms, c) and perceived behavioural control over the outcome. Attitudes defined as the disposition to respond favourably or unfavourably to the self, others, and environment in relation to their intentions (Hwang, 2012;

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Yean, Johari and Sukery, 2015) can be strong or weak depending on the degree of importance attached to it (Howe and Krosnick, 2017). Such a degree of importance is influenced by personal values, interests and beliefs (Safa and Solms, 2016). Subjective norms are postulated as the outcome of cognitive structures such as perceived consequences of the behaviour and normative structures, like perceived approval by others (Hwang, 2012). Perceived Behaviour Control (PBC) is the individuals' belief about their ability to exhibit certain behaviours (Kuo and Young, 2008; Yean, Johari and Sukery, 2015). While the TPB focuses on nature rather than nurture driven factors, its wide usage in related studies make it suitable for this study.

2.1 Literature Review

In this section, we thematically discuss previous studies relating to antecedents of knowledge sharing behaviour in the public sector. The discussion is hinged on the theory of planned behaviour examined in the previous section.

2.1.1 Attitudes Towards Knowledge Sharing Behaviour in the Public Sector

Previous researchers have defined 'attitude' as a disposition to respond favorably or unfavorably to the self, others, and environment in relation to their intentions (Hwang, 2012; Yean, Johari and Sukery, 2015). Such a disposition towards behaviour can be strong or weak depending on the degree of importance attached to it (Howe and Krosnick, 2017). Such a degree of importance is influenced by personal values, interests and beliefs (Safa and Solms, 2016). An individual's attitude towards knowledge sharing will influence the behaviour to share. If one derives happiness in sharing his expertise, skills and know-how, he/she will share and it would appear, the reverse is true (Punniyamoorthy and Asumptha, 2019). Public sector employees who value their contribution to the organization or who feel that their contribution is valued by others are likely to develop strong attitudes to share their knowledge (Safa and Solms, 2016).

Scholars have further revealed more factors that shape employees' attitude towards knowledge sharing behaviour in the public sector. According to Wang and Noe (2010), if public sector employees have high capacity to absorb the knowledge that has been shared, people feel motivated to share more knowledge with them. Yet in some situations, public sector employees may have negative attitudes to share knowledge if they are worried of being misunderstood, or if they feel that their knowledge will not be used adequately (Zhang and Fai Ng, 2012). Literature does not examine the circumstances under what the shared knowledge is likely to be taken out of context. It is also not clear when misunderstandings relating to the knowledge shared are likely to arise. Some scholars have indicated that even when there is enough absorptive capacity, seekers and givers of knowledge may have arrogant behaviours which hinder inter-personal collaborations for knowledge sharing (Hew and Hara, 2007). Hence, managers should facilitate employees to share knowledge (Yang, 2008).

2.1.2 Subjective Norms and Knowledge Sharing Behaviour in the Public Sector

The TPB conceptualizes subjective norms as perceptions of social pressures relating to performing behaviour (Ajzen, 1991). Subjective norms relate to an employee's perception of colleagues' views about the suggested behaviour (Yean, Johari and Sukery, 2015). These norms are reflected in the expectations of managers regarding an individual's sharing behaviour, proceeded by intentions (Hwang, 2012). If a public sector employee believes that fellow workers approve or disapprove sharing certain type of knowledge, he/she is likely to decide whether to share or not. Yet, the extent to which social norms prevail in the public sector and how this prevalence relates to knowledge sharing behaviour is not clearly articulated in the previous studies. Although Yean, Johari and Sukery (2015) contend that such norms put pressure on an individual to perform a particular behaviour, the same norms may force an employee to consider abandoning the planned behaviour (Safa and Solms, 2016). In the public sector, it is assumed that social norms are entrenched in the hierarchical ladders of seniority. Yet, we cannot tell from the literature which source of social norms impose pressure on employees to share or not to share knowledge. Do social norms from below pressurise top managers to share knowledge? Is the reverse true?

Previous research has further indicated that public sector employees have a role to manage subjective norms. Much as the norms held in groups impose pressure on an individual's sharing behaviour, personal preferences play a role in deciding whether to share or not. The choice still lies in hands of the knowledge giver (Nguyen, Nham and Hoang, 2019). Public sector employees are likely to share knowledge with colleagues who will reciprocate (Wang and Noe, 2010), a situation of 'I scratch your back, and you scratch mine too'. This is the case regardless of the prevailing subjective norms. Moreover, as employees interact more often so do the chains of subjective norms tend to weaken (Amayah, 2013). In this case, reciprocity is seen as the only way employees who share knowledge will cause others to share. Yet, reciprocity may not be sufficient without the backup of a knowledge sharing culture.

2.1.3 Perceived Behaviour Control and Knowledge Sharing in the Public Sector

Perceived Behaviour Control (PBC) has been conceptualized as the individuals' belief about their ability to exhibit certain behaviours (Kuo and Young, 2008; Yean, Johari and Sukery, 2015). If public sector employees believe that they have sufficient ability and resources, they will likely share their knowledge. If they feel resources for knowledge sharing are unavailable, the sharing behaviour will diminish (Chen, Chen and Kinshuk, 2009; Punniyamoorthy and Asumptha, 2019). Under the PBC, public sector employees make judgements regarding their ability to predict the planned behaviour. If workers believe their PBC over knowledge sharing is high compared to risks involved, the intention to share increases (Hajli and Lin, 2016).

Previous studies have indicated that a number of factors transcend resources in the control of behaviour for knowledge sharing. Scholars such as Wang and Noe (2010) have indicated that supervisor's control over employee behaviour was a significant predictor of an employee effort towards knowledge sharing. Yet, there is another body of literature painting a different picture. Scholars such as Liu and DeFrank (2013) demonstrated that self-interest, power and status affected knowledge sharing intentions even when the resources and incentives were in place. In other words, PBC on its own could not determine knowledge sharing intentions. From the foregoing, we can infer that previous studies have not adequately examined antecedents of knowledge sharing behaviour in the public sector. The current study attempts to address the existing knowledge gap.

3. Research Methodology and Design

In this exploratory study, three public sector institutions were requested in writing to participate in the study which request was granted. The three institutions were; Ministry of Public Service, Ministry of Education and Sports and Ministry of Justice and Constitutional Affairs in Uganda. The selected ministries were knowledge intensive with interconnected functions. The Ministry of Public Service had an overall mandate to guide performance management practices in the other two ministries. Yet, the laws enacted by parliament with guidance of the Ministry of Justice impacted on the ministries of Public Service and Education. While the three ministries were not the only knowledge intensive ones, with interconnected functions, their selection made the study feasible within the resource constraints. The individual worker was treated as the unit of analysis since subjective and personal insights were key for this study rather than group perspectives. Purposive sampling was used to identify and select 19 key informants (Creswell, 2014) in line with a similar design by Petty, Jarvis and Thomas (2018). The informants had rich information regarding the antecedents of knowledge sharing in the public sector. The key informants who were senior managers at the level of Heads of department were requested to give informed consent prior to the study. Semi-structured interviews were conducted in the informants' offices in order to elicit their perceptions in a natural setting (Hew and Hara, 2007; Yin, 2011). Perceptions were captured using field notes technique because it is more superior to any other technique (Halcomb and Davidson, 2006) in generating qualitative data (Castleberry and Nolen, 2018). The interview process ended after saturation in which case no new additional useful data emerged to constitute a conceptual category (Francis, et al, 2010). In order to enhance conformability and credibility three more interviews in addition to the 19 were conducted. In addition, three key informants were interviewed twice so as to guarantee response consistencies as advised by Aldiabat and Navenec (2018).

We applied thematic analysis technique in order to reduce data into workable themes and the emerging conclusions (Halcomb and Davidson, 2006). We took the advice from Halcomb and Davidson (2006) to the effect that researchers should code their own data since they are much more involved in the interview process. Mindful of the fact that text as data is often difficult to break into categories and themes (Castleberry and Nolen, 2018), we kept coding and re-coding as we identified codes, categories and themes in moving back and forth fashion (Erlingsson and Brysiewicz, 2017). We discarded codes reported by one informant purposely to avoid occasional incidence (Zhang and Fai Ng, 2012). We identified a number of inductive themes emerging a posteriori. Such themes included, employee attitudes; subjective norms and perceived behaviour control. The themes related closely to the constructs discussed in the theoretical framework and in the literature review. We interpreted and discussed the findings basing on the emerging themes as guided by Clarke (2009). An attempt was made to dig deep into the lived experiences of interviewees to understand the real meaning attached to the antecedents of knowledge sharing behaviour in the public sector.

4. Findings relating to Antecedents of Knowledge Sharing in the Public Sector

The discussion below highlights key findings from the study relating to the antecedents of knowledge sharing behaviour in the public sector. The discussion is organised around three themes that emerged during the coding process. To recapitulate, the themes are; employee attitude to share knowledge, subjective norms and perceived behavioural control.

4.1 Attitude towards Knowledge Sharing Behaviour in the Public Sector

Informants were asked to indicate their attitude towards knowledge with colleagues; and whether colleagues shared knowledge with them. The study revealed a number of positive attitudes towards knowledge sharing behaviour. More than half the number of interviewees indicated that they willingly shared knowledge. *"I share my knowledge with colleagues during formal and informal meetings".* When asked when they shared their knowledge, they further stated; *"I share knowledge during departmental planning, and when undertaking task accomplishments".* Knowledge sharing behaviour was triggered by knowledge seekers. Some informants reported that quite often they sought knowledge from their peers and supervisors before, during and after task performance. There were also instances when workers had to seek clarifications on why certain activities had to be performed. While most informants reported good reception from colleagues they contacted for knowledge, there were some employees who harboured negative attitudes towards knowledge sharing. In support of this, four of the nineteen interviewees reported knowledge hoarding behaviour. *"Some employees are not willing to share their knowledge. They think that hoarding knowledge makes them powerful and gives them a comparative advantage over their colleagues".* This could testify to the prevalence of negative attitude towards knowledge sharing behaviour. Two informants revealed some occasional rudeness and hostility from colleagues during seeking knowledge.

It was also revealed that attitude to knowledge sharing was hindered by misperceptions. The misperception that knowledge sharing was a one man's activity rather than being perceived as everybody's responsibility seemed apparent. Some interviewees remarked, *"we don't have a Public Relations Officer (PRO) to disseminate knowledge'. There is need for Monitoring and Evaluation Officer (M&E) to help in knowledge sharing".* With this misperception, some employees did not believe it was their responsibility to share knowledge. One would therefore infer that the positive attitude to share knowledge is shaped by the right perception of both the giver and receiver of knowledge.

4.2 Subjective Norms and Knowledge Sharing in the Public Sector

In this section, we examine findings relating to how subjective norms shaped knowledge sharing behaviour in the public sector. The findings are organised around norms that shaped knowledge sharing.

The public sector ministries studied nurtured norms which were not aimed at knowledge sharing, though they made the sharing inevitable. One of such norms was frequent formal meetings. All interviewees indicated that weekly and monthly meetings imposed on them an obligation to attend and exchange ideas. *"we meet weekly to review the previous week's performance. My colleagues meet monthly for strategic planning and consideration of field reports".* While frequent meetings were not deliberately intended to facilitate knowledge sharing, they formed part of the public sector norms in which knowledge sharing behaviour was reflected. Informants revealed that there was active participation in the meetings. Half of the interviewees revealed that they shared their views freely in these meetings. Yet, they could not ascertain why they shared and whether their shared knowledge was put to the right purpose.

The other well pronounced subjective norm related to job rotation in which some workers in the studied ministries were often transferred to departments within the same ministry, or to other ministries. An informant indicated, *"I joined the public sector as a junior officer in the ministry of public sector. I have been transferred recently to the ministry of Justice".* Rotated workers encountered new experiences; knowledge networks useful for knowledge sharing. While job rotation stimulated knowledge sharing behaviour it was undertaken for other reasons. Managers in the departments responsible for job rotations indicated that rotations targeted some employees who had been promoted to fill vacancies in other departments. Informants revealed other reasons such as transfer of a problematic employee to a remote department or ministry, or transfer of a worker to a ministry perceived as 'lucrative'. Moreover, job rotation targeted employees below Heads of units that performed similar jobs. In this regard, some interviewees remarked, *"I have worked in this department for ten years now. If am transferred to another department it may take me a year to learn".* Two other interviewees indicated that they had worked at the department for over 20 years and had never been rotated. So, the likelihood that employee rotation imposed social pressures to share knowledge is debatable.

4.3 Perceived Behaviour Control and Knowledge Sharing in the Public Sector

Employees in the public sector studied had control over their knowledge. Even when they were sponsored for training, they still had power to decide whether or not to share their knowledge. For example, two informants indicated that, *"we encourage people to make presentations after the training but most of them don't want to share. We have arranged meetings for people to share their knowledge but they don't turn up".* This perceived behaviour stems from the fact that training guidelines as enshrined in the standing orders did not spell out clear and enforceable procedures relating to knowledge sharing.

To some extent, however, formalization of systems and procedures weakened individual perceived behaviour control. Employees who participated in those tasks were required to share knowledge with team members. It was reported that employees who participated in special projects, assignments and field activities submitted reports to their supervisors in the department. The senior management teams discussed policy issues before forwarding such matters to the top. Such highly formalised environment imposed an obligation on the participating employees to share knowledge and so their behaviour control was to some extent limited.

Much as employees had the ability for behaviour control over knowledge sharing, the resources and incentives for sharing were inadequate. A number of interviewees indicated that the working environment did not motivate them to share knowledge. One informant revealed, "*there is no designated place for break tea or lunch. We sit in our offices from morning to evening with only one-hour lunch break. We need staff rooms for health break and informal discussions".* Moreover, the ICT infrastructure was not adequate as reported by a number of informants. An informant remarked, *"We have always requested for an intranet as a ministry to share information. We need an organizational portal for knowledge sharing".* Without this environment, it meant that employees had to physically meet for knowledge sharing instead of using online platforms.

The findings have revealed a number of insights relating to employee attitude towards knowledge sharing, subjective norms that impact on knowledge sharing behaviour, and the perceived behavioural control. The next section is about the discussion of the findings. We attempt to shed light on the practical implications of the findings.

5. Discussion and Practical Implications

While workers' attitude to share knowledge in the public sector existed, we notice that the highly formalised environment shaped such attitudes. Knowledge sharing occurred during formal meetings, planning sessions and task related discussions. Yet, even in such a formalised environment, some workers harboured negative attitude to knowledge sharing. Some public sector workers justified knowledge hoarding as a tool to gain and maintain competitive advantage. Previous studies have indicated that employees often feel they are giving away power if they share knowledge (Caruso, 2017) especially in the absence of knowledge sharing incentives (Wang and Noe, 2010). Previous studies especially by Heo and Toomey (2016) also revealed that persuading employees to share their knowledge was challenging because their inherent interests differed. In the same vein, Shanab and Shehabat (2018) studied the perceived behaviour control of public sector employees towards knowledge sharing behaviour and concluded that in the absence of relevant policies and incentives, employees resisted knowledge sharing based on their interest. While we do not subscribe to this practice of knowledge hoarding, bearing in mind that knowledge gains value when it is shared and applied, we are concerned about this negative attitude towards knowledge sharing. However, we are mindful of the fact that asking employees to simply share their knowledge without giving them some incentives is counter-productive. Even when such knowledge has been acquired using organizational resources, it is important that employees are given monetary and non-monetary incentives to share knowledge.

The findings in respect of attitude to knowledge sharing reveal instances when knowledge sharing behaviour was triggered by knowledge seekers. Quite often employees contacted their peers and supervisors on how they were required to undertake certain activities. The theory of planned behaviour has unfortunately focused on attitude of knowledge givers and disregarded the attitude of knowledge seekers. Previous studies have also ignored knowledge seekers' attitudes (Yang, 2008, Safa and Solms, 2016; Howe and Krosnick, 2017). To the best of our knowledge, available studies on the subject focused on knowledge seeking in information systems research projects (Sutanto and Jiang, 2013), which is outside the scope of the current study.

The Findings have indicated that employees' behaviour to share knowledge was shaped by the perceived approval by colleagues. Such approval was received during weekly and monthly meetings. There were also some practices such as job rotation which impacted on subjective norms. Job rotation was conducted for reasons beyond knowledge sharing enhancement. Thus, employee rotation was reported as being of little significance in imposing social pressures on the public sector workers to share knowledge. This finding is consistent with previous studies which reflect authors' mixed feelings about job rotation. While such rotation is common among the less performing employees, it can lead to rotated employees gaining more knowledge at their new organisation than actually sharing what they have (Kampkötter, Harbring and Sliwka, 2018). Moreover, when employees are assigned new tasks, their previous knowledge may not be relevant to the current job needs which affects sharing behaviour (Hakenes and Katolnik, 2017). Although the findings of the current and previous studies tend to agree that job rotation does not drive knowledge sharing behaviour, we believe that the rotated employee moves to the new work environment with both tacit and explicit knowledge. On the basis of our findings and previous research, we strongly believe that job rotation may not be a useful component of social norms to drive knowledge sharing intentions. Moreover, some highly specialized jobs such as Legal practice, auditing, Information and Communication Technology (ICT), records and archives management were not rotated.

Although formal meetings were regular and participatory, such meetings imposed an obligation on employees to attend and exchange ideas as part of the organizational norms. Much as these norms were not deliberately nurtured to enhance knowledge sharing, we believe they facilitated knowledge transfer during meetings. Moreover, knowledge sharing activities in government institutions include workshops and meetings (Sensuse, Cahyaningsih and Wibowo, 2015), and brainstorming sessions, using policy documents and reports (Aerts and Haezendonck, 2017; Shanab and Shehabat, 2018). However, we did not find evidence of visible informal meetings which have been found to enhance socialization and fusion of tacit knowledge. Formal meetings should be maintained in governments to facilitate group discussions, brainstorming and exchange of tacit and explicit knowledge. Informal gatherings should be promoted to enhance sharing of tacit knowledge.

Findings revealed that formal work teams imposed social pressures to share knowledge. All interviewees revealed that they often worked in teams. Unfortunately, senior members in such teams dominated discussions. This finding is consistent with previous research by Rushmer, Hunter and Steven (2014) who investigated knowledge sharing in teams and concluded that workshop discussions did not work when dominated by particular individuals and groups. However, earlier researchers (Zhang and Fai Ng, 2012) studied knowledge sharing behaviour among construction teams in Hong Kong and concluded that work teams caused pressure on team members to share knowledge. They, however, noted that such knowledge sharing behaviour depended on antecedents such as provision of rules of the game, error tolerance and provision of team incentives all of which apply in the current study.

The study reveals that some social pressures emanated from Communities of Practice (CoP). The common CoP were among lawyers, management specialists and professional teachers. Some minority CoP such as accountants, engineers, ICT specialists also existed. Previous research has indicated that knowledge sharing behaviour was enhanced in CoP amidst strong support systems from management (Jeon, Kim and Koh, 2011). Other scholars such as Schofield, et al (2018) revealed that some members of CoP sought to enhance their own knowledge as well as strengthen relationships among professional colleagues through the knowledge sharing behaviour. The knowledge sharing behaviour manifested itself during and after the meetings, by use of phone numbers and e-mail. These studies focused on knowledge sharing among CoP. The surprising finding however is that minority CoP in the current study felt that they did not benefit from the knowledge of dominant large CoP such as lawyers and teachers. Inter-CoP collaboration was missing across the three cases. We did not venture deep into this missing link as it was outside the scope of the study. But we believe that future scholars may pick interest in this aspect.

The study has demonstrated that employees' ability and control over knowledge sharing was affected by inadequate organisational resources and incentives. Organizational resources are usually provided through support from management. Previous studies by Wang and Noe (2010) indicated that management support enhanced employee knowledge sharing, the absence of which affected the sharing behaviour. Other studies have identified factors such as steep structure and leadership that pose threats to knowledge sharing, compensation and culture (Amayah, 2013; Henttonen, Kianto and Ritala, 2016). A common denominator in all these studies is the key role of management in removing negative perceived behavioural controls to enhance knowledge sharing in the public sector. Our findings in this case agree with previous research that perceived behavioural control can diminish if management creates a flexible environment for knowledge sharing behaviour.

In light of the findings and the preceding discussion, we propose a knowledge sharing model for the public sector. The model attempts to highlight key constructs and dimensions critical to knowledge sharing behaviour in the public sector.

