



**FUNDAÇÃO GETÚLIO VARGAS ESCOLA BRASILEIRA DE ADMINISTRAÇÃO  
PÚBLICA E DE EMPRESAS**

**Key Success Factor Ranking for Intrafirm Knowledge Sharing: A Delphi Method  
Approach in the Oil and Gas Industry**

**THASSIA CONCEIÇÃO ALMEIDA DA SILVA**  
Rio de Janeiro, 2017

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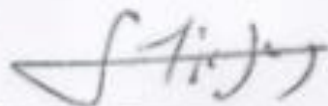
THASSIA CONCEIÇÃO ALMEIDA DA SILVA

"KEY SUCCESS FACTOR RANKING FOR INTRAFIRM KNOWLEDGE SHARING IN THE OIL AND GAS INDUSTRY: A DELPHI METHOD APPROACH".

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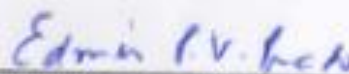
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## **ABSTRACT**

Knowledge and its propagation are unquestionably at the center of most, if not all, discussions on innovation, performance, as well as other elements related to firm success. Although the literature has proposed several key success factors for knowledge sharing, it has yet to explore how these factors rank in terms of importance from a firm nationality perspective. Through a Delphi Method approach, upstream professionals from four major multinational Oil & Gas firms (Brazilian, North American, Norwegian and French), with at least seven years of experience, ranked specific literature-based proposed factors for successful intrafirm knowledge sharing. There was a total of three rounds, where the first round had 41 participants, and the remaining two rounds (second and third) had 39 participants. On average, open door policy was the most relevant factors that lead to knowledge sharing among the four firms. In terms of the least relevant ones, acknowledgement and status were seen, on average, as factors less likely to lead to intrafirm knowledge sharing.

*Keywords: knowledge sharing, tacit knowledge, Oil & Gas Industry, cross-country study.*

## FIGURES

<b>Figure 1</b> – A Three Round Delphi Method Process.....	27
<b>Figure 2</b> – Delphi Research Process-Expert Group Analysis.....	28

## TABLES

<b>Table 1</b> – Success Factors and Supporting Literature.....	24
<b>Table 2</b> – Interpretation of Kendall’s W.....	32
<b>Table 3</b> – Interpretation of Kendall’s W p-value.....	33
<b>Table 4</b> – Delphi Panel Participants: Educational Background and Firm Nationality Breakdown.....	34
<b>Table 5</b> – First Round Antecedent Evaluation.....	35
<b>Table 6</b> – First Round Rank Based on Average Scores.....	36
<b>Table 7</b> – Second Round Delphi Statistics.....	37
<b>Table 8</b> – Second Round Overall Key Factor Rank.....	38
<b>Table 9</b> – First & Second Round Convergence Check.....	38
<b>Table 10</b> – Third Round Delphi Statistics.....	39
<b>Table 11</b> – Third Round Overall Key Factor Rank.....	40
<b>Table 12</b> – Rank Comparison Between Rounds Two and Three.....	40
<b>Table 13</b> – Second & Third Round Convergence Check.....	41
<b>Table 14</b> – Round Two- Key Factor Rank by Nationality Based on Average Scores.....	42
<b>Table 15</b> – Round Three - Key Factor Rank by Nationality Based on Average Scores.....	43
<b>Table 16</b> – Third Round—W Value Based on Firm Nationality.....	44
<b>Table 17</b> – Kendall’s Correlation Coefficient (Tau-b)—Third Round Comparisons Between Firm.....	44
<b>Table 18</b> – Second & Third Round Convergence Check Based on Firm Nationality.....	44
<b>Table 19</b> – Comparing Rounds Two and Three Rankings (American Firm).....	50
<b>Table 20</b> – Comparing Rounds Two and Three Rankings (Brazilian Firm).....	52
<b>Table 21