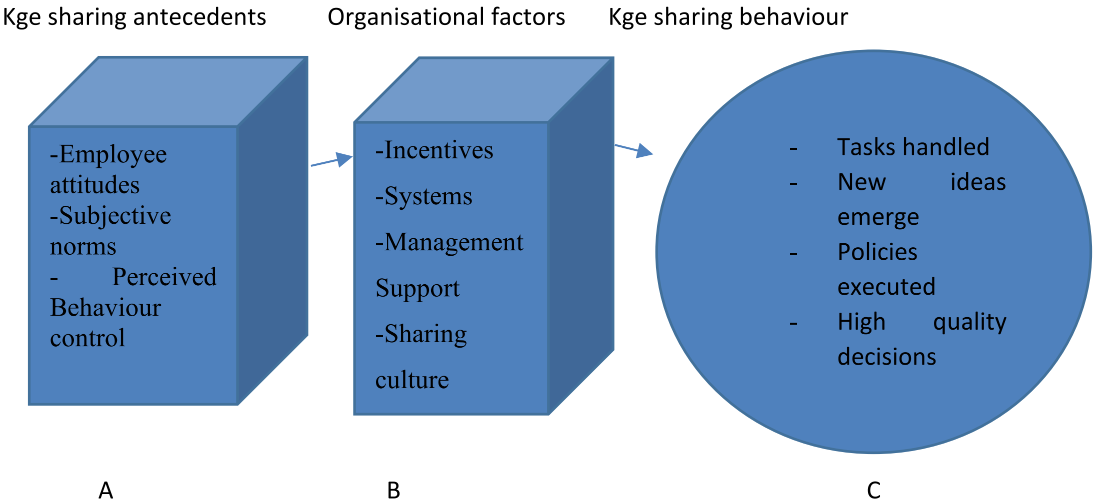

Figure 1: Knowledge Sharing Model

The discussion has been guided by the three antecedents of knowledge sharing behaviour reflected in box A. These are; employee attitudes to share; subjective norms and perceived approval by others to share knowledge; and lastly, perceived behavioural control. While these antecedents shape the knowledge sharing behaviour in the public sector, they are not self-sufficient. The need for incentives, appropriate systems, management support and sharing culture is critical as indicated in box B. Incentives refer to the combination of various inducements offered to the public sector workers as motivation for them to share knowledge. Such inducements can be monetary or non-monetary. Systems refer to structured practices that position workers to share knowledge with ease. Such systems include formal and informal meetings, teamwork, and staff baraza. Management support relates to any action taken by top management to facilitate knowledge sharing. Such actions include establishment of knowledge sharing policies and creation of knowledge sharing platforms such as social media. In order for knowledge sharing to be effective, antecedents of knowledge sharing and organisational factors should act in concert so as to facilitate solving of task related problems, generating new ideas, designing and executing good policies, as well as making high quality decisions.

6. Conclusion

This study was undertaken to examine the antecedents of knowledge sharing behaviour in the public sector. The study has revealed three key antecedents namely; employee attitude to share knowledge, subjective norms, and perceived behavioural control. The study further reveals two surprising findings namely; the recognition of the attitudes of knowledge seekers which have been ignored by previous researchers and collaborations among communities of practice. In the former, the study showed that the knowledge giver’s belief that employees seeking knowledge will put it to good use motivated knowledge sharing. Additionally, the knowledge giver’s attitude to share was also shaped by how they were approached and respected by the knowledge seekers. In the latter, minority CoP felt sidelined by the large and influential communities of practice thereby limiting knowledge sharing among inter- communities of practice. In light of the revealed antecedents and other key findings, we strongly believe that the research question was answered.

6.1 Recommendations and Areas for Future Research

The study revealed that most employees have negative attitude towards knowledge sharing behaviour. Moreover, it was alleged that some knowledge givers in the public sector were rude to colleagues who sought knowledge from them. While we recommend that employees are given monetary and non-monetary incentives to share knowledge, future researchers should investigate further the kind of incentives likely to enhance knowledge sharing attitudes in the public sector.

Much as the study focused on attitudes towards knowledge sharing behaviour of knowledge givers in the sector, it was discovered that the attitude of knowledge seekers played a role in knowledge sharing. Future studies should investigate how the knowledge seeker behaviour affects the givers attitude to share knowledge.

While we thought that job rotation was useful in enabling knowledge sharing in the public sector, findings and previous studies proved the contrary. It is recommended that the public sector conducts regular job rotations purposely to enhance knowledge sharing.

Highly formalised structures stifled knowledge sharing behaviour. The study recommends establishment of an environment to support informal interactions. Such environment would create employee hubs, online platforms such as social media and knowledge bases, as well as knowledge directories, expert locators and repositories. While Communities of Practice (CoP) in teams played a key role in knowledge sharing behaviour, the study did not venture deep into inter-CoP collaboration. Future scholars may pick interest in it this aspect to ascertain how collaborations between communities of practice in a single organizational setting affected knowledge sharing behaviour.

The importance of management support stood out as one of the organisational factors shaping knowledge sharing behaviour. The current study did not venture into the nature of support required as this was outside the scope of the study. We recommend that future researchers should investigate the nature of management support required to enhance knowledge sharing behaviour.

The proposed knowledge sharing model can be tested in studies from different contexts to ascertain its efficacy in settings beyond the public sector.

6.2 Limitations of the study

Limitations of this study are two-fold and relate to sample size and design. The public sector in Uganda is bigger than three ministries we studied. The 19 interviewees conducted might be perceived as small. However, we carefully and purposively selected informants on the basis of their wealth experience. Moreover, the purpose of this exploratory study was to help generate deeper insights relating to antecedents of knowledge sharing behaviour in the public sector within a natural setting (Yin, 2011). We relied on the qualitative design well knowing that the purpose of this study was not to generalize the findings (Creswell, 2014) but to reveal a contextualized detail of the phenomenon.

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Misled by Data? Review of Data Sources in National Intellectual Capital Research

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Abstract: This paper is a review of National Intellectual Capital (NIC) literature that focuses on the documented use of data and the data sources used in the NIC literature. The topic is important as the NIC research is largely based on data analysis and thus the use of data and the data sources used ultimately shape the reality around what is the big picture of national intellectual capital, as it is understood today. While this is the case, questions about use of data and the data sources used have not been in the core of the research tradition. The review focuses on 57 systematically collected NIC articles with a documented data source, published between the years 1991 and 2018. The results show that the majority of data-based NIC research is concentrated around a set of often-used data sources, while the rest of the data-based NIC literature uses a fragmented set of data sources. New data sources are rarely utilized. The documentation of data and data source use in the literature leaves room for criticism. Researchers and the users of NIC analyses benefit, if they are able to evaluate the quality, the coverage, and the relevance of the data sources used as a basis of NIC analyses. To the best of our knowledge, this is the first time that data sources used in the NIC literature are the main focus of a literature review.

Keywords: National Intellectual Capital, data use, data sources, literature review, data bias, data quality

1. Introduction

Over the past two decades, research on national intellectual capital (NIC) has received a lot of attention within the community around intellectual capital (IC) research. NIC research has highlighted the importance of information in the societal level of value creation that is, when nations target competitiveness, wealth, well-being, and performance gains on the aggregate level. Among other things NIC-research has created a conceptual platform and methodologies to improve and to benchmark the progress of nations. Importantly, NIC-research has widened the understanding of the dynamics behind aggregate performance (of nations) and lifted the status of researching the effects brought about by changes in the structures of the societies, such as the effects of globalization and of technological development.

As the review does not take a position or exclude articles based on the definition of NIC used in the studied articles, a strict definition of national intellectual capital is not necessary for this review. However, for the purposes of this review an in vein with Pedro, Leitão and Alves (2018b) NIC is understood as the variety of intangible assets that give long-term advantages to a nation and interact with organizations, regions, or globally and that are able to produce future and equal benefits measured at all levels. Importantly, NIC is understood as research that focuses on the national level.

Advanced national data-ecosystems and data-management (institutions) are key elements of modern data-driven societies and as such create the physical bedrock of NIC - they enable high-level value creation and ensure and enable fact-based decision-making for all sectors of the society at organizational, industrial, regional, national, and global levels. They also function as a mirror of successful value creation, when measures and indicators based on information gathered are used in this context.

The aim of this paper is to study and answer to the question "what data sources (data ecosystems) have been used as the basis for the academic literature on National Intellectual Capital during the period between 1991 and 2018?" and to discuss the use of data and the sources in connection with national intellectual capital research. In order to reach this aim, this work presents a review of the academic NIC-literature from the perspective of data sources by first identifying 111 articles published on NIC and selecting the 57 articles, where the data source used is documented and reviewing them in detail. While data is widely utilized as the basis of analysis in the majority of NIC articles and while the use of data has previously been the subject of some criticism (see, e.g. Alfaro, López and Nevado, 2011; Chew, Sharma and Bontis, 2014; Käpylä, Kujansivu and Lönnqvist, 2012; Lee, Lin and Lin, 2017), studies focusing on the use of data and data sources used in the NIC research are non-existent. While meritorious literature reviews on NIC exist (see, e.g. Dumay, Guthrie and Puntillo, 2015; Labra and Sánchez, 2013; Pedro, Leitão and Alves, 2018a and 2018b; Petty and Guthrie, 2000), these reviews do

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not specifically concentrate on the use of data or the data sources used in the literature. To the best of our knowledge, this is the first time that data sources used in the NIC literature are the main focus of a literature review.

The approach taken here highlights the importance of the use of data and the data sources used as a part of the national intellectual capital discussion. The question of the effective utilization of data and the indicators used in the research- and policy-making levels is discussed together with a discussion around the challenges with access to data. As such, this review is relevant to the stakeholders in national intellectual capital questions that deal with data- and indicator-related questions. For researchers this review identifies potential problems with the use of data sources and the effects of these potential problems on research outcomes. Researchers and the users of NIC analyses benefit, if they are able to evaluate the quality, the coverage, and the relevance of the data sources used as a basis of NIC analyses. For the data ecosystem actors, at national, private, and global levels, such as national statistical institutes this review highlights their role in ensuring the operational conditions of scholars and the NIC research community, not to mention public data-based decision-making. Furthermore, this article highlights the importance of the dialogue between data ecosystem actors and policymakers in securing the availability and quality of data for research and offers support for evidence-based decisions concerning data management questions for policy-makers.

We present a discussion about the possible and apparent problems with regards to data source and content documentation in the NIC literature and shortly discuss the risks and weaknesses associated with opaque data handling and other data related “less than perfect” modes of operation in research.

The rest of this article is structured as follows: first we shortly present the methodology used in the literature review and then we present the review-results. Then follows a literature-based discussion on the use of data-sources in the NIC literature and on observed problems connected to data-use. The paper is closed with a section that offers a short summary, presentation of conclusions, and some future directions for research.

2. Methodology

This literature review follows the state-of-the-art practice proposed by Webster and Watson (2002) and uses a paper selection process to gather relevant literature. Four article databases were utilized in collecting the articles written in English used: *Emerald Journals, EBSCO (all databases), Scopus Elsevier, and Science Direct*. Depending on the database filters “article”, “peer-reviewed”, “scholarly” were used, where available. Articles related to Intellectual Capital at macro, or national levels were included. The review covered years 1991 – 2018 (until the month of September).

Articles were searched based on their abstract with a number of variants of the key phrase “National Intellectual Capital” that included strings such as: “national intellectual capital”, “national” and “intellectual capital”, “nation” and “intellectual capital” and “country” and “intellectual capital”, also the abbreviation “IC” was used. In summary, the search was narrowed down by:

1. Including only select subject areas: Scopus (Business, Management and Accounting, Social Sciences, Economics, Econometrics and Finance, Decision Sciences); Ebscohost (IC, human capital, knowledge management, economic development and competition, globalization, international trade, intellectual property, industrialization, information economy and technology, management, strategic planning and assets), for other sources the original search words were used without further filtering.
2. Including only English language articles
3. Including scholarly articles (articles, peer-reviewed, scholarly; depending on the archive)
4. Searching keywords (combinations) only from the document abstracts

The result of the initial abstract-level search was 848 articles – all these articles were scanned and exclusions were made, based on the article title pointing directly to exclusion criteria with relation to the focus of the level of analysis (firm, organization, region, university, research institute) that is, non NIC research focus. The included set contains one article with multiple-level analysis, where, based on author judgment the focus was strongly on NIC. Also, some purely technology-oriented papers and articles that concentrate on ethical issues were excluded.

PROCESS	SOURCES / NUMBER OF ARTICLES			
Intellectual capital search	EMERALD Journals 1 033 articles	EBSCOhost 2 606 articles	SCOPUS, Elsevier 3 885 articles	ScienceDirect 2 654 articles
Criteria 1-4	189 articles	238 articles	137 articles	340 articles
Merging results	848 articles			
Exclusion of non-NIC articles	213 articles			
Exclusion by abstract and full paper scanning	111 articles			
Articles with documented data source	57 articles			

Figure 1: Selection process used with the quantity of remaining articles after each step

The remaining 213 articles were again manually scanned by reading the abstracts, which resulted in a final total of 111 articles on NIC of which 101 we had access to in full text. The 111 articles were published in 63 different journals, Journal of Intellectual Capital (JIC) being the single most important source with a 25 % share of the NIC articles. All the articles selected were cross-checked with the Finnish Publication Forum (www.julkaisufoorumi.fi/en) listing of high quality academic publications and 91 of the articles are rated at least level 1 (basic academic). The rest of the articles were either journals under the level 1 or conference articles.

Of the 111 articles in 57 the data-source used is documented. This set of 57 articles is the main focus of this review. Of these 57 data-based NIC articles 80% were rated at least level 1 in the Finnish Publication Forum classification. Figure 1 visualizes the selection process used.

For each article the following information was extracted:

1. Database where the article is stored (one of the four databases searched)
2. Year of publication (1991 – 2018)
3. Main focus / research question (shortly)
4. Article type ("general NIC", "country comparison", "country analysis" or "special NIC focus") done after a holistic overview of the articles and based on that the creation of the four classes
5. Data source(s) used in the article (the sources)
6. Number of citations the article had received by early 2019
7. Relation to public sector data (if and how public sector data is used)
8. Presence of public sector data providers (if and when data is used)
9. Geographical coverage (# of countries in the analysis)
10. Country of the university of the main writer of the article

A synthesis and an analysis of the information collected from the selected papers gives a holistic picture of the data-use and the data sources used in the NIC literature and reveals the what are the most often used data sources. The collected information (points 1-10 above) for the 57 studied articles is available as a table in Appendix 1.

3. Results

This section presents the results from the review. We look at the set of 111 identified NIC articles and observe that fifty-four of the total 111 NIC articles do not document the data source used, the data source is unknown, or no data is used, which leaves fifty-seven (57) articles that disclose the source of data used and of which, forty-seven specifically describe the data set used (in addition to mentioning the source). In other words, roughly half (51,4%) of the selected NIC articles fall under the focus of this review.

We start by taking a look at how the used data sources are indicated in the reviewed articles – we do this by article type for which purpose, we create a taxonomy of four different article types (or classes), according to the main focus of the article identified during review of all the articles. The four classes are: “General NIC”, “Country comparison”, “Country analysis”, and “Special NIC focus” (articles with focus in a specific topic, e.g., environment, culture, crises).

Forty (40) of the reviewed 57 articles are comparative or country specific analyses, seven special NIC focus, and ten general NIC articles. See Table 1 for detailed information.

Table 1: Information of the data sources used according to the main focus of the article

	# articles	A (General NIC)	B (Country comparison)	C (Country analysis)	D (Special NIC focus)
Data source info available	57	10	26	14	7
- information on data sets used	47	7	26	7	7

In many of the reviewed articles the way the used data sources are identified and described is imprecise, e.g., detailed information about the reference year(s) in the data is not often available. A data source can have a wide range of designations that changes from article to article and the databases used are typically unclearly and vaguely specified. What is typically identified is the “department” or “division” from which the data comes from, within a larger data-providing organization. Referencing and listing of data sources as references is typically non-transparent or incomplete.

The above-mentioned problems with documenting data sources used are prevalent for all types of data sources, while some commonly used sources can be specifically identified with a less precise referencing, most often missing and imprecise documentation of data sources does not allow a complete understanding of what the actual source used had been. In the studied 57 articles, where information about the data source used was available, in 35% information detailed enough to allow the identification of the specific data source (within, e.g., a larger source organization) and the data-sets used was missing. Replication of previous research results and validation of results becomes remarkably easier, when the data sources used are documented properly and transparently. The lack of specificity in the information about the used data sources information may be an indication of a low attention paid to the impact of data on the research results in this field.

The typically and most often used data sources in the studied articles that indicate the data source used, include the various data bases housed within The World Bank organization. Other often used sources include The World Economic Forum with reports and indexes, and the United Nations with its various data providing organizations. More than half of the 57 articles use at least one of the above three as a data source. The three main data sources are often complemented with other data providers with index data. It can be observed that the most commonly used sources are also well-known by policy-makers (Salonius and Lönnqvist, 2012). Table 2 lists some of the organizations often used in the NIC literature as data sources and Appendix 1 offers a more complete listing of the used data sources with an article by article documentation.

Table 2: The most often used data sources

Organization	Examples of data sources and indicators / indexes published
The World Bank (WB)	World Bank (WB), World Bank group (WBG), WB’s World development indicators (WDI), World Bank database (WB DB), Knowledge economy Index (WBG KEI), World Bank's Knowledge Assessment Method database (WB KAMD)
The World Economic Forum (WEF)	World Economic Forum (WEF), Global Competitiveness Report/WEF (GCR), Global competitiveness index (GCI), Network Readiness Index (NRI)
The United Nations (UN)	United Nations (UN), UN development Programme (UNDP), Human development index (HDI), Human development Report (UNHDR), UN Public Administration Country Studies (UN/PA), Millennium Development Goals (UN MDG), United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), ILO survey data, International Labour Organisation (ILO)

Further statistics about the data sources used in the 57 articles are shown in Table 3, where one can see that the aforementioned three sources are the most frequently used data sources, while international and national statistics organizations form the group of the second most used data sources. We note that the percentages in Table 3 do not add to one hundred as many articles use several data sources.

Table 3: Data sources used in National Intellectual Capital measurement

Main data sources in the articles; classification used in the Appendix 1 indicated in (•)	articles n=57	%
The World Bank (a)	24	42
The World Economic Forum (b)	21	37
The United Nation (c)	21	37
International Statistical offices (OECD and Eurostat) (e)	17	30
International Institute for Management Development (d)	15	26
National Statistical Offices (f)	14	25
European Commission and other European bodies (g)	6	11
Other banks and financial institutions (h)	5	9
Interview (j)	4	7
New data sources (i)	1	2
Other index and other sources (k, l)	18	32

It is common that multiple or combined data sources are used and information is collected from a number of sources – in the 57 articles reviewed the number of different data sources mentioned was 74. Table 4 shows statistics about the number of sources used per article in the studied population. Article specific information and classification can be found from Appendix 1.

Table 4: Number data sources used per an article

Number of data sources used	Number of articles (sample 57)	Percent of articles, %
1	13	22.8
2	13	22.8
3	13	22.8
4	5	8.8
5	5	8.8
6+	8	14.0
Total	57	100

It can be seen that 23% of articles used one, two, or three data sources – this already constitutes more than two thirds of all articles studied and means that about thirty percent of the articles used four or more data sources. Fourteen percent of the reviewed articles (8) used six or more data sources. It is common that the top data sources are used simultaneously, all three were used in eight articles and World Economic Forum and World Bank together in twelve articles.

The countries studied and the number of countries simultaneously studied varies between articles. The most common area studied in the reviewed articles is the European Union, which accounts for over one fourth of research, with 16% of the articles looking at all EU countries. Eleven percent of the articles studied a smaller group of EU countries, or one EU country alone. Fifty-six percent (56.1%) of the articles had more than 20 countries in their sample, while the largest number of countries simultaneously studied was 148 (Seleim and Bontis, 2013). Under ten countries were focused on in ca. thirty-seven percent (36.9%) of the studies. Table 5 shows statistics of the geographical coverage of the reviewed articles.

Roughly a quarter (24.5%) of the studied articles utilized data from more than 50 countries in their research. These studies were from nine different main authors with altogether fourteen co-authors, with López Ruiz being the most prolific single author of high-number multi-country analyses. According to a count based on first author affiliation, documented data-based NIC research is most active in Spain (10 articles) followed by Taiwan and by Finland (7 articles). It is somewhat interesting to note that USA, Australia, and the UK are not among the top countries.

Table 5: Geographical coverage of reviewed articles

Number of countries in the studies	Number of studies	Percentage of all
>100	4	7.0%
50-99	10	17.5%
20-49	18	31.6%
10-19	4	7.0%
3-9	5	8.8%
1-2	14	24.6%
unknown/none	2	3.5%
Total	57	100%

One area of interest to this research is to find out to what extent the studied literature uses public sector data and the (national) public sector data providers as data sources. Table 6 shows the public sector data use in the studied literature. It can be seen that the use of public sector data is prevalent in all types of articles and acts as the base of analysis in over two thirds of the articles overall. Use of public sector data is most pronounced in country specific and country comparison focused articles.

Table 6: Public sector data use in the surveyed NIC literature

	No public sector data used	Some public sector data used	Public sector data used as the base	Total
A (General NIC)	18.2% (2)	27.3% (3)	54.5% (6)	100% (11)
B (Country comparison)	7.7% (2)	15.4% (4)	76.9% (20)	100% (26)
C (Country analysis)	7.1% (1)	21.4% (3)	71.4% (10)	100% (14)
D (Special NIC Focus)	0% (0)	50.0% (3)	50.0% (3)	100% (6)
Total	8.8% (5)	22.8% (13)	68.4% (39)	100% (57)

The role of public sector data providers in the studied literature, in the light of the prevalent use of public sector data, can be expected to be important. All in all, this expectation is not fully met, as the public sector data providers have a strong visible role in less than half (45.6%) of the studied articles overall. Table 7 shows the role that public sector data providers have in the studied articles. It can be seen that one fifth (21.1%) of the articles do not mention public sector data providers at all and that they are given a strong visible role typically only in approximately half of the country specific and country comparison focused articles. Interestingly more than one third (35.7%) of the country comparison focused articles omit mentioning public sector data providers.

Table 7: Presence of public sector data providers in data-based NIC literature

	No role / not mentioned	Minor role / recognized	Strong visible role in an article	Total
A (General NIC)	27.3% (3)	45.5% (5)	27.3% (3)	100% (11)
B (Country comparison)	12.0% (3)	36.0% (9)	52.0% (13)	100% (25)
C (Country analysis)	35.7% (5)	7.1% (1)	57.1% (8)	100% (14)
D (Special NIC Focus)	14.3% (1)	71.4% (5)	14.3% (1)	100% (7)
Total	21.1% (12)	33.3% (19)	45.6% (26)	100% (57)

It seems that even if public sector data is often used in the literature, public sector data providers do not commonly have an important role outside providing the data. That is, there seems to be a low "state of interaction" between the NIC research community and the public sector data providers, which may be a tell-tale sign of weak collaboration between these "two camps" in terms of developing the public sector data collection and indicators that are important for research purposes.

The utilization of main data sources seems to of have been similar throughout the studied period in all types of articles with the exception of some special aspect focused articles that typically used indexes and special data sources, even new big data sources related to the chosen specific topic. Only 0.9 % of the articles recognize the options to renew also the data sources with big data/smart data (see Vahanyan, Vahanyan and Ghazaryan, 2018). Another "casual" observation about the Intellectual Capital literature is that what one can see is that the majority of recent studies on intellectual capital (IC) concentrate on other areas than national, or macro level intellectual capital. The NIC proportion of all IC studies was only 1.1 % according to our search. Pedro and others estimate that the proportion of studies with an organizational focus is as high as 92.7% of the IC literature and that the proportion of NIC studies is only 4% and that the rest of the studies (3.3%) concentrated on a regional level (Pedro, Leitão and Alves, 2018a, 2018b). The difference between the findings can be attributed to differences in the way the searches were conducted. NIC literature is a niche of less than five percent of the overall IC literature.

While the overall weight of the NIC is not great, the selection and use of data sources is an important issue for NIC research as NIC research is often data-based and the NIC research has a strong history of using data. The theoretical formation of NIC is also largely based on data analysis, which makes the clarity and transparency of the sources used important.

4. Discussion about the data-related problems and relevance-issues observed in the literature

In this section, we discuss problematic issues connected to data that underlie the data-based research on national intellectual capital. As observed above, there are critical voices in the NIC research community that point to problems with data – main problematic issues identified in literature are the ill-availability of (relevant) data and data quality issues. Observed are also inconsistencies and biases in the use of data. The observed problems with data and the use of data have consequences with regards to the credibility and replicability of the results obtained. The real-world relevance of, e.g., indicators used in describing the state of and the progress (of NIC) in a specific nation and comparatively is also an issue of importance.

4.1 Observed data-related problems and consequences

One of the most pronounced observed shortcomings and limitations to NIC research (and reporting) with regards to data is the *lack of availability of data* for a number of nations (Alfaro, López and Nevado, 2011; Bounfour, 2003; Chew, Sharma and Bontis, 2014; Frederick and McIlroy, 1999; Jednak, Dmitrović, and Damnjanović, 2017; Käpylä, Kujansivu and Lönnqvist, 2012; Lin and Edvinsson, 2008; Lin and Lin, 2008; Lin and Edvinsson, 2012; López *et al.*, 2011; Park and Oh., 2018; Piekkola, 2018; Stachowicz-Stanusch, 2013). The lack of availability of data has had serious consequences for NIC research in that it creates a *country bias and affects the research designs* used.

Country bias in this context means that the available data has guided data-based research to take place mostly and even only on countries for which there is ample data available and *consolidated the use of data from the incumbent data providers* (see Herciu and Ogrean, 2015; Stachowicz-Stanusch, 2013). Research designs used have been such that they are not necessarily optimal from the point of view of NIC research and reporting, but such that are able to utilize the data that is available for the purposes of NIC research and reporting (Käpylä, Kujansivu and Lönnqvist, 2012; Stachowicz-Stanusch, 2013). In other words, the availability of data and the type of data that is available may have (remarkably) limited the universe of usable methods (López *et al.*, 2011) and in effect steered the type of NIC research that has been conducted. It has been observed that the relatively small number of countries for which data is available often makes it difficult to apply advanced comparative statistical analysis methods to test data-based hypotheses (Lee, Lin and Lin, 2017). The statement has been made that "*the available data apparently determines the understanding of NIC*" (Käpylä, Kujansivu and Lönnqvist, 2012).

In situations, where data is available, there are often limitations to it, such as the lack of longitudinal data (Chew, Sharma and Bontis, 2014; Seleim and Bontis, 2013), or there might be significant year to year changes with regards to the data sources and in the available statistical data (Tomé, 2011) – both are issues that typically create problems in time series- and comparative analyses. It is typical that data sets reflect the past national IC performance, rather than the current or the future status of a nation (Chew, Sharma and Bontis, 2014; Lin and Edvinsson, 2008; Lin and Lin, 2008; Lin and Edvinsson, 2012; Pedro, Leitão and Alves, 2018a). Data limitations can also affect the reliability of any analyses that attempt to establish causal relationships (see, e.g. Lee, Lin and Lin, 2017; Seleim and Bontis, 2013). Similarly, the credibility of comparative analyses based on (single) country indicators that are composed of numbers that do not consistently (year to year) come from the same sources and that are not constructed in an identical way is suspect (Radjenovic and Krstic, 2017). This problem is similar to the common problem with the lack of *consistency* between quality criteria, accuracy requirements, and contents of data that different (national and regional) statistical systems require from the collected data (Lin and Edvinsson, 2012). Because the manner in which (certain indicator) data is gathered varies from country to country, as a result there are typically inconsistencies and inaccuracies in comparisons and in analyses (Hervas-Oliver and Dalmau-Porta, 2007; Lin and Edvinsson, 2008; Lin and Lin, 2008) sometimes the differences can render comparisons pointless (Łukasiewicz, 2013; Navarro, Lópes and Nevada, 2011). Typically the institutions in each country can determine the set of (most suitable) indicators for which data is collected and the way in which the data is collected – although this practice may capture the unique traits of each country, it efficiently prevents (relevant) cross-country comparisons (see Käpylä, 2012).

Generally, it is noticed that it *is difficult to find the correct composition of variables to address and measure specific phenomena* (Lin and Edvinsson, 2008; Tomé, 2011). The selection of indicators used in indexes that try to capture the development of different phenomena most often also depend on data availability, rather than on (maximizing the) substantive content of the given index (Łukasiewicz, 2013). An easily measurable and definable format of knowledge is appreciated, as the dominant NIC discourse relies on measurement, numbers, indices, and quantitative comparisons and not on qualitative descriptions, hermeneutic understanding, or in-depth and detailed case-studies (Käpylä, 2012) and again, the typical source of information for different indexes are the few well-established and well-known sources.

It has been observed that in some cases the proposed composite-indexes may contain elements based on inherently subjective judgment that may create biases such as over- or underestimation of the results due to, e.g., the use of difficult to justify weights for variables (see Önsel *et al.*, 2008). Also the use of proxy variables in indexes is common (López *et al.*, 2011; Edvinsson and Bounfour, 2004; Bounfour, 2003); it is well known that proxies are not completely representative of the variables for which they are proxies, therefore, if a composite-index is composed of a large number of proxies, the results may become inaccurate. Proxies are likely under- or overestimating the phenomenon they are used to measure (Ståhle and Ståhle, 2012).

Generally, the use of data in form of measurements, indicators, indices, and international comparisons easily creates an *illusion of objectivity and universal applicability* (Käpylä, 2012; Käpylä, Kujansivu and Lönnqvist, 2012). If this is put in the light of data-related problems that NIC research and reporting is observed to have, it can be observed that completely trusting the reported results may lead to imperfect decisions.

Pedro and others (Pedro, Leitão and Alves, 2018a) estimate that due to the difficulty in obtaining suitable data, the growth in the number of empirical studies related to NIC is not as rapid as it would be under better circumstances. They further estimate that the lack of uniformity in indicators and data collection practices in different levels of IC is the reason for the relatively low number of empirical studies on NIC (Pedro, Leitão and Alves, 2018a). Ståhle and Pöyhönen state that the “consequences of the data and statistical indicators formation is seen as a drawback for the IC research tradition” (Ståhle and Pöyhönen, 2005).

4.2 Relevance issues related to data in NIC

The explanatory power of NIC indicators varies with time as a function of the developmental stage of the society that is being measured. For this reason it is important to review and update the NIC measures used for a given society regularly, or to perform measurement with a wide-enough selection of measures, in a way that guarantees that changes are captured, even if the structure and the drivers that drive a society forward change. Typically, the more mature an indicator is, the less explanatory power it has with regards to the development of NIC – this saturation is a testament to the constant development that takes place in what is considered to be a part of NIC and an indicator that is considered to be a growth driver at one point of time may “dry out” and outlive its usefulness as a measure of development (Salonius and Lönnqvist, 2012; Ståhle and Bounfour, 2008). When, for example, the penetration of mobile devices rises high enough, it no longer serves as an indicator of economic growth or performance, similarly circulation per capita of newspapers has lost its measurement value due to the media revolution.

Intangible goods are most likely the main type of IC that is making a large difference in the development gap between developed and developing countries. The impact of intangible goods on NIC is hard to measure, because a large part of that impact is in terms of hidden wealth (López et al., 2011). This also means that if we are unable to measure the impact intangibles have on NIC we most likely are not very good in measuring the NIC gap between countries either. The same kind of problem is associated more generally with all indicators that are only poorly able to capture the whole picture of what they endeavor to measure.

This boils down to noting that when societies change, the way the development in the societies is measured must change with it. That is, the way change takes place changes and the measuring instruments designed for the past ways change takes place may become irrelevant in measuring the new ways change takes place. This means that the way measurement is made should be reviewed and updated regularly to ensure the relevance of the measures. Changing the way measurements are made may cause problems of comparability of the gathered data over time, exactly as was observed above, within the discussion of the data-related problems and their consequences. It becomes increasingly important to understand that if there is an evolution in how change takes place and in the measures used to capture the qualities and size of the change, then documenting the measures and designing "backwards compatibility" becomes very important for the sake of allowing at least some credible longitudinal data to be collected. Put in another way, it is important to conserve core measures that are kept unchanged in how they are measured and reported throughout the changing forms of development. One must also note that intellectual capital is contextual and when the context changes the form and format of intellectual capital also and naturally changes (Ståhle and Bounfour, 2008).

What can be said is that the relevance of the measures used in understanding the state of NIC depends to a large extent to the fit of the NIC measures to the actual status quo in the country in which the measurement is made. It makes no sense to use the same measures in countries with vastly different developmental stage – where it makes sense to measure "literacy" in developing countries it makes sense to measure both "literacy" and "media- or data-literacy" in highly developed countries, because "literacy" is a saturated NIC measure for highly developed countries. To retain the relevance of NIC reporting and research there must be an evolution of measures and a backwards compatibility in the sense that also transitions from one developmental stage to another in a country could be observed also through the data collected. This also means that in designing measurement, the values of the future must be allowed to be different from the values that are accepted now (Käpylä, 2012), one can refer to the change of view with regards to strict environmental policies and how they today are considered to be indicators of positive development, where they were first considered to hinder economic development (Stavropoulos, Wall and Xu, 2018).

Maintaining NIC relevance most likely requires tools for making sure that relevant and "correct" indicators are used, there is however no consensus on evaluation models for NIC indicators (Radjenovic and Krstic, 2017). This is a clear path for further research and action in the NIC community and a challenge to the national and international data providers.

5. Summary, Conclusions, and Future Directions

This article presents a review of the academic National Intellectual Capital literature that focuses on the use of data and on the data-sources used. The review consists of presenting data collected from fifty-seven (57) articles from between the years 1991 and 2018 that have documented their data sources and discussion about the data-related problems observed in the reviewed literature.

The results show that number of different data sources used is rather high as a whole, but a small number of commonly used "preferred" data sources dominate in the literature. More than half of the studied articles use three or less data sources simultaneously, while only fourteen percent use six or more data sources. The number of countries analyzed in a paper varies between a set of papers that concentrate on one or two countries and a set of papers that study more than fifty countries – both of these groups represent about a quarter of the studied articles. Over seventy percent of all papers are either single country analyses or country comparisons. European Union is in the focus of a large number of articles, most likely due to the high availability of data.

The reviewed research is to a high degree based on data from public sector data providers, where about seventy percent of them are mainly based on public sector data and over ninety percent are at least partly utilizing public sector data. The role attributed to public sector organization in the studied is strong, while it is not as pronounced as the use of public sector data. There may be an opportunity for increased collaboration around research issues with the public sector data providers for the NIC community.

The review of literature shows that authors (in the literature) seem to feel that there is much to be desired with regards to the documentation connected to data use in both, documenting the data sources used and in documenting how the data used was actually used. Over one third of the data-based articles fail in documenting the data source in a transparent way. The problems with documentation hamper possibilities of replicating research, which is an important issue with scientific data-based research.

In the literature observed problems regarding data use in NIC literature include the ill-availability of relevant data and data quality issues. Furthermore, inconsistencies and biases in the use of data may be found. The above may cause the applicability and credibility of obtained results suffer and in case the results are used as the basis for decision-making the problems may cause misleading decisions to be made. Availability of the data has likely determined data-based NIC research to a large degree and has therefore also affected the obtained results and the understanding of the NIC status quo.

A way to resolve the observed shortcomings is to require closer documentation of the data and data sources used in the research publication phase. If data is well documented then research that builds on well documented sources is able to update previous findings based on the same type of data used in the same way and by doing so ensuring longitudinal comparability, which at this time is also one issue that has been observed to hold challenges.

We want to point out some limitations to this work, first of all research on NIC is a marginal niche in within the otherwise quite abundant research on intellectual capital, therefore the results presented here can hardly be generalized beyond NIC research. While we have tried to ensure that all the most relevant articles are included we want to point out the possibility of having inadvertently excluded some relevant articles, however, we feel that the results are representative of the NIC research literature as a whole. We have not contacted the authors of the previous literature to study their data use any further – this may be an interesting avenue for further research. When choosing articles we have not used a multi-expert based (inter-rater) method, all choices are those of the authors.

Future research about the data-use and data sources of NIC that is needed from the point of view of better understanding the NIC status quo and development includes research into the development of well-functioning measures and indicators for the various NIC issues that the community studies and research that explores the state of NIC in different nations. As there is constant development in the world of intellectual capital, fueled by the ever-expanding new ways of using technology, the measures used to capture the status quo must constantly develop with the times, on the other hand, nations in different stages of development require different measures and indicators – mapping measure / indicator fit with stage of development would be a fine addition to NIC literature. There is also room for research concerning the connections between the NIC research community and the national data policies.

As an answer to the question “Misled by data?” we say “No”. Not misled, perhaps led; and while being led, we must be vigilant so that we are not being misled.

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Appendix 1

Full listing of the reviewed literature with detailed classification is available on-line at https://lutpub.lut.fi/handle/10024/162353

Social Connection and Knowledge Brokerage in a State Government Research Network in Australia

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Abstract: The social dimensions of knowledge management are often overlooked when attempting to develop innovative approaches to preserve and balance the multiple values of protected natural landscapes. This oversight can hinder the incorporation of knowledge from research and experience, particularly tacit knowledge held by experts and experienced individuals. Building social connection between leaders, researchers and experienced staff within an organisation can address this challenge because it fosters knowledge incorporation and dissemination. However, this can be a slower, more costly and more challenging method of incorporating diverse knowledges. Organisations, particularly government organisations, need to demonstrate the value of building social connection and cohesion. Our work was designed to evaluate social connection and the development of deliberative knowledge networks. We tracked social connection during the formation of a research network within a state government organisation in Australia. The aim of the network was to improve the adoption of research knowledge into management of the alpine region in the state of New South Wales, Australia. Social Network Analysis (SNA) was used to evaluate the effectiveness of forming a research network, given it was a costly, time-consuming and challenging method for the organisation. SNA was used to visualise social connections and measure changes during the planning phase of the research network over 12 months, when scope of the alpine research program was being identified and priorities determined. The analysis revealed individuals in the network grew social connections over time (total ties, average degree and density increased) which is likely to lead to better knowledge sharing. The SNA also identified individuals with knowledge brokerage roles (betweenness scores) and those with the greatest reach and potential influence in the network (key players) who were targeted for future roles in the network. The majority of alpine information was sought from and shared with staff within the network, particularly those in two Groups/ Divisions, which may limit the innovation by the network. The results provided insight to the government research network that is invaluable in its transition from the planning phase to implementation of research priorities and adaptive management. Our approach provides evidence for the value of building social connections and knowledge brokerage to improve environmental outcomes.

Keywords: Social Network Analysis, knowledge exchange, social connection, evaluation, environmental management, alpine

1. Introduction

Effective management of environmental challenges needs more than knowledge of the environment. We must understand social interactions in human systems (Robinson, et al., 2019) because knowledge, and indeed wisdom (Easterbrook, 2012), is conceptualised and embedded in social relations (Nguyen, Young and Cooke, 2017). A diversity of knowledge and values needs to be integrated into decisions to achieve effective environmental management (Reed, 2008). However, this process can be costly, time-consuming and challenging. Therefore, organisations, particularly government organisations, need to demonstrate the value of building social connection when developing environmental management programs.

It has been assumed people with different levels of expertise could listen, understand and respond to each other's needs (Porter and Dessai, 2017). However, knowledge exchange is a complex process and the conditions that make it effective remain uncertain (Fazey, et al., 2012). Knowledge moves in dynamic, non-linear and iterative ways (Nguyen, Young and Cooke, 2017) so integrating knowledge of multiple individuals with varying expertise, backgrounds, problem-solving styles and personalities can be challenging (Cross, Borgatti and Parker, 2001). The challenges have been attributed to a lack of understanding (Cullen, 1990) caused by differences in language, background, rewards, pressures, power and needs (Briggs, 2006; Fazey, et al., 2012).

As individuals, we continuously create our world through our various experiences, memories and references (Reis, 2001; Mannheim, 1960). Conceptual models of knowledge exchange affect how we create and attempt to

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share knowledge. Fazey, et al. (2012) listed two models of knowledge exchange that create different outcomes. The first model was 'transmissive' and the second, for the purpose of this paper, the authors named 'co-created'. The traditional 'transmissive' model of knowledge exchange assumes knowledge is something explicit which can be passed between people. This model results in traditional methods of disseminating knowledge – where 'facts' are communicated to different groups. It tends to maintain the status of those involved and fails to recognise the complexities of the learning process (Fazey et al., 2012). Eden (2011) calls the traditional approach for science in government the 'loading dock' model – where results are produced and users are expected to seek them out. Failures of the model include problems with salience, credibility and legitimacy. This 'deficit model' assumes 'correct' policies will automatically follow once scientific results are provided to politicians (Lawton, 2007).

The 'co-created' model of knowledge (Fazey, et al., 2012) is a "more complex, iterative process of reflection and experiential learning" which makes implicit knowledge explicit. The model leads to approaches that emphasise co-production of knowledge and to more adaptive forms of learning. This model leads to increased agility in environmental management that produce more effective and enduring outcomes (Fazey, et al., 2012).

Leaders in (the former) Office of Environment and Heritage (OEH) in New South Wales (NSW), Australia, wanted to adopt the latter model and develop a research program using a collaborative approach with co-production of knowledge. Co-production of knowledge can be a costly, time-consuming and challenging process (Goggin, et al., 2019) so leaders in OEH needed to evaluate their investment in building social connection to improve knowledge exchange.

Knowledge exchange in government organisations can present many challenges, particularly with the flow of scientific knowledge into decision making. According to Head (2013), scientific or rigorous knowledge is "widely valued" by decision-makers in government but must "contend with business, political and professional understandings about the nature of the problems, and about what kinds of solutions are practical and feasible." There is also evidence that government decision makers do not seek evidence from published scientific literature. For example, Pullin, et al. (2004) analysed management plans for nature reserves written by statutory and non-governmental conservation organisations in the United Kingdom. They found most plans were compiled from a limited amount of the total information available. None of the plans critically evaluated the quality of evidence in support of actions. Few planners used scientific literature because they said it was too time-consuming to access and read, and too technical and difficult to interpret in the context of their decision making. In Australia, policy officers from the Victorian state government Department of Primary Industries (DPI) said they sought information from the internet (their preferred source of information), the library and from other policy documents (Dripps and Bluml, 2008) rather than from scientists or from scientific literature.

There is growing evidence that decision makers seek concise information in context from trusted sources, rather than from published literature. The information must be relevant, timely, credible and legitimate (Cook, et al., 2013). For example, policy officers from the Victorian DPI, Australia, sought information from their personal networks (formed after face-to-face meetings in working groups, technical support groups, seminars and forums) (Dripps and Bluml, 2008). Similarly, water managers and policy officers in New South Wales (NSW), Australia, reported interpersonal communication was their preferred means of accessing information (including scientific outputs) (Inca Consulting, 2011). They did not actively search for scientific information but would consider and/ or use scientific information presented to them, particularly by scientists they trusted or with whom they had built a relationship.

Therefore, a collaborative approach can help address the challenge in knowledge exchange in government (Wall, Meadow and Horganic, 2017; Goggin, et al., 2019) because it improves the creation, uptake and flow of knowledge between groups. A collaborative approach can also foster social learning and integrate knowledge from different groups so novel results can be reached that were not achieved by the groups separately (Xavier, Jacobi and Turra, 2018). Collaboration is also a key factor in successful translation and implementation of knowledge (Long, Hibbert and Braithwaite, 2016). For example, building relationships between scientists and practitioners from Australia was key to better outcomes in environmental programs and practice (Goggin, et al., 2019). Interactions between scientists and stakeholders also overcame gaps in perception and improved the use of climate science (Briley, Brown and Kalafatis, 2015). Gibbons, et al. (2008) also found successful research-policy partnerships were built around personal relationships.

Crona and Bodin (2006) found strong social networks facilitate the generation, acquisition and diffusion of knowledge and information. This aligns with work by Long, Cunningham and Braithwaite (2013) who reviewed the flow of information between groups or silos in networks (from 24 published articles), including in Australian hospitals. They found the optimal network structure to spread factual and especially tacit knowledge is cohesion (high density) not sparseness (more structural holes). The process within (the former) OEH was designed to build social connections in order to improve the flow of tacit knowledge between groups. However, there is little published research on changes in social connection in research networks in Australia (although see Long, Cunningham and Braithwaite, 2012; Cvitanovic, et al., 2017), and even less within government. Our research aimed to fill that gap and evaluate its effectiveness.

In Australia, alpine landscapes are rare, restricted to the south-east of the continent (Williams, et al., 2008) and one of six key regions that are highly vulnerable to climate change (Hennessy, et al., 2007). Some of the largest alpine landscapes in Australia are within Kosciuszko National Park (KNP) which preserves a range of special places and values that are unique in Australia and recognised internationally. The Park is a UNESCO Biosphere Reserve, preserving the only true alpine zone in mainland Australia (National Parks and Wildlife Service NSW, 2006). In addition to its natural and cultural values, KNP has significant tourism and visitor values. In 2016, there were 2.2 million visits to the Park, making it one of the ten most visited national parks in the state (Roy Morgan Research Ltd, 2017). All four ski resorts in NSW are also within the Park and these businesses and local livelihoods are vulnerable to the impacts of climate change (Sharpe, Delaney and Cunningham, 2020).

Like many protected areas around the world, balancing and protecting the multiple values of KNP is challenging. Managers must balance the needs of increasing numbers of visitors and development, and risks from climate change which are exacerbating threats from pests, weeds and fire. Wild horses have established in KNP and their management is emotive and controversial (Knight, 2019). In addition, a major expansion of the Snowy Mountains hydroelectric scheme will affect the Park (Normyle and Pittock, 2020). These multiple challenges need robust evidence and innovative approaches to enable adaptive management in order to continue to protect the natural, socio-economic and heritage values of the Park.

The former NSW Office of Environment and Heritage (OEH) established an Alpine Research Program to foster collaboration and improve flow of knowledge about the alpine region within the organisation. The Program was designed to inform the management of the alpine region, particularly KNP which is managed by National Parks and Wildlife Service (NPWS) on behalf of the NSW Minister for Energy and Environment. At the time of this research, NPWS was part of the former OEH and one of the seven functional areas or groups (Office of Environment and Heritage NSW, 2018). The Alpine Research Program was designed as a model for prioritising and undertaking research that informs management, particularly management of emotive and controversial issues in national parks. The theory of change (Funnell and Rogers, 2011) underpinning the Program was that building social connection would improve the generation, acquisition and exchange of knowledge between participants in the network (Crona and Bodin, 2006). Therefore, our research was designed to evaluate the effectiveness of building social connection within government to improve knowledge sharing.

Social Network Analysis (SNA) is a tool that identifies social groups, influential people and patterns of communication (Crona and Bodin, 2006). It allows quantitative analysis and qualitative insights into interactions between individuals in a network (Borgatti, Everett and Johnson, 2013; Cunningham et al., 2014). In this study, SNA was used to track changes in social connection between individuals from a state government department with expertise, experience and/or responsibilities in the alpine region of NSW, Australia. We used longitudinal SNA to track development and changes in the network over time as well as shifts in social connection between participants. SNA was also used to identify individuals with knowledge brokerage roles. The aim of the research was to evaluate the role of the social network in fostering knowledge exchange and inform management of the alpine area within a government context.

2. Materials and methods

The former Office of Environment and Heritage NSW (OEH) employed staff to provide evidence and advice to support government policy and management decisions, including decisions about protecting the environment in the state of New South Wales (NSW), Australia. At the time of this research, OEH employed about 3,000 staff in seven functional areas (OEH, 2018). The focus of this study was the interaction between Heritage Division (Heritage), National Parks and Wildlife Service (NPWS), Regional Operations Group (Regional Operations) and

Science Division (Science). The majority of OEH's functions were transferred to the NSW Department of Planning, Industry and Environment in July 2019.

In early 2017, leaders (referred to as managers within the organisation and throughout this paper) in (the former) OEH with responsibilty for the alpine region of NSW became aware that a large number of OEH staff were involved in research in the alpine region. In June 2017, an audit of alpine research in OEH found more than 30 staff were involved in over 60 research projects in the alpine region of NSW and elsewhere. However, the research was not well known nor coordinated across the organisation. Managers with responsibility for the alpine region wanted to evaluate the use of the contemporary conceptual model of knowledge exchange to improve knowledge sharing between Groups/ Divisions in the organisation. Therefore, in July 2017, leaders held a workshop with staff to discuss challenges and opportunities in the alpine region. They invited staff with expertise, experience and/or responsibilities for the alpine region. The meeting was designed to build connection between staff from different Groups/Divisions so knowledge about the alpine region would be better shared within the organisation. In turn, this would allow the use of collective expertise to develop a coordinated program of collaborative research. The research program was designed to use natural, socio-economic and heritage values to inform and guide management, so the condition of the alpine region would continue to be protected and improved.

Social Network Analysis (SNA) was used to evaluate the organisation's investment in face-to-face meetings to improve knowledge sharing. Bringing staff together for face-to-face meetings was costly in both staff time and funds (travel, accommodation, etc). It was also challenging logistically with a number of staff needing to travel up to six hours to attend. Therefore, although face-to-face meetings were preferred and additional meetings may have built better connection, the number of face-to-face meetings was restricted.

Many connections within the alpine network were invisible to managers but were crucial to sharing information; SNA was an appropriate approach because it can visualise connections between participants. Longitudinal SNA was identified as the preferred method because it allowed the exploration of changes in the number and strength of connections between individuals in the network over the three meetings (ALPINE network: July 2017, November 2017, June 2018). These three time periods and three networks are used as a proxy for knowledge sharing. In addition, SNA identified individuals from whom information about the alpine region was sought (SEEK network: November 2017, June 2018), and with whom information about the alpine region was shared (SHARE network: November 2017, June 2018).

Prior to the first meeting in July 2017, a list was made of 59 staff with experience, expertise and/or responsibilities in the alpine region. The staff were invited to a meeting in Canberra, Australian Capital Territory (ACT) to discuss issues and challenges with management of the alpine region. Thirty staff from across NSW attended. They were given a list of 59 names prior to the meeting and asked to rank their connection to each one.

A second meeting was held in November 2017 in Queanbeyan, NSW, to finalise the scope and goal of the research program (by developing a program logic). Eighteen staff attended; 16 people who attended the first meeting and two people who were new to the network. Those who attended were given a list of 61 people and asked to rank their connection to each one. The list included 59 names from the previous list (N1-N59) and two people (N60, N61) invited to the second meeting.

After the first two meetings, those who attended were asked for feedback via an online survey. As part of the feedback, respondents were asked how many new people they met at each meeting.

In March 2018, a Steering Committee was formed, followed by two Working Groups (with representatives from across the organisation) to advise and support decision-making by the Steering Committee. In June 2018, the Working Groups met to review and prioritise research listed in the 2006 KNP Plan of Management (NPWS, 2006) as well as those research questions raised by staff in the previous two meetings.

In June 2018, 26 staff attended a third meeting in Queanbeyan. Participants were given a list of 85 names which included 61 names from November 2017 (N1-N61). The additional names on the list were: two people (N75, N76) who responded by email in November 2017 (but did not attend that meeting); seven people (N66, N77, N78, N79, N80, N82, N94) nominated in November 2017 as part of the ALPINE network; 10 people invited to the meeting in June 2018 (two of them were listed in the SEEK or SHARE networks, N74, N95); four people (N62, N63, N72, N73) added from the SHARE network; and one person (N65) added from the SEEK network.

Before each meeting, those who attended were asked to rank their connection to people on the supplied lists (n=59 in July 2017; n=61 in November 2017, n=85 in June 2018) as none (0), weak (1), moderate (2) or strong (3). Therefore, responses reflect connection of individuals prior to meetings. This resulted in the potential to create a directional value-weighted matrix; individuals ranked the strength of connection according to their intuition because researchers did not define 'weak', 'moderate' or 'strong' within the survey instrument (De Brún and McAuliffe, 2018).

In November 2017 and June 2018, respondents were also asked to name three people who they sought information about the alpine region from (SEEK network) and three people who they shared information with (SHARE network).

Between July and September 2018, the Working Groups continued to prioritise research. They provided a list of research priorities with recommendations to the Steering Committee who considered their recommendations and finalised a list of research for the alpine region in November 2018. The SNA did not capture connections that changed during this period.

The three networks were treated as unique and discrete networks, i.e. ALPINE, SEEK and SHARE networks. Individuals were numbered sequentially so an individual is represented by the same number in all networks. In the analyses, individuals were assigned one of six categories (as listed in Table 1) which we defined as follows. 'Attend – response': the individual attended the meeting and provided data. 'Did not attend – email response': the individual did not attend the meeting but provided data by email. 'Not in this time period – email response': the individual was not identified as part of the network at that time but provided an email response, and their data were included in the analysis. 'Attend – no response': the individual attended the meeting but did not provide data. 'Did not attend – no response': the individual did not attend the meeting or provide data. 'Not in this time period – no response': the individual was not identified as part of the network at that time, and was analysed as missing values for that time period.

After the three meetings, the networks were bound to the total number of participants from every time period: ALPINE = 87; SEEK = 124; SHARE = 124. The total number included missing data such as non-responses and inactive nodes. Missing data was listed as null responses. The data were used to create a symmetric-directed matrix so networks could be mapped and analysed. Visualisations and analyses were run in UCINet (Borgatti, Everett and Freeman, 2002) and Netdraw (Borgatti, 2006). The visualisation layout uses geodesic distance to position the nodes so those with similar characteristics (i.e. similar properties or structural positions) were forced together.

We calculated UCINet Multiple Cohesion Measures (Borgatti, Everett and Freeman, 2002) including average degree, density, fragmentation, closure and diameter to measure changes in network efficacy over time. To identify individuals with knowledge brokerage roles for each time period, we calculated metrics including the UCINet Freeman betweenness (Freeman, 1979) which is a centrality measure that considers degree and closeness. Key players (diffuse) were identified using the key player problem 1 algorithm (Borgatti, 2006) which calculated nodes with the most and strongest connections in the network. Individual key player diffuse algorithms were run for the ALPINE, SEEK and SHARE networks. The total number of ties in the ALPINE network at each time period was calculated to estimate change over time.

3. Results

3.1 ALPINE network

In July 2017, 29 individuals ranked their connection to a list of 59 names. There were 28 responses at the meeting and one emailed response afterwards (from someone who did not attend) (Table 1). At the next meeting in November 2017, 29 individuals ranked their connection to a list of 61 names (Table 1). Those who ranked their connection included 18 individuals who attended the meeting (including two individuals who did not attend the first meeting but were added to the list in November 2017). There were also responses from nine individuals who did not attend the meeting but were on the original list of 59 people and provided data after the meeting. The remaining two individuals did not attend either meeting, were not in the network list, but were sent the list from someone in the network. In June 2018, a total of 26 individuals ranked their connection to a list of 85 names. All individuals who responded were on the supplied list (Table 1).

Response rate in the ALPINE network declined over time (Table 1). Response rate will affect results but an "adequate" response rate for a whole network analysis has not been defined (Long, Hibbert and Braithwaite, 2016). In this analysis, missing sections of the network were partly filled by respondents who nominated non-respondents so we believe response rate was adequate for our purposes.

The ALPINE network was bound to 87 internal nodes: five from Heritage (D1); 45 from NPWS (D3); 10 from Regional Operations (D3) and 27 from Science (D4). The network was visualised for July 2017 (Figure 1), November 2017 (Figure 2) and June 2018 (Figure 3). All nodes (i.e. attend, no attend, not in this time period, etc) were visualised. The node size in the visualisation reflects the total number and strength of connections, i.e. sum of the strength of nominated connections. Isolates (or inactive nodes) did not respond at that time period nor were they nominated by another node in that network. They appear on the left of the visualisations.

The total number of ties in the ALPINE network increased by 53% over time: from 784 in July 2017, to 902 in November 2017 and to 1,199 by June 2018.

Table 1: Number of participants, response rate and participation at each time period

	JUL 2017	**NOV 2017**	**JUN 2018**
Names on supplied network list	59	61	85
Attend - response	28	18	26
Not attend – email response	1	9	0
Not in this time period – email response	0	2	0
TOTAL RESPONSES	**29**	**29**	**26**
Attend - no response	2	0	0
Not attend – no response	30	34	61
Not in this time period – no response	26	24	0
TOTAL in ALPINE network	**87**	**87**	**87**
Response rate (percent)	33.3	33.3	29.8

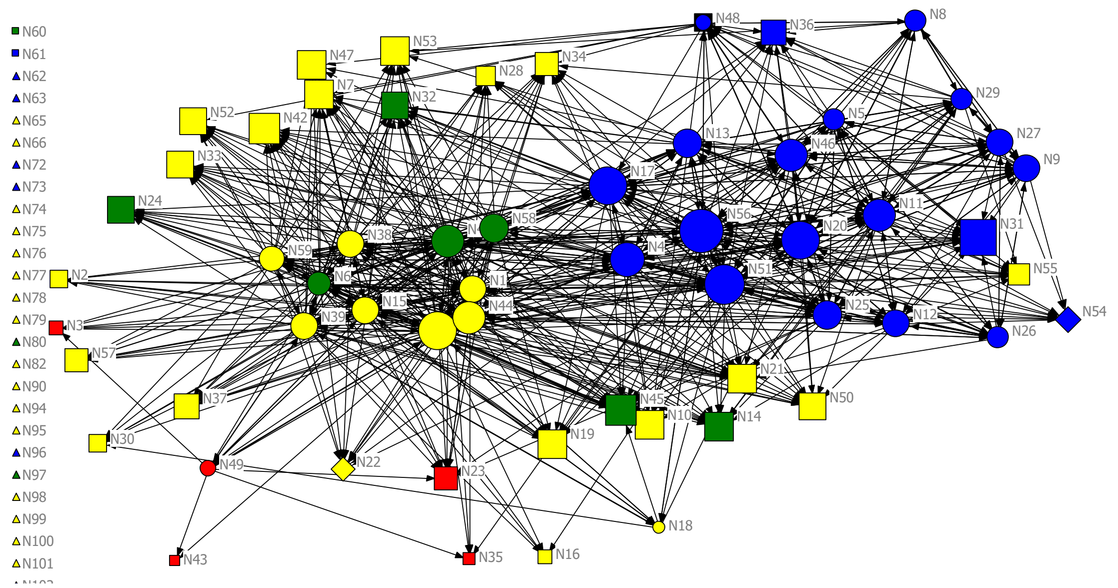

Figure 1: Visualisation of ALPINE network (July 2017). Node colour represents (former) OEH Division/ Group: Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science. Shape of nodes represent attendance: circle = attended and responded; square = did not attend; square with circle = email response (did

not attend); diamond = attended with no response; triangle = not in this time period; plus = email response but not in this time period

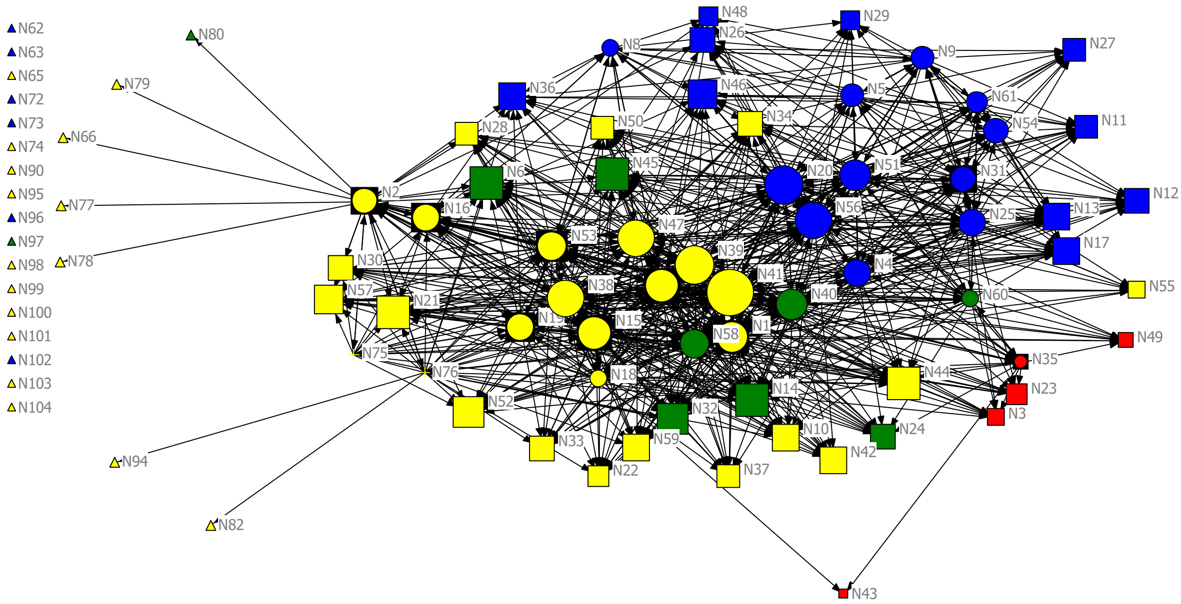

Figure 2: Visualisation of ALPINE network (November 2017). Colour of nodes represent (former) OEH Division/ Group. Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science. Node shape represent attendance at the meeting: circle = attended and responded; square = did not attend; square with circle = email response (did not attend); diamond = attended with no response; triangle = not in this time period; plus = email response but not in this time period.

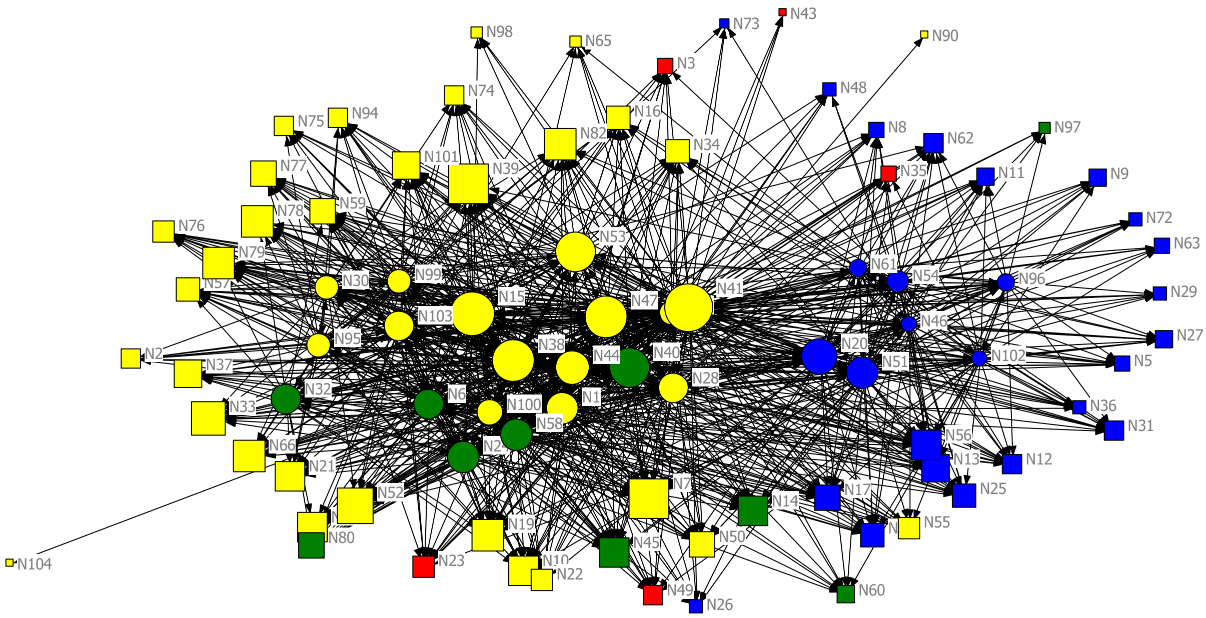

Figure 3: Visualisation of ALPINE network (June 2018). Node colour represents (former) OEH Division/ Group. Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science. Shape of node represents attendance at the meeting: circle = attended and responded; square = did not attend or respond; square with circle = email response (did not attend); diamond = attended with no response; triangle = not in this time period and no response; plus = not in this time period and email response.

In July 2017, a manager from Science (N56) and one from NPWS (N41) had the highest UCINet Freeman betweenness scores (Freeman, 1979) in the ALPINE network (Table 2). The NPWS manager (N41) maintained high betweenness scores over time. By November 2017, a scientist from Science (N20) also had high betweenness scores. At this time, a different NPWS manager (N2) had the highest betweenness score at that time period and at any time period. This individual did not attend meetings, and their high score is likely to be bias – they provided data sheets to individuals (not on the supplied list) who responded. In June 2018, N2 did not complete data sheets nor pass them to others so did not maintain a high betweenness score.

Table 2: UCINet Freeman betweeness score for nodes in the ALPINE network over time, with affiliation and role of each node

TIME	NODE	DIVISION/ GROUP	ROLE	BETWEENESS
July 2017	N56	Science	Manager	117
	N41	NPWS	Manager	113
	N51	Science	Manager	92
	N17	Science	Manager	68
	N20	Science	Scientist	64
	N40	Regional Ops	Manager	62
	N44	NPWS	Manager	59
November 2017	N2	NPWS	Manager	255
	N41	NPWS	Manager	128
	N20	Science	Scientist	100
	N56	Science	Manager	99
	N1	NPWS	Manager	64
	N47	NPWS	Scientist	58
June 2018	N41	NPWS	Manager	234
	N47	NPWS	Scientist	95
	N20	Science	Scientist	70
	N40	Regional Ops	Manager	59
	N51	Science	Manager	54
	N15	NPWS	Manager	52

Multiple Cohesion Measures tracked growth of the ALPINE network over time (Table 3). The average degree increased from July 2017, when individuals had an average of nine connections, to more than 13 by June 2018. Density (total connections divided by total possible connections) increased between July 2017 and June 2018, so individuals were connected to more people over time. Fragmentation (a measure of lack of connectivity in the network) decreased between July 2017 and June 2018 reflecting better connection over time. Closure measures the degree to which 'the friend of my friend is likely to be my friend' and is calculated by dividing the number of triads (three nodes) by two. Closure of the ALPINE network was similar throughout the project. Diameter estimates the number of steps to reach everyone in the network (Cunningham, et al., 2017). Individuals in the majority of the ALPINE network could be reached in three to five steps.

Table 3: Multiple Cohesion Measure Metrics for the ALPINE network over time

METRICS	JUL 2017	NOV 2017	JUN 2018
Average degree	8.98	10.37	13.76
Density	0.11	0.12	0.16
Fragmentation	0.78	0.73	0.70
Closure	0.65	0.65	0.67
Diameter	3	5	3

In July 2017, the 17 key players in the ALPINE network included managers from NPWS (n=4), Science (n=3) and Regional Operations (n=1) (Table 4). Key players also included rangers (n=2), project officers (n=2), environmental liaison and management officers (n=2) from NPWS, as well as a scientist from Science and from Regional Operations, and a regional coordinator from Regional Operations. A combination of key players from each run could reach over half (69%) the network.

In November 2017, the 14 key players in the ALPINE network were managers from NPWS (n=6) and Science (n=3), a ranger, Discovery coordinator, Indigenous liaison officer and environmental management officer from NPWS, and scientists from Science (n=2) (Table 4). A combination of key players for each run could reach most (81%) of the network. In June 2018, there were only three key players, all of whom were from NPWS (a manager and two scientists) and they could reach the entire network.

Table 4: Key player (diffuse) in the ALPINE network at each time period (Time) for each key player query run (Run). A combination of any three key players from each run can reach the listed percentage of nodes in the network

TIME	RUN	KEY PLAYER	KEY PLAYER	KEY PLAYER	NODES REACHED (%)
Jul 2017	1	N40 (Manager, Regional Ops)	N61 (Scientist, Science)	N75 (Manager, NPWS)	69
	2	N40 (Manager, Regional Ops)	N62 (Manager, Science)	N74 (Manager, NPWS)	69
	3	N40 (Manager, Regional Ops)	N77 (Ranger, NPWS)	N80 (Regional coordinator, Regional Ops)	69
	4	N40 (Manager, Regional Ops)	N78 (Ranger, NPWS)	N94 (Project officer, NPWS)	69
	5	N40 (Manager, Regional Ops)	N94 (Project officer, NPWS)	N96 (Manager, Science)	69
	6	N40 (Manager, Regional Ops)	N95 (Environmental liaison officer, NPWS)	N97 (Scientist, Regional Ops)	69
	7	N41 (Manager, NPWS)	N65 (Manager, NPWS)	N82 (Manager, NPWS)	69
	8	N41 (Manager, NPWS)	N76 (Environmental management officer, NPWS)	N95 (Environmental liaison officer, NPWS)	69
	9	N41 (Manager, NPWS)	N77 (Ranger, NPWS)	N79 (Project officer, NPWS)	69
	10	N41 (Manager, NPWS)	N82 (Manager, NPWS)	N94 (Project officer, NPWS)	69
Nov 2017	1	N104 (Ranger, NPWS)	N2 (Manager, NPWS)	N56 (Manager, Science)	81
	2	N2 (Manager, NPWS)	N39 (Manager, NPWS)	N99 (Discovery coordinator, NPWS)	81
	3	N2 (Manager, NPWS)	N56 (Manager, Science)	N65 (Manager, NPWS)	81
	4	N2 (Manager, NPWS)	N56 (Manager, Science)	N98 (Indigenous liaison officer, NPWS)	81
	5	N39 (Manager, NPWS)	N73 (Scientist, Science)	N76 (Environmental management officer, NPWS)	81
	6	N41 (Manager, NPWS)	N72 (Manager, Science)	N76 (Environmental management officer, NPWS)	81
	7	N41 (Manager, NPWS)	N76 (Environmental management officer, NPWS)	N96 (Manager, Science)	81
	8	N56 (Manager, Science)	N63 (Scientist, Science)	N76 (Environmental management officer, NPWS)	81
	9	N56 (Manager, Science)	N74 (Manager, NPWS)	N76 (Environmental management officer, NPWS)	81

TIME	RUN	KEY PLAYER	KEY PLAYER	KEY PLAYER	NODES REACHED (%)
Jun 2018	1	N18 (Scientist, NPWS)	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	100

3.2 SEEK networks

Total individuals from all time periods in the SEEK network was 124 (Table 5) with 91 nodes from four OEH Divisions/ Groups (five from Heritage, 46 from NPWS, 10 from Regional Operations, 30 from Science) and 33 nodes from 11 external organisations (Table 6). Response rate increased between November 2017 and June 2018 (Table 5).

Table 5: Number of individuals in the SEEK and SHARE networks and response rate over time

RESPONSE TYPE	SEEK Nov 2017	SEEK Jun 2018	SHARE Nov 2017	SHARE Nov 2018
Attend - response	18	28	18	28
Did not attend – no response	58	96	58	96
Not in this time period – no response	48	0	48	0
TOTAL	**124**	**124**	**124**	**124**
Response rate (%)	**14.5**	**22.6**	**14.5**	**22.6**

Table 6: Number of individuals in each category for the SEEK and SHARE networks over time. An individual may have been nominated several times in the same network but is counted once for each time period in this table

CATEGORY (ATTRIBUTE)	SEEK Nov 2017	SEEK Jun 2018	SHARE Nov 2017	SHARE Jun 2018
OEH Heritage (D1)	1	1	1	
OEH National Parks & Wildlife Service (NPWS) (D2)	21	18	22	21
OEH Regional Operations (D3)	6	7	5	5
OEH Science (D4)	12	8	14	9
TOTAL OEH INDIVIDUALS NOMINATED	**40**	**34**	**42**	**35**
ACT Govt (D5)		1	1	1
NSW Govt (D6)	2		2	1
University (D7)	3	3	1	1
Traditional Custodian (D8)	2	1		
Committee (D9)		1	1	2
Zoo (D10)		1		1
Resorts (D11)	3		2	
Consultant (D12)	2			
Business/ company (D13, D15)	1			1
Research organisation (D14)		1		1
Research group/ network/ association (D16)		1		1
Education centre (D17)				1
TOTAL EXTERNAL INDIVIDUALS NOMINATED (% of total individuals nominated)	**13 (24.5%)**	**9 (20.9%)**	**7 (14.3%)**	**10 (22.2%)**

Table 7: Frequently nominated individuals (four times or more) in the SEEK and SHARE networks over time, in decreasing order of nominations. Individuals who increased their nominations over time are heavily shaded. Those who maintained the number of nominations over time are in a lighter shade.

NODE	ROLE (Group/ Division)	SEEK Nov 2017	SEEK Jun 2018	SHARE Nov 2017	SHARE Nov 2018	TOTAL
N47	Scientist (NPWS)	5	6	4	5	20
N41	Manager (NPWS)	2	4	9	5	20
N32	Scientist (Regional Ops)	4	4	2	2	12
N58	Scientist (Regional Ops)	3	6	3		12
N38	Manager (NPWS)		3		5	8
N15	Manager (NPWS)		2	2	4	8
N66	Ranger (NPWS)		2		5	7
N10	Scientist (NPWS)	4	3			7
N20	Scientist (Science)	2	2		2	6
N51	Manager (Science)	2		4		6
N53	Scientist (NPWS)	2	2			4
N21	Scientist (NPWS)	2	2			4
N25	Manager (Science)			4		4

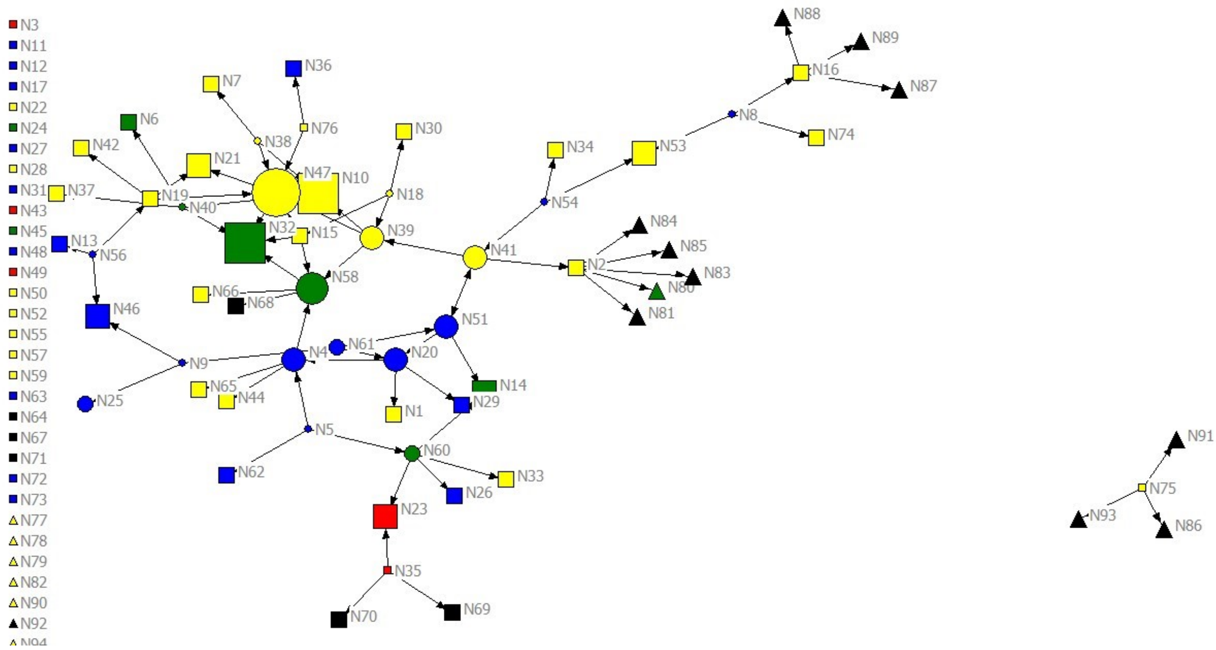

Figure 4: Visualisation of SEEK network for November 2017. Node colour represents OEH Division/ Group or organisation. Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science; Black = non OEH. Node shape represents attendance: circle = attended; square = did not attend; triangle = not in this time period. Arrow direction indicates whom the node seeks information from

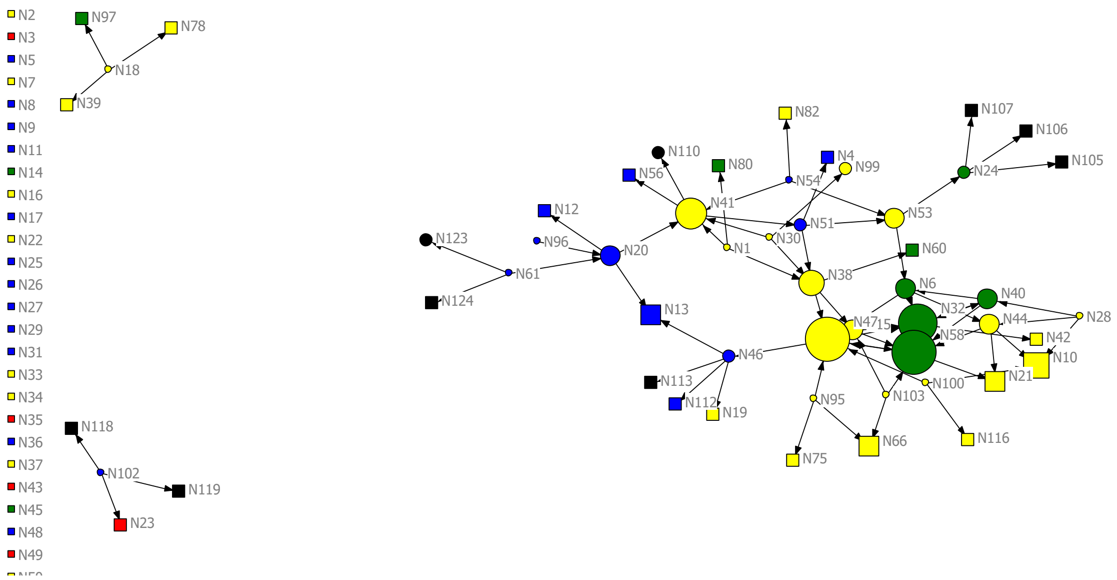

Figure 5: Visualisation of SEEK network for June 2018. Node colour represents OEH Division/ Group or organisation. Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science; Black = non OEH. Shape of node represents attendance: circle = attended and responded; square = did not attend or respond. The direction of the arrow indicates whom the node seeks information from

Most multiple cohesion measures for the SEEK network remained similar between November 2017 and June 2018 (Table 7). Different participants provided data at each time so similarities may reflect varied responses from different individuals. Fewer people attended the meeting in November 2017 than in June 2018 which may also affect the result.

The average degree for the SEEK network remained similar and density did not change between November 2017 and June 2018 (Table 8) so people in the network did not seek information from more or different people over time. Indeed, the fragmentation of the SEEK network decreased and closure increased, suggesting more individuals sought information from similar individuals over time. It also suggests that in triads, where originally person A knew both B and C but B and C may not have known each other that by June 2018, it was more likely B and C knew each other (see Granovetter, 1973). However, the diameter of the SEEK network increased so more steps were required to access all nodes in most of the network.

Table 8: Multiple Cohesion Measures for SEEK and SHARE networks over time

METRICS	SEEK Nov 2017	SEEK Jun 2018	SHARE Nov 2017	SHARE Jun 2018
Average degree	0.597	0.589	1.129	1.113
Density	0.005	0.005	0.009	0.009
Fragmentation	0.985	0.972	0.844	0.857
Closure	0.083	0.155	0.127	0.128
Diameter	6	7	8	7

The composition and number of key players in the SEEK network changed over time (Table 9). In November 2017, there were three key players which increased to five key players by June 2018. In November 2017, there were more key players from Science (n=2) than NPWS (n=1), but by June 2018, most key players were from NPWS (n=4) with only one from Science. In November 2017, key players were managers from Science (n=1) and NPWS (n=1), and a scientist from Science. By June 2018, four of the five key players were scientists from NPWS (n=3) and Science (n=1) with one NPWS manager.

Table 9: Key players (diffuse) from SEEK networks over time; and percent of nodes reached by a combination of key players for each key player query run (Run)

TIME	RUN	KEY PLAYER	KEY PLAYER	KEY PLAYER	NODES REACHED (%)
Nov 2017	1	N41 (Manager, NPWS)	N5 (Manager, Science)	N8 (Scientist, Science)	22
Jun 2018	1	N1 (Scientist, NPWS)	N4 (Scientist, Science)	N53 (Scientist, NPWS)	20
	2	N30 (Manager, NPWS)	N47 (Scientist, NPWS)	N53 (Scientist, NPWS)	20

3.3 SHARE networks

There were 124 individuals in the SHARE network (Table 5) with 91 nodes from (the former) OEH (5 nodes from Heritage, 46 from NPWS, 10 from Regional Operations, 30 from Science) and 33 nodes from 10 external categories (Table 6). Attendance and response rate increased over time (Table 5). SHARE networks for November 2017 and June 2018 were visualised in Figures 6 and 7 respectively.

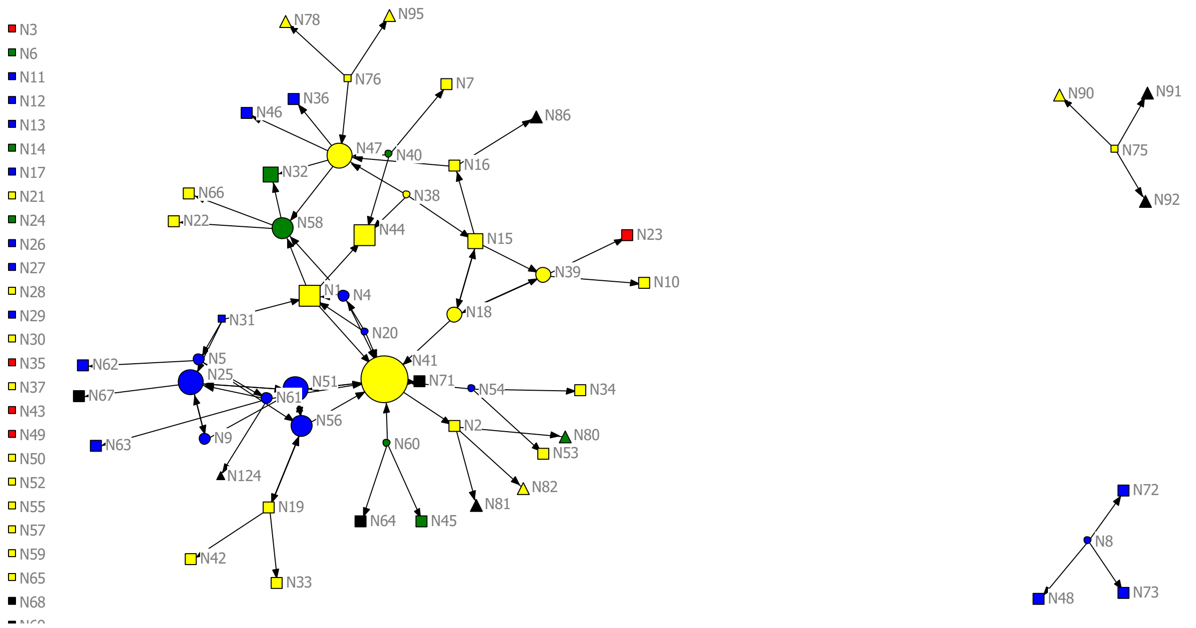

Figure 6: Visualisation of SHARE network for November 2017. Isolates listed on the left of the visualisation. Node colour represents OEH Division/ Group or organisation. Red = Heritage; Yellow = NPWS; Green = Regional Operations; Blue = Science; Black = non OEH. Node shape represents attendance: circle = attended; square = did not attend; triangle = not in this time period. Arrow direction indicates whom the node shares information with.

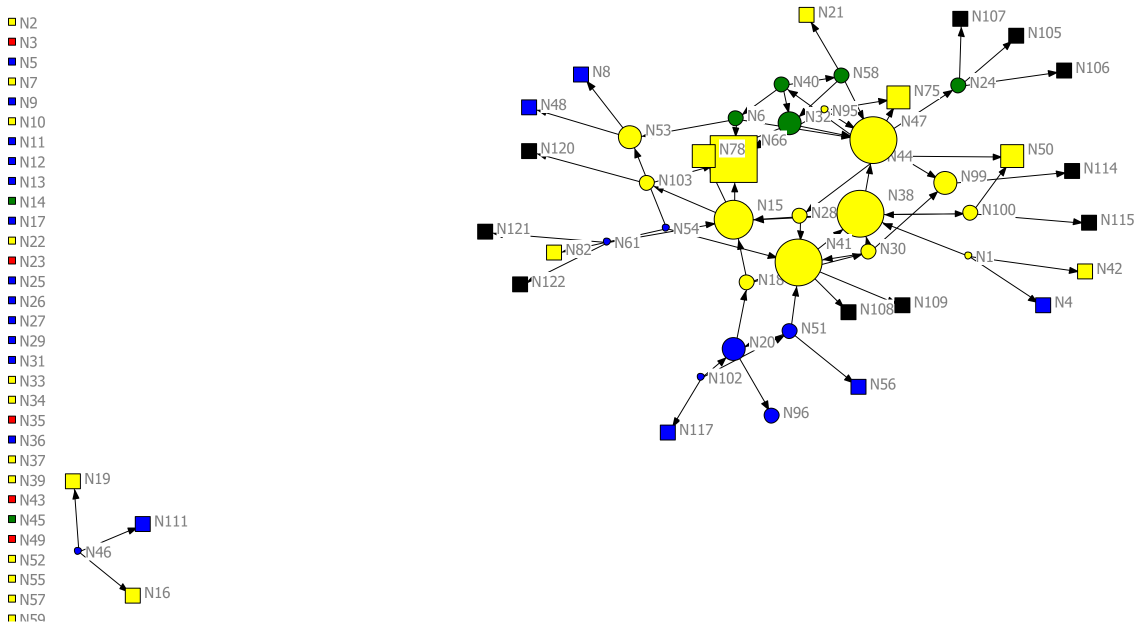

Figure 7: Visualisation of SHARE network for June 2018. Isolates are listed on the left. Node colour represents OEH Division/ Group or organisation. Red = OEH Heritage; Yellow = OEH NPWS; Green = OEH Regional Operations; Blue = OEH Science; Black = non OEH. Node shape represents attendance where circles = attended; square = did not attend. Arrow direction indicates whom the node shares information with

Multiple cohesion measures for the SHARE network were similar or the same over time (Table 8). Results may have been affected by the declining response rate. Different participants also provided data each time so the lack of difference may reflect varied responses by different individuals. Density and closure did not change, and decreases in average degree and diameter, and increases in fragmentation were small, indicating participants shared information with similar numbers of people over time.

The composition of key players in the SHARE network changed, and their number and reach declined between November 2017 and June 2018 (Table 9). In November 2017, four of the seven key players were from NPWS, with the rest from Science. By June 2018, an NPWS scientist (N47) remained one of the five key players with others being replaced by scientists (n=2) and a manager from Science, and a different NPWS manager (N38).

Table 10: Key players (diffuse) in the SHARE network over time; and percent of nodes reached for each key player query run (Run)

TIME	RUN	KEY PLAYER	KEY PLAYER	KEY PLAYER	NODES REACHED (%)
Nov 2017	1	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	N72 (Manager, Science)	36.4
	2	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	N73 (Scientist, Science)	36.4
	3	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	N75 (Environmental management officer, NPWS)	36.4
	4	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	N8 (Scientist, Science)	36.4
	5	N41 (Manager, NPWS)	N47 (Scientist, NPWS)	N90 (Project officer, NPWS)	36.4
Jun 2018	1	N102 (Scientist, Science)	N38 (Manager, NPWS)	N47 (Scientist, NPWS)	31.4
	2	N20 (Scientist, Science)	N38 (Manager, NPWS)	N47 (Scientist, NPWS)	31.4
	3	N38 (NPWS)	N47 (Scientist, NPWS)	N51 (Manager, Science)	31.4

3.4 Survey results

A total of 22 people (73%) provided feedback about the meeting on 25 July 2017. Respondents were from Heritage (1), NPWS (6), Regional Operations (1) and Science (10). Four respondents did not nominate a Division/ Group. The opportunity to meet colleagues from across the organisation was considered the best part of the meeting. All respondents said they met at least one new person. Half those who attended (50%, n=11) met 1-5 new people at the meeting, eight respondents (36%) met 6-10 new people, and three respondents (14%) met more than 10 new people. Respondents said they would have liked more time to network during the meeting.

A total of 10 people gave feedback (of the 18 who attended) on the workshop in November 2017. Respondents were from NPWS (3), Regional Operations (2) and Science (5). They said the best part of the workshop was meeting colleagues and participating in the discussion. Everyone who responded said they met new people, with most respondents (80%, n=8) saying they met 1-5 new people, and the rest (20%, n=2) meeting 6-10 new people.

4. Discussion

Our analysis demonstrated the value of exploring and evaluating social dimensions of knowledge management when planning a collaborative research program. Social Network Analysis (SNA) visualised the informal knowledge network of staff involved with the alpine region in an Australian state government organisation which was invisible without the analysis. The visualisations were crucial for beginning a conversation about knowledge sharing across the organisation. The SNA also helped evaluate the knowledge network by revealing its structure supported long-term planning and knowledge sharing. The analysis also identified people with knowledge brokerage roles who were crucial in bridging the divide between different cultures. These insights will be invaluable in transitioning the network from planning, scoping and prioritising, to implementing a coordinated program of collaborative research.

4.1 ALPINE network

Although it is assumed that knowledge flows freely within organisations, this is often not the case. Information can get stuck or siloed in different segments of society and within parts of organisations (Cunningham, Jacobs and Measham, 2021). There can also be a striking contrast between a person's position in the formal hierarchy and in the informal knowledge network (Cross, Parker and Borgatti, 2002). For the first time, our analysis visualised connections in the ALPINE network so members could see their position in the informal structure, and links and/or divisions between groups. We found that showing the visualisations to people in the network stimulated discussion about how to improve knowledge sharing. This was an unexpected benefit of the analysis.

As expected, the ALPINE network illustrated homophily which means similar actors were attracted together and have more contact with each other (Wood, et al., 2014). Homophily is common in social networks (McPherson, Smith-Lovin and Cook, 2001). In July 2017, Science staff, in particular, were clustered together (Figure 1) and, in June 2018, NPWS staff were drawn together (Figure 3). People who are similar often have mutual understanding which reduces cognitive distance so they can better share complex information that relies on tacit knowledge (Prell, Hubacek and Reed, 2009; Wood, et al., 2014). Homophily also has a role in innovation. For example, innovation is initiated by interpersonal discussions between close colleagues which are most influential when there is uncertainty (Wood, et al., 2014). Cvitanovic, et al. (2015) highlighted the need for institutional innovation by decision-making agencies and research institutions to overcome barriers in knowledge exchange in Australian adaptive resource management. They noted that innovation is required to legitimise, recognise and reward knowledge exchange activities by research scientists. Therefore, the work by (the former) Office of Environment and Heritage (OEH) in New South Wales (NSW), Australia, is to be applauded for recognising and legitimising knowledge exchange activities by establishing the ALPINE network. The stated aim was to use the network to create a collaborative research program to inform management by OEH of the alpine region.

Homogeneity between groups can also enhance transfer of tacit knowledge (Cross, Borgatti and Parker, 2001). Before our research, NPWS and Regional Operations were more homogenous than Science (Figure 1) which suggests better knowledge transfer within clusters than between. High levels of homogeneity can also reduce diversity and limit access to distant resources (Krackhardt and Stern, 1988 in Crona and Bodin, 2006). Therefore, the ALPINE network needs to be monitored into the future to track homogeneity, and its impact on access to resources.

The visualisations also showed individuals who disrupted the pattern of homophily. For example, an individual from NPWS appeared within the Science cluster (N55), and two individuals from Regional Operations (N40, N58) appeared within the NPWS cluster (Figures 1, 2, 3). Their positions in the network probably result from secondments and transfers, illustrating the importance of movement in an organisation to build social connection, disrupt homophily and improve the knowledge flow across boundaries. Dowd, et al. (2014) found individuals in Australian primary industries who sought ties with people “outside their peer groups, geographical locations and industry boundaries” were more likely to be transformational adaptors and undertake purposeful action that created significant structural or functional change. Therefore, to find novel solutions to the challenging environmental issues within the alpine region, leaders of the state government knowledge network must consider ideas from individuals who disrupt patterns of homophily.

Those who attended meetings became more central and grew connections over time (Figures 1, 2 and 3). Hoffman, Lubell and Hills (2015) also found participation in outreach events correlated with network centrality, i.e. the more outreach activities a person attended, the more knowledge sharing relationships they had. This supports results from both the SNA and the surveys because respondents who attended meetings reported they met new people in the network and valued the opportunity to do so. It is pertinent that Obstfeld (2005) found social knowledge (not technical knowledge) was a significant predictor of involvement in innovation. Therefore, it is likely that innovation was fostered during the planning phase of the alpine research program – as leaders hoped.

Individuals with high degree centrality can help mobilise a network and bring others together (Prell, Hubacek and Reed, 2009), suggesting those with high centrality in the alpine research network in June 2018 would be effective members of a Steering Committee to progress the work. However, highly central individuals can also be more influenced by and embedded in their own group (Prell, Hubacek and Reed, 2009) and less influenced by other groups. Therefore, future research on the ALPINE network should monitor behaviour of people identified as central individuals to ensure they foster knowledge sharing and do not function as road blocks.

Goggin, et al. (2015) found state government scientists in NSW, Australia, had extensive knowledge networks. We also found the ALPINE network had connections to external sources of information with 19-25% of individuals in the SEEK network and 14-22% of individuals in the SHARE network nominated from external organisations (Table 6). As mentioned above, Dowd, et al. (2014) found those with far-reaching knowledge networks were more likely to make transformational change in Australian primary industries. Therefore, staff with more external contacts may be more likely to implement novel strategies and options. Innovation in organisations is also fostered by creating new social connections between people, their resources and ideas that combine in new ways (Obstfeld, 2005). Therefore, continuing to encourage novel and existing ties in this homogenous network is likely to allow the emergence of innovative strategies and options to address management challenges in the alpine region.

In general, NPWS staff became better connected in the ALPINE network over time, while Science staff became less connected (Figures 1, 2, 3). It is likely more staff in NPWS have expertise, experience and/or responsibilities for the alpine region than other groups because staff work directly with park management and are based adjacent to the alpine region. It is also possible that NPWS staff renewed and strengthened existing social connection with each other but failed to build new trusted connections beyond their group. Haynes, et al. (2011) found researchers who influenced public health policy in Australia had a personal relationship with policy makers, i.e. they were trusted. Goggin, et al. (2019) also found trusted connections improved knowledge exchange in Australian environmental programs. At the time of this research, the network was still in the planning phase, and yet to transition to implementing research priorities. Research suggests (Goggin et al., 2019; Cvitanovic, McDonald and Hobday, 2016) that new trusted connections between groups will form in the next phase of the program as staff from across the organisation work together to co-design and undertake projects. Of more concern, is that Heritage staff remained disconnected to the network throughout our research. This disconnection needs to be addressed to ensure social and heritage issues are included in a future alpine research program.

The analysis revealed the ALPINE network is likely to support its goal of developing a coordinated program of collaborative research that informs management. The network was decentralised which is conducive to long-term planning and collective problem-solving (Prell, Hubacek and Reed, 2009). The density (or cohesion) of the ALPINE network also increased over time (Table 4). Strong networks with high density (or cohesion) have the optimal structure to generate, acquire and spread knowledge, particularly factual, tacit knowledge (Long, Cunningham and Braithwaite, 2013; Crona and Bodin, 2006). Since the network became more dense (cohesive) over time, it is likely that tacit knowledge could be shared more efficiently through the network as people built connections. Dense networks are also effective for implementing action (Wineman, Kabo and Davis, 2009) which will be required as the network transitions from planning a program of research to undertaking it.

The SNA indicated the ALPINE network improved knowledge transfer over time. The network remained dynamic during the 12 months of the analysis, with people joining and others becoming inactive. This suggests the network continued to form and storm but was yet to 'norm' so it could better perform (Tuckman and Jensen, 1977). The network became less fragmented over time, indicating there was better connection between individuals and it was less vulnerable to change (Borgatti, Everett and Freeman, 2002; Prell, Hubacek and Reed, 2009). The average degree of the ALPINE network also increased (Table 3) indicating each individual was connected to more people. These measures bode well for the future of the alpine research network.

Betweeness explores the brokerage role of individuals. Actors with high betweenness have the most holistic view of a problem (Prell, Hubacek and Reed, 2009) so it is encouraging that, in July 2017, a manager from Science and one from NPWS had the highest betweenness scores (Table 2). The NPWS manager stayed involved in the ALPINE network for the 12 months and maintained a high betweenness score reflecting their diverse links throughout the network and continued role in knowledge brokering. In contrast, the Science manager moved to a different role in the organisation and no longer had responsibility for the alpine region; the change is reflected in the decline of their betweenness score. Long, Cunningham and Braithwaite (2013) found brokerage can mediate and resolve conflict, make knowledge more accessible and create environments where collaboration flourishes. However, there are different types of brokerage behaviour; mediation brokers help coordinate and transfer information between individuals while separation brokers maintain an advantageous disconnect between them (Grosser, et al., 2019). There are also challenges in measuring efficacy of knowledge brokers (Cvitanovic, et al., 2017). We recommend brokerage behaviour is investigated in the future to ensure knowledge brokers are functioning as mediators in the alpine research network. We also recommend further research into measuring the efficacy of knowledge brokers.

Key players may have the greatest reach and potential influence in a network (Cunningham, et al., 2017). The composition of key players in the ALPINE network changed over time, shifting from staff in NPWS, Regional Operations and Science (in July 2017), to those in NPWS and Science (in Nov 2017) and then to NPWS staff only (in June 2018). A manager from NPWS (N41) maintained their position as a key player throughout the 12 months with two scientists from NPWS (N18, N47) emerging as key players by June 2018. The changing composition reflects the shifting dynamics of the ALPINE network and changing dominance from Science staff to NPWS staff. It may also indicate better integration of social science into the network because one of the new key players was a social scientist. This is an encouraging development for the network because socio-economic research is often overlooked when determining research priorities but is critical to improving environmental outcomes (Robinson, et al., 2019).

The number of key players needed to reach most nodes in the network decreased over time. Initially, 17 key players were needed to reach 69% of the network but one year later, only three key players were needed to reach the entire network (Table 4). This suggests there may be some resiliency or redundancy in the network after 12 months. The composition of the ALPINE network will be reviewed as a result of this analysis to avoid duplication.

4.2 SEEK and SHARE networks

There was little change in multiple cohesion measures of the SEEK or SHARE networks over time (average degree, density, fragmentation and diameter stayed similar) (Table 7). The greatest shift was increasing closure of the SEEK network suggesting more individuals sought information from similar individuals. This suggests there is more work to be done to build connections in the network. Increasing the number of meetings could have improved these measures, but face-to-face meetings were costly and had to be limited.

Knowledge brokers are often suggested as a way to bridge the divide between different cultures. They can help build relationships of trust and facilitate transactions between actors who lack access to or trust in one another (Long, Cunningham and Braithwaite, 2013; van Kammen, de Savigny and Sewankambo, 2006). Most people in the state government research network sought information about the alpine region from scientists (Table 7).

Some scientists from NPWS (N47) and Regional Operations (N32, N58) (Figure 4, 5) remained important sources of alpine information over time. However, no scientists from universities or research organisations were nominated more than once (Table 7), suggesting the network could improve links to external sources. People also sought information from managers, particularly in NPWS (N38, N41). These individuals functioned as bridges between groups, and probably gained social capital from their role (Long, Hibbert and Braithwaite, 2013).

One manager from NPWS (N41) held a pivotal role in the network. This individual remained a source of alpine information, was frequently nominated as someone who people shared information with, and was identified as a key player throughout the analysis. In addition, an NPWS scientist (N47) was also identified as a key player in the ALPINE network in June 2018 (Table 4) and frequently nominated in the SHARE network in November 2017 and June 2018 (Table 7). Therefore, the NPWS manager (N41) and NPWS scientist (N47) hold influential positions in the network. There are risks with having a few key players in a network. Prestigious and successful individuals can spread unproven or ineffective ideas and practices in a knowledge network (Hoffman, Lubell and Hills, 2015; Henrich, 2001). Therefore, influential individuals particularly when they are "embedded" in a group (Prell, Hubacek and Reed, 2009) need to seek knowledge from different and diverse stakeholders. Access to information increases the ability to facilitate action that differs from social norms, and plan and implement novel strategies and options (Dowd, et al., 2014). So, although it is important to integrate existing knowledge in the network, it is also vital that key players widen their knowledge network to new sources. The influence of these key players needs to be harnessed in the research network by inviting them to join Steering Committee for the research program. Their knowledge brokerage behaviour also needs to be monitored (Long, Cunningham and Braithwaite, 2013) to ensure they are fostering knowledge flow and not hindering it.

The reach of key players remained similar over time in both the SEEK and SHARE networks. However, key players in the SHARE network had more reach than those in the SEEK network. This suggests people share with fewer well-connected individuals and seek information from a broader network. This is encouraging for the alpine research network because individuals are drawing information from diverse sources which is being consolidated by sharing it with a few key individuals. Weak ties are also important for innovation (Granovetter, 1973). However, as discussed above, there are risks associated with only a few key individuals in a knowledge network.

Individuals in the ALPINE network sought and shared information with a majority of NPWS staff over time, with fewer (but similar numbers of) staff from Regional Operations nominated in both networks over time. In contrast, the number of Heritage and Science staff nominated in both networks declined over time, suggesting Heritage and Science Divisions became less connected to the network. This suggests the expertise of Science and Heritage staff is not well known. It is also likely that staff in the network continue to seek and share information with existing connections, and have not yet formed trusted connections in other Groups/ Divisions as a result of the meetings. Therefore, the organisation must continue to foster connection between staff from different groups (particularly with Heritage Division) and build social connection, so their relevant expertise is highlighted within these groups and in turn can inform the development of the research program. In these instances, there may need to be organisational intervention to encourage additional collaboration between these groups (Cross, et al., 2001).

Information about the alpine region was often shared with managers, particularly in November 2017 when most individuals (seven of 11, 64%) who were nominated frequently in the SHARE network were managers (Table 7). By June 2018, more than half (four of seven, 57%) the individuals nominated frequently were managers, with most from NPWS. No Science or Regional Operations staff were nominated more than twice, and no Heritage staff were nominated, suggesting the network was contracting. It may also reflect that Science staff helped coordinate the network at the start, but later many of them stepped away because few of them have experience or responsibilities for the alpine region. Regardless of the cause, it highlights a gap in knowledge sources informing the alpine program, and it is recommended that connections beyond NPWS to Regional Operations, Heritage and Science Divisions are encouraged. A research program will only be considered legitimate if it is developed through a process that considers the values and perspectives of all relevant actors (Cook, et al., 2013).

5. Conclusion

Leaders and managers need to integrate a diversity of knowledge and values into their decision making for effective environmental management (Jacobs, et al., 2016, Easterbrook, 2012). This challenge is particularly difficult for managers within government organisations because social connections are invisible and the role of staff as knowledge brokers may not be recognised (Fliervoet et al., 2016; Cross, et al., 2001). We found Social Network Analysis (SNA) allowed invisible connections to be uncovered; to analyse and visualise the dynamics of this government research network. Longitudinal SNA enabled us to measure growth in social connections and identify individuals with knowledge brokerage roles. The results of the analysis will be invaluable in transitioning the network from the planning to the implementation phase, and ensuring it creates a collaborative program of research that is considered legitimate and also addresses the multiple challenges in the alpine region.

Our analysis highlighted risks and opportunities for the network if it is to achieve its aim of fostering knowledge exchange. It revealed the government research network is building more and stronger connections between participants. The network also had connections through both the SEEK and SHARE network to external sources of information which are likely to be sources of novel ideas. However, individuals continued to seek and share information with existing (trusted) connections, particularly from one group which could limit new innovative solutions to the challenging management issues in national parks in NSW. The behaviour of key players also needs to be studied to ensure they are fostering, not hindering, knowledge exchange. Additional research on measuring the efficacy of knowledge brokers is also recommended Future planning will draw on the influential individuals identified as key players in the ALPINE, SEEK and SHARE networks, while continuing to track their roles and undertake research to understand their knowledge brokerage behaviours and effectivness.

In conclusion, our analysis provided insight to manage the research network so it integrates diverse sources of knowledge into environmental management of a unique Australian region. Our results suggest that with ongoing collaboration, a deepening of shared knowledge, and appropriate adaptation policies, the network may achieve its goal of building a coordinated program of collaborative research that informs management and improves condition of the natural, socio-economic and heritage values of the alpine region.

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Knowledge Management and Academic Performance in Indian Public Schools

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Abstract: Knowledge Management (KM) systems were implemented widely in corporate organizations for past three decades, but there is little research on KM in schools. The key objectives of this study are to identify the major components of School Knowledge Management and analyze the impact of KM in secondary education on academic performance, based on the perception of school teachers. The survey-based study is conducted in government schools of an Indian State. Exploratory Factor Analysis and Binary Logistic Regression methods are used to identify the KM factors and their impact on academic performance. This study identified the processes and enablers of school KM and its impact on academic performance. Academic performance, being mentioned as the primary outcome of School KM has not been empirically tested from a School KM perspective earlier. Knowledge creation, technology infrastructure and teacher's competency are identified as KM variables that can significantly influence the Academic Performance and therefore the schools can initiate policies and methods to improve these vital factors.

Keywords: School Knowledge Management, Academic Performance, Secondary Education, Logistic Regression

1. Introduction

Knowledge Management (KM) is a concept that prominently arose in the 1990s. KM initiatives in organizations primarily target on improved performance, competitive advantage, innovation, organizational learning, process integration and continuous improvement of the organization (Davenport and Prusak, 1998; Hatch and Dyer, 2004; Wiig 2004). KM was important in improving the performance of human resources in corporate organizations, both manufacturing and services. But KM in education is comparatively under-researched especially in schools as, they lagged behind to accept KM as a practice (Chu, 2016a; Supermane and Tahir, 2018). Therefore, this study analyzes KM in education, focusing on the government schools in India. School KM was well defined by Cheng (2015) as a set of relatively new organizational activities that make use of knowledge as an important resource to improve organizational behaviours, collaborative learning, student learning, teaching processes, improved decisions and collegial relationships that enable schools to improve their overall performance.

During 1990s the concept of learning organizations received more attention as a way to restructure educational organizations in terms of better autonomy and improved academic performance (Fullan and Fullan, 1993; Vandenberg, 1993; Louis 1998; Karsten, Voncken and Voorthuis, 2000). It was identified that rather than implementing planned projects for change, the schools should themselves bring change with each team member contributing to change through learning initiatives (Karsten, Voncken and Voorthuis, 2000; Fauske and Raybould, 2005).In this context KM acts as that management practice whose objective is to enhance the organizational learning process in schools for creating a sustainable innovation system through various processes such creation, storage, sharing and application of knowledge (Firestone and McElroy, 2004). Schools can therefore be also called knowledge organizations where teachers, students, parents and staff form the major stakeholders and the role of teachers as knowledge workers is more significant (Tahir *et al*., 2013).

The education sector in India can be classified into three levels namely school education, graduation and higher education. There are private schools managed by private stakeholders and also public schools purely organized and managed by the government. A vast majority of the Indian students depend on public education because of low cost and accessibility compared to private schools. As far as the economic and social growth of a nation is concerned, the opportunity and quality of secondary education need to be focused on as they contribute significantly to the social, cultural, moral and technological orientation of an individual (Chu, 2016a). Many international and national organizations have started considering the importance of secondary education for developing a creative and skilful youth.

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The EFA Global Monitoring Report 2015 presented by UNESCO, with the theme "Education for all', clearly states that the educational priorities and actions initiated after 2015 would be intended to contribute to the final formulation of 'Sustainable Development Goals' in education. The first goal is stated as follows: 'By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes'. This decision was as a result of observation of outcomes from various assessments conducted at national and international levels on quality of secondary education. It is alarming to find that millions of children struggle to acquire even minimum levels of basic skills, which indicates a lack of planning on educational quality improvement (EFA Global Monitoring Report, 2015). Although the secondary curricula have the potential of providing spaces for exploration and experimentation, they are hardly implemented in the majority of cases. This results in long-term consequences where students lack the pragmatic skills to excel in future.

Now from a national perspective, in India, The Ministry of Human Resource Development (MHRD) has taken a number of initiatives including various Centrally Sponsored Schemes (CSS) to enhance quality of education in 2014. About Secondary Schools (IX-X) under the educational scheme, one of the priorities is to improve the quality of secondary education despite providing educational access to more students in the country. Financial assistance is provided to public schools to improve the physical and academic infrastructure and also for managing all issues of pedagogy focusing on academic performance through professional development of teachers, teaching methodology, assessment and evaluation methodology, teacher training, research in pedagogy, curriculum design and effective pedagogy.

In this context, it is important to analyze the KM practices in Indian public schools. Therefore, the key objectives are to identify the major factors of School Knowledge Management and analyze the impact of KM in secondary education on academic performance, based on the perception of school teachers. Though academic performance was defined in the context of higher education referring to universities, it is also equally relevant in school education. Academic performance in schools is defined as the display of knowledge or skills of students in schools subjects or any expression used to represent students' scholastic achievement (Adediwura and Tayo, 2007). The first objective is to identify the KM practices followed in the Indian context, as the variables of School KM are identified from the past studies conducted in other geographical contexts. Though a few studies were conducted in the past to identify the scope of KM in schools and its variables, a predictive analysis of the impact of these variables on academic performance of students remains neglected except for the study done by Cheng (2012) in Hong Kong secondary schools that focused on knowledge strategies from a process perspective. Besides, the recent studies conducted on School KM focused on strategic outcomes of KM including school learning capacity, KM leadership, Teacher Competencies, School effectiveness in terms of career development, initiatives for implementation of KM and Capitalising School knowledge (Cheng, 2012; Chu 2016a; Chu 2016b; Shih and Tsai, 2016; Cheng, 2017; Supermane and Tahir, 2018; Hallinger, Liu and Piyaman, 2019), ignoring the impact of KM on academic performance of the students. This study identified the possible processes and enablers of school KM comprehensively involving all the internal dimensions (curriculum standards, teaching process, learning initiatives, collaborative learning, shared culture and leadership support) and its impact on academic performance.

The scope of School KM had only been explored in the Asian context and needs to be researched in European and western context as well. As school education is demanding a rigorous revamp in terms of technology and virtual learning, this study would add value to the implementation of effective KM systems in schools.

2. Literature Review

2.1 Knowledge Management

Knowledge resources are strategic assets that play a significant role in differentiating an entity from competition through the dynamic process of knowledge creation (Drucker, 1966: Nonaka and Takeuchi 1995). In organizations, knowledge is managed through organizational routines, processes, practices and norms (Davenport and Prusak, 1998). Gartner Group (1998) defined KM as a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an organization's information assets. The KM processes such as creation, generation or acquisition support the management of explicit knowledge and enhance organizational learning (Firestone and McElroy, 2004; Jain and Moreno, 2015). Lee and Choi (2003) had defined that KM factors include enablers, processes and organizational performance. KM process represent basic operations of knowledge, whereas KM enablers are influencing factors that are necessary to provide the infrastructure to increase the efficiency of KM (Lee and Choi, 2003).

In the case of corporate organizations, KM inside and outside the organization's boundaries contributed to the value chain with the purpose of achieving corporate objectives efficiently (Davenport 1994; Nonaka and Takeuchi, 1995; Nonaka and Teece, 2001; Alavi and Leinder, 2001; Drucker 2001; Dalkir, 2005; Chen and Chen, 2006; Magnier-Watanabe and Senoo, 2008; Shakerian, Dehnavi and Shateri, 2016; Lim *et al*., 2017). KM is also identified to be significant in the public sector contributing to effective policymaking and better service delivery (Cong and Pandya, 2003; Reige and Lindsay, 2006; Pee and Kankanhalli, 2016). Rapidly evolving technology has paved the way for innovations, which also depended on KM in organizations both inter-and intra-organizationally (Obeidat, Al-Suradi and Tarhini, 2016). Sallis and Jones (2002) explained how educational institutions can benefit from KM as the business of education itself is knowledge. Education again can be categorized from primary education to higher education and universities, where the KM practices vary with differences on the institutional objectives. Schools as learning organizations were focused seriously because the ideology reoriented the nature of learning and learning outcomes creating a broader impact on society (Giles and Hargreaves, 2006). Though the idea of schools becoming a learning organization is interesting, schools still have many obstacles such as improving internal communication, regular review of learning experiences, better leadership, addressing the local environment and considering the interests of clients and other stakeholders (Karsten, Voncken and Voorthuis, 2000; Fauske and Raybould, 2005; Tahir *et al*., 2013).This requires the implementation of systematic KM process to streamline the learning initiatives.

2.2 KM in Schools

KM systems were implemented widely in corporate organizations since the late 1990s, but research on the integration of knowledge practices in schools are few (Fullan, 2002; Lee, Lu, Yang, 2010; Chu, 2016b; Supermane and Tahir, 2018).The role of internet technology and the increasing digitization have increased the complexity of educational practices which made it critical for school organizations to introduce KM (McKenzie, Truc and van Winkelen, 2001; Richard, 2001; Kuo, 2003). School KM was well defined by Cheng (2015) as a set of relatively new organizational activities that make use of knowledge as an important resource to improve organizational behaviours, decisions, student learning, teaching processes and collegial relationships that enable schools to improve their overall performance. KM and conversion process between tacit and explicit knowledge illustrated by SECI model (Nonaka and Takeuchi, 1995) which can be applied in any industry is also relevant in managing the schools. SECI model explains a set of processes such as Socialization, Externalization, Combination and Internalization, which results in effective creation, transfer, storage and application of organizational knowledge. Joia (2002) conducted study in schools using the SECI to evaluate the knowledge creation and sharing process and their impact on skill development of teachers. The Socialization process enables the creation of new tacit knowledge when internalized knowledge is shared. The externalization helps in converting this tacit knowledge to explicit knowledge through practices of lesson plans, classroom sessions and other learning activities. The documentation of these activities helps in the codification of knowledge and the knowledge embedded in the structural capital get internalized in the next phase. Several factors enable the effectiveness of KM in schools such as leadership support, sharing culture, competency of people and technology infrastructure (Rodrigues and Pai, 2005). Leung (2010) found that leadership and change management, strategies and goals, organizational learning, technical support, school culture and trust among teachers are the critical factors affecting KM in the school context. School leaders need to know their school's overall intellectual capital, not only on an individual level, but about the whole school structure and culture and take strategic initiatives to improve the academic performance (Hargreaves, 1999; Tahir *et al.,* 2013; Chu,2016b). It is the responsibility of the leader(principal) to assess the staff, existing practices and infrastructure before initiating KM in schools (Chu, 2016a; Chu, Wang and Yuen, 2011). Newman (2000) explains five components as function of ‘school capacity', namely, individual teacher knowledge, skills and dispositions, professional learning community (across teachers), program coherence, technical resources, and principal leadership.

Teachers are knowledge workers and can therefore act as sources of knowledge creation. The existing pedagogy involves a tinkering process where teachers undergo a ‘trial and error’ activity in their classroom. When such tinkering becomes more systematic, more collective and explicitly managed, it is transformed into knowledge creation and generates learning, even if successful knowledge transfer does not occur (Hargreaves, 1999). Another important phase of KM in school is knowledge sharing, as it can transform the teaching profession in intellectual and moral aspects also in developing a collegial knowledge culture in schools (Fullan, 2002; Chu, 2016b). This is possible only if organizations have a sharing culture that promotes a collaborative environment for discussions. However, this is not prevalent in many schools (Harris, 2001) and management intervention and supportive leadership may be necessary to enable mutual support among the teachers to learn and grow. A collaborative environment for teachers to share ideas and provide mutual support offers the potential benefits of raising teacher confidence, facilitating teacher learning and embedding improvements in professional practice within the classroom (Rhodes and Beneicke, 2002). But it is the sole responsibility of teachers to ensure their teaching effectiveness. Teachers should regularly update themselves with new information and enhance their knowledge. Benefits of KM based on teachers perceptions include facilitating students' learning, understanding students capability, gaining practical knowledge, facilitating teacher collaboration for knowledge creation, nurturing a sharing culture in the school, creating new knowledge and keeping abreast of new knowledge, compiling expertise from teachers and better document management (Azman, 2003; Chu, 2016). Rodriguez and Pai Model (2005) on KM strategies for school education include eight variables namely: Leadership and Support, Technology and Infrastructure, Knowledge Creation, Acquisition and Learning, Dissemination and Transfer, Application and Exploitation, People Competency and Sharing Culture. These eight dimensions include most typical KM enablers and processes. Chu, Wang and Yuen (2011) used this model to explore the factors of KM implementation in a secondary school in their qualitative study. Compared to the private sector, public sector organizations are challenged by the knowledge hoarding generated by the conventional mind-set of people and hence need to focus on improving organizational culture that supports knowledge creation (Joshi, Jamal and Chawla, 2013; Jain and Jeppesen; 2013). KM in public schools also faces the same challenges. But there are several benefits that public sector organizations can acquire through ideal KM practices which can also be effectively applied in education. Some of them are clearly defined by Cheng (2015) such as improving organizational behaviours, decisions, better pedagogy, student learning, etc. Overall challenges that are faced by public schools in developing KM include the technological limitations in school systems, the lack of time for teachers to facilitate outside the classroom, and budgetary constraints (Edge, 2005).

Cheng (2012) had already identified knowledge retrieval, utilization and sharing as the predictive factors for individual learning capacity and school learning capacity. Applying KM makes the KM processes such as creation, sharing and application create a sound foundation for academic performance of students and performance in other areas and for the school's development as a whole (Zwain, Lim and Othman, 2012; Cheng, 2013; Shih and Tsai, 2016). Shih and Tsai (2016) combined both processes and enablers as predictors of School KM. But the impact of KM on academic performance was not empirically tested in this study; instead, it focused on the strategic outcome such as perceived school effectiveness of career. Cheng (2017) further explored how KM can generate human capital in school organizations. Supermane and Tahir (2018) researched how KM can improve teaching quality and learning initiatives. This study is indeed a shift from studies focusing on strategic outcomes to immediate outcomes that can significantly contribute to strategic goals. Another immediate impact of KM that was not empirically tested is academic performance. This was rather considered to be obvious to achieve, but it is important to explore the effect of the KM processes and enablers on academic performance as it would help the school organizations to improve on every level of KM initiative and make changes wherever required.

Adediwura and Tayo (2007) defined academic performance in schools as the display of knowledge or skills of students in schools' subjects or any expression used to represent students' scholastic achievement. Academic performances are usually assessed or rated based on examinations scores/report card grades (Adediwura and Tayo, 2007; Brackett *et al.,* 2012). The attributes 'grades' and 'attendance' are relevant for predicting the end of the year academic outcomes of student performance and these grades are based on analysis of discipline and elaborate written communication which was contemporarily improvised include mathematical and aptitude skills (Marks and Louis,1997; Luiselli *et al.,* 2005; Fernandes *et al.,* 2012). Though grades are used to objectively evaluate academic performance, the subjective evaluation of the teachers are also well correlated with this objectivity. Meissel, Meyer, Yao and Rubie-Davies (2017) explored the relations between standardized tests and teachers' judgments about student scholastic achievement and identified a strong correlation between the two measures.

3. Methodology

The study is empirical and the data is collected from the secondary school teachers to analyze their perceptions of existing KM practices. The study is done with the support of a structured questionnaire which included five-point Likert scale questions based on KM variables identified from past literature. The variables were identified from the qualitative research done by Chu, Wang and Yuen (2011) on KM in a secondary school at Hong Kong using the Rodriques and Pai Model. The authors of this study had indicated the scope of further survey-based studies on these KM variables in a different context for better clarity of learning outcomes in schools. Moreover, the model has comprehensively identified all the major KM processes and enablers that are significant to secondary education from teacher's perspective. Some questions and statements were adapted from qualitative studies of Cheng (2015) on KM in school education. Table 1 illustrates the variables formulated from existing works of literature on teaching and education.

Table 1: Variables of School Knowledge Management

Item	Variables
1	Curriculum standards and quality (Chu, 2016b)
2	Management and leadership support (Hargreaves 1999; Harris,2001; Tahir *et al.,*2013)
3	Principal's Coordination of activities (Harris,2001)
4	Use of Information and Communication Technology (ICT) (Haughey, 2006).
5	Freedom to develop lesson plans (Newmann,2000)
6	Regular update of subject knowledge (Tahir *et al.,*2013;Petrides and Nodines, 2003)
7	Seminars, Workshops and Trainings (Tahir *et al.,* 2013)
8	Support of fellow teachers (Rhodes and Beneicke, 2002; Azman, 2003)
9	Innovative methods in teaching (Haughey,2006)
10	Regular feedback from students (Chu, 2016).
11	Collaborative environment for open discussion (Dixon, 2000; Paraponaris *et al.,* 2015; Chu, 2016a).
12	Access to alumni (Chu, 2016b).
13	Technology oriented evaluation and reporting (Haughey, 2006; Chu, 2016).
14	Evaluation of teaching methodology (Petrides and Nodines, 2003)
15	Teacher's self-satisfaction on their teaching skills(Newmann,2000)
16	Support for new teachers (Rhodes and Beneicke, 2002).
17	Free Internet access (Paraponaris *et al.,* 2015)
18	Data-driven decisions and interventions by principal (Haughey,2006)
19	Support of administrative staff (Chu, 2016).
20	Appraisal of student suggestions (Paraponaris *et al.,* 2015)
21	Principal's support for teachers (Hargreaves, 1999; Tahir *et al*., 2013).

The scope of the study is limited to the secondary school teachers of government schools in the Kasargod district of Kerala state. Kerala is the southern state of India with high Human Development Index (HDI) and good literacy rate compared to other Indian states. The district has a total of 90 Government Higher Secondary Schools with an average of 7 secondary school teachers in each school. The list of these 90 schools were taken from the official website of Kerala Government. Out of these 40 schools are rural (44%), 32 schools semi-urban (35%) and 18 schools are urban (21%). But out of 40 rural schools, 10 schools were excluded in the study as they are geographically located in remote areas and are not easily accessible for the researchers. A proportionate stratified random sampling method is used where 28 schools were identified as the stratified sample (13 rural schools, 11 semi-urban schools and 4 urban schools). The random number generator is used in the list of the schools to create the final list for the survey. But due to practical difficulties of getting official approval, we could collect data from 18 schools only. Therefore, a stratified random sample of 175 respondents from 18 Government Schools of Kasargod district constituted the study. The study is purely based on the perception of school teachers on School KM. The researcher personally visited the schools, distributed and collected the questionnaires from teachers.

4. Data Analysis

It was important to identify the key factors of KM in secondary education based on the interrelated variables and therefore, factor analysis was conducted using SPSS v.20. A Principal Component Analysis with varimax rotation was adopted. Exploratory factor analysis requires certain basic assumptions to be satisfied namely multivariate normality and sampling adequacy (Bryant and Yarnold, 1995; George and Mallery, 1999; Lattin, Carroll and Green, 2003). The KMO Bartlett test includes Bartlett test of sphericity that measures the multivariate normality of variables in addition to analyzing whether the correlation matrix is an identity matrix (i.e., a spherical set of multivariate data) (George and Mallery, 1999; Lattin, Carroll and Green, 2003). The Kaiser-

Meyer-Olkin (KMO) test can measure whether the sample size is adequate for conducting factor analysis (George and Mallery, 1999).

The KMO measure of sample adequacy is .654 which is greater than the acceptable threshold of 0.5. Therefore, the sample is adequate for exploratory factor analysis (Table 2). As the Bartlett's Test of sphericity is highly significant (p <.05), the correlation matrix is identical and thus suitable for factor analysis.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.654
Bartlett's Test of Sphericity	Approx. Chi-Square	962.354
	df	210
	Sig.	0

Chu, Wang and Yuen (2011) explored the eight KM variables proposed by Rodriguez and Pai (2005) in their qualitative study on a secondary School in Hong Kong. The sub-variables which were further identified (Table 1) from literatures were analyzed in Indian schools and therefore it is important to explore the key factors in the new context. The Exploratory Factor Analysis (Table 3) using Principal Component Analysis with varimax rotation also extracted eight factors, which were conceptually identical to variables of Rodriguez and Pai's (2005) model.

Table 3: Exploratory Factor Analysis

Item	Factor	Variables included in the factor	Factor Loading	Eigen Value	Variance explained %	Cumulative variance explained %
1	Acquisition and learning	Innovative method of teaching	0.771	4.669	11.304	11.304
2		Support for new teachers	0.756			
3		Freedom to develop lesson plans	0.669			
4		Collaborative environment for open discussion	0.641			
5	Dissemination and Transfer	Support of fellow teachers	0.955	2.488	10.603	21.907
6		Regular feedback from students	0.899			
7	Leadership and Support	Principal's support for teachers	0.943	2.044	10.453	32.36
8		Principal's Coordination of activities	0.921			
9		Management and leadership support	0.506			
10	Application and Exploitation	Appraisal of student suggestions	0.764	1.503	10.111	42.472
11		Curriculum standards and quality	0.682			
12		Evaluation of teaching methodology	0.662			
13	Knowledge Creation	Use of ICT	0.803	1.431	8.754	51.226
14		Regular update of subject knowledge	0.747			
15		Seminars, workshops and Trainings	0.508			
16	Sharing Culture	Access to alumni	0.839	1.237	8.202	59.428
17		Support of administrative staff	0.837			
18	Technology Infrastructure	Data driven decisions and interventions by principal	0.764	1.153	7.594	67.021
19		Free internet access	0.725			
20	People Competency	Technology oriented evaluation and reporting	0.692	1.013	6.974	73.996
21		Teacher's self-satisfaction on their teaching skills	0.498			

The eight factors, namely: Acquisition and Learning, Dissemination and Transfer, Leadership and Support, Application and Exploitation, Knowledge Creation, Sharing Culture, Technology Infrastructure, People Competency together contribute 73.996 percent of cumulative variance to the study. The remaining 26 percent are contributed by other factors.

A binary logistic regression was applied to estimate the impact of KM in Government Schools on academic performance of the students. The academic performance of students is the dependent variable and the independent metric variables are Acquisition and Learning, Dissemination and Transfer, Leadership and Support, Application and Exploitation, Knowledge Creation, Sharing Culture, Technology Infrastructure, People Competency. The hypotheses for the logistic regression can be stated as follows:
H_0: The School KM factors do not have a significant impact on Academic Performance.

H_1: The School KM factors have a significant impact on Academic Performance.

The binary logistic regression model is as follows: Ln$[p/(1 - p)] = \alpha + \beta x + \varepsilon$, where p is the probability that the event occurs. The p/(1-p) is the odds ratio which is the ratio of the probability of an event occurring to the probability of the event not happening. The α is the Y intercept; *x* is a set of predictors; ßs are regression coefficients.

A 5-point Likert-scale with questions ranging from strongly disagree (1) to strongly agree (5), was used to measure the opinion of teachers on the sub-variables (Table 1) of KM in schools. The reliability of the questionnaire is tested for the KM Enablers and KM Processes with a sample of 30 respondents and the Cronbach's alpha values are .813 and .794 respectively. Since the reliability is 81% and 79% respectively, which is above the acceptance level of 70%, the questionnaire was considered reliable.

The maximum likelihood estimation procedure is used to estimate the binary logistic regression model. Since the p-value is 0.007(<.05), it proves that overall model was statistically significant. This indicated that the full model was a better predictor than a model with the intercept alone. The model is statistically reliable in distinguishing KM practices that can create an improvement in academic performance and those that cannot. It is required to test the basic assumption of evaluating the goodness-of-fit of the model and the Hosmer – Lemeshow Test (Table 4) is used for it (Hosmer and Lemeshow, 2000).

The resulting test statistic was not statistically significant ($\chi 2$ value 14.401 and, p-value 0.072); therefore, the null hypothesis (*H_0: There is no difference between the observed and the model predicted values on academic performance*) was rejected. This implied that the model fits the data well at a statistically, acceptable level.

Table 4: Hosmer and Lemeshow test

Step	Chi-square	df	Sig.
1	14.401	8	0.072

Another test statistic (Table 5), the Nagelkerke R^2, indicates how useful the explanatory variables were in predicting the response variable. The Nagelkerke R^2, which varies from 0 to 1, was 0.256, indicating the model was useful in predicting the impact of KM practices on academic performance.

Table 5: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	81.361	0.113	0.256

The logistic regression coefficient, standard error, Wald's chi-square, p-value and odds ratio for each of the predictors are shown in Table 6. The Wald and associated p-value is used to test the statistical significance of each coefficient (β) in the model (Field, 2007), which represent the KM variable.

Table 6: Logistic Regression

	B	S.E.	Wald	df	Sig.	Exp(B)
Acquisition and learning	-0.783	0.573	1.867	1	0.172	0.457
Dissemination and transfer	-0.599	0.739	0.657	1	0.418	0.55
Leadership and support	-0.097	0.947	0.01	1	0.919	0.908
Application and Exploitation	-1.422	0.627	5.144	1	0.023	0.241
Knowledge creation*	0.024	0.776	0.001	1	0.975	1.025
Shared culture	-0.818	0.443	3.404	1	0.065	0.441
Technology infrastructure*	1.442	0.876	2.708	1	0.1	4.23
People Competency*	0.005	0.145	0.001	1	0.973	1.005
Constant	5.396	3.734	2.088	1	0.149	220.462

Note: ‘*” indicates variables with odds ratio greater than 1

The results indicate that the application and exploitation of knowledge is significant to academic performance in schools (p-value .023< .05). Hence the H_o is rejected for this KM process. Other factors are currently not significant in improving the academic performance of students. This result is purely based on the perception of school teachers. Considering the Odds ratio (Exp (B), in Table 6 it is observed that the Exp (B) of Knowledge Creation (1.025), Technology Infrastructure (4.230) and People Competency (1.005) are greater than 1 and it indicates that a slight increase in value of these variables can result in improving academic performance by 1.025 times, 4.23 times and 1 time respectively. This indicates that these KM practices can probably improve the academic performances in public schools to a greater extend compared to other parameters of KM. Notably, the technology infrastructure plays a significant role in improving the KM practices for better academic performance of students.

5. Discussions

The existing studies on KM in education reveals many factors that are significant in improving the academic quality such as leadership support, collegial relationship among the teachers, organizational behaviour, teaching methodology and student learning (Chu, Wang and Yuen, 2011; Cheng, 2015; Chu, 2016b; Cheng, 2017). But this study has identified the processes of KM that enhance learning along with the enablers that significantly contribute in the execution of the knowledge processes. Out of the eight factors Acquisition and Learning, Knowledge Creation, Dissemination and Transfer, Application and Exploitation are the KM processes (Nonaka and Takeuchi, 1995; Cheng, 2012). Leadership and Support, Sharing Culture, People Competency and Technology Infrastructure are the knowledge enablers (Chu, Wang and Yuen, 2011). The knowledge facilitators in organizations that positively enable the KM processes such as Organisational Culture, Organisational structure, Technology Infrastructure, Human Resource Management processes, etc. are also referred to as knowledge enablers (Lee and Choi, 2003). Among the KM factors, Acquisition and Learning process involve the methods used by teachers in searching knowledge and learning; Knowledge Creation involve workplace knowledge creation through ICT and initiatives to develop new knowledge; Dissemination and Transfer refers to facilitations of transferring knowledge and information within the organization; Application and Exploitation involves employee’s attitudes and requirements for applying knowledge and putting it into practice (Rodriques and Pai, 2005; Chu, Wang and Yuen, 2011). Table 3 clearly illustrates the various School KM activities that are initiated for the above processes. These processes are important in the SECI model for KM in Schools. When Acquisition and Learning contribute to the process of socialisation, the externalisation of knowledge is initiated by Creation, Dissemination and Transfer. Application and Exploitation contribute to Codification and Internalization of Knowledge.

It was identified from the analysis that the Technology Infrastructure plays a significant role in improving the academic performance through KM. The existing infrastructure is not found to be satisfied as the relationship of Technology Infrastructure to academic performance is not significant. Although the schools are equipped with internet access and Use of ICT, the extent to which they are being utilized to improve the academic quality is not sufficient. The studies conducted in other Asian countries like China, Malaysia, Taiwan and Japan clearly states the contribution of technology in education, as the development of internet technology has increased the scope

of KM in education (Richard, 2001; David, 1999; Kuo, 2003; McKenzie, Truc and van Winkelen, 2001; Chu, Wang and Yuen, 2011; Cheng 2017). This is a challenge to public schools compared to private schools in India.
People's Competency is an inevitable factor in education. Though the recruitment of teachers in public schools is conducted systematically, a consistent development of skill is lacking as teaching is always limited to a regular tinkering process (Hargreaves, 1999). In this study the competency is measured by analysing how effectively the teachers use technology for evaluation and to the level of self-satisfaction they have on their teaching skills. Teachers should be well aware of their effectiveness and should always strive to develop their teaching skill (Chu, 2016). Personal strategies of teachers also tend to influence the knowledge culture within schools. The personal strategies can manipulate the way people seek and tolerate new knowledge, and how ideas are valued and used (Hamid, 2008). Higher levels of personal knowledge strategies are also likely to result in a stronger belief in the quality process of decision making in schools and teachers are required to develop their learning competency in order to acquire subject knowledge and pedagogical knowledge when implementing the new curriculum. (Cheng, 2012; 2015).

When the teachers effectively use the technology infrastructure to update the developments, the regular tinkering process can be made more creative, systematic and explicit resulting in Knowledge Creation (Hargreaves, 1999). This can be enhanced through participation in seminars, workshops and conferences (Tahir *et al*., 2013). The study reveals that knowledge creation process can definitely contribute to academic performance of students. Knowledge creation in this study actually refers to creation of new knowledge through learning initiatives and use of information and communication technology for regular updates.

6. Conclusion

As far as the economic and social growth of a nation is concerned, the opportunity and quality of secondary education need to be focused as it contributes significantly to the social, cultural, moral and technological orientation of an individual. As such orientation can be greatly brought through effective KM practices; this study reveals an eye-opening reality of the impact of KM practices on academic performance in public schools in India. Some of the significant contributions of the study include:

1. Out of the School KM factors, Acquisition and Learning, Knowledge Creation, Dissemination and Transfer, Application and Exploitation are the KM processes, and Leadership and Support, Sharing Culture, People Competency and Technology Infrastructure are the KM enablers. Although these variables were explored in other geographical contexts, it was not explored in the Indian context so far. Except for the study conducted by Shih and Tsai (2016) other recent studies focused on one or few of KM processes or enablers. But this study comprehensively identified all major factors of school KM, both processes and enablers.
2. Although the public schools are equipped with internet access and Use of ICT, the extent to which they are being utilized to improve the academic quality is not sufficient. Knowledge Strategies that can effectively utilize the technology infrastructure through KM systems in schools are mandate for better academic outcome.
3. Apart from the schemes implemented by national and international agencies to improve the competencies and skills of teachers, personal knowledge strategies should be initiated by teachers for self-evaluation and individual learning to increase their competency.
4. When the teachers effectively use the technology infrastructure to update the developments, the regular tinkering process can be made more creative, systematic and explicit resulting in Knowledge Creation, contributing to academic development of students.
5. Academic performance, being mentioned as the primary outcome of School KM has not been empirically tested from a School KM perspective earlier. The knowledge creation, technology infrastructure and teachers competency being identified as KM factors that can influence the Academic Performance, the schools can initiate policies and methods to improve these vital factors.

It was interesting to note that the key KM factors that predicted higher impact on academic performances were enablers such as technology infrastructure and people competency. The knowledge creation process needs to be revamped with dissemination and application of knowledge, which would undoubtedly enhance the academic quality and school effectiveness (Shih and Tsai, 2016). Moreover, knowledge creation can pave way to innovation and creativity. It is high time to remove the dilemma of what is important and how to prioritize based on the changing scenario of education. Though Fullan (2002) has stated that sustainability depends on system wide efforts at the level of schools, communities and districts, as well as radically more enlightened

policies and incentives at the level of the state and the state took up various initiatives to this regard, the outcome is yet to materialize.
The study is limited to the government schools of Kasargod district in Kerala state. Kerala is an Indian state with high Human Development Index (HDI), where education is given prime importance compared to other states of India. Therefore, the sample could be an ideal representative for the study, though the results could not be generalized fully in Indian context. But the curriculum and practices of education followed in all the states are similar and hence not fully limited in scope. Future studies can better focus on other districts of the country on the same parameters. From an international perspective the findings of this study can be generalised in Asian context, as this study was inspired by School KM conducted in Iraq, China, Thailand and Malaysia (Zwain, Lim and Othman, 2012; Cheng, 2013; Chu, 2016; Shih and Tsai, 2016; Supermane and Tahir, 2018) and further tested in Indian context. Future researches need to explore the scope of KM processes and enablers in European and western contexts. Besides the study is limited to the subjective evaluation of teachers on KM practices existing in secondary education and teachers are the best respondents for this study, as they are the key knowledge workers directly involved in School KM and also in the evaluation of academic performance of students. This study also limits to identifying the impact of KM on academic performance. There are several other aspects of school education such as pedagogy, teacher skill development and leadership which can be explored based on KM practices. Besides, feedback from other stakeholders such as students' parents and the administrative authorities in education development on improving the KM practices can also enhance the future research.

The future studies can be extended to the perception of other stakeholders of schools including students, parents, administrators and the public. Approach of school KM also need to be researched in the European and western contexts. Practically school KM factors can be used for the implementation Knowledge Management Systems (KMS) in school in future to streamline all the knowledge activities effectively. This is highly relevant in the context where teaching and learning are becoming virtual and more technology orient.

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Editorial Volume 19 Issue 1

Even in these problematic times, with an upsurge of critical challenges for management and research, the studies of Knowledge Management (KM) proposed by our authors provide interesting insights and food for thought. This issue includes a collection of stimulating papers that put a spotlight on a variety of different topics and application contexts – from public services to business, from public research to education. Also, these studies provide, to our readers, the opportunity to reflect on a variegated set of theoretical backgrounds, research methods, application contexts, and managerial or research implications, in line with the multi-disciplinarity that characterizes KM.

KM in public sector or for public decision making is an emerging field that attracts the interest of many academics. This issue offers three papers that focus on different topics. The first one is a literature review on an issue that has always had a significant place in the KM and intellectual capital field: the proper collection, analysis, and measurement of data regarding intellectual capital at a national level. Indeed, the appropriate public policies for boosting innovation or for deciding investments in education and research are often based on the available data on level and growth of intellectual capital, which is considered a vital ingredient of our knowledge societies. But how do we really measure intellectual capital, and are these methods always consistent and appropriate? In "Misled by Data? Review of Data Sources in National Intellectual Capital Research" Hannele Orjala discusses this point and reviews a significant number of papers that used different data sources and methods of analysis. The author signals potential problems of transparency or methodological consistency. So, according to this study, some caution should be exercised when dealing with the results of the statistical reports and analyses regarding national intellectual capital, and their possible use for decision making.

Knowledge sharing and social connections are two of the most typical topics in KM. Their analysis is also relevant to the case of the public sector, but the peculiarities and specificities of this environment, compared for example to the business sector, deserve investigations. This is what Everest Turyahikayo, Venitha Pillay and Mary B. Muhenda do in "Antecedents of Knowledge Sharing Behaviour in the Public Sector". Based on the theory of planned behaviour, the authors propose a qualitative study of the determinants of knowledge sharing. They highlight a number of key factors and discover that the attitude of both knowledge givers and knowledge seekers can count. These noteworthy insights are of interest for both researchers and policy makers.

In "Social Connection and Knowledge Brokerage in a State Government Research Network in Australia", C. Louise Goggin and Rebecca Cunningham focus on the social dimension of KM in a specific context that is becoming increasingly important considering the climate changes: the processes of social interactions and how they can influence the dissemination, incorporation and application of tacit knowledge of experts in the protection of natural landscapes. Based on a social network analysis in the Australian context, they evaluated the effectiveness of forming research networks and the role of social connections in these processes. They conclude that individuals in a network can grow connections over time and this is likely to lead to better knowledge sharing. The message for policy makers and public administrators is that favouring social interactions to improve public decisions can have a value, and can positively affect the environmental outcomes of public actions.

Education is another field that is gaining popularity in the KM literature. We have two papers in this Issue that focus on this context. While KM processes and methods are increasingly adopted in schools and universities worldwide, how can this impact upon the performance of the education system? This vital question is addressed by Arunima Kambikanon Valacherry and Pakkeerappagari Pakkeerappa in "Knowledge Management and Academic Performance in Indian public schools". The key objective of this study was to identify the major components of KM in schools, and to analyse their possible impact on education performances based on the perception of teachers: the key variables that can influence a positive correlation between the application of KM and the performances of the school system, which clearly has significant importance for the organization of education systems, and for school management.

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The collaboration between teachers and the effectiveness of education model are important not only for the KM literature. In “Using SECI To Improve Teachers’ Pedagogical Content Knowledge”, the authors (Zulfikar Alimuddin, Jann Hidajat Tjakraatmadja, Achmad Ghazali and Henndy Ginting) adopt Nonaka’s popular SECI model of knowledge conversion to analyse the effectiveness of pedagogical content building and delivery and, more broadly, the effectiveness of teaching and learning. Especially, the authors focus on knowledge creation by teachers, and ultimately propose a model to facilitate teachers in the same school to share, externalise, combine, and internalise teaching practices and contents.

The last paper, “The Effects of Organizational Absorptive Capacity, Professional Experience and Training over the Use of Sales Force Automation” by Kaouther Jridi and Amel Chaabouni is also related to “education” or, more precisely, processional training. It focuses on the impact of training and professional experience on organizational absorptive capacity for the effective use of business information systems. Through a survey and a statistical analysis, the study confirms a positive impact of training and professional experience over absorptive capacity of organizations, which in turn can have a positive effect on the use of an information system. This research provides useful lessons for business managers, who constantly seek to improve the use of information systems in their companies.

The Journal Editor
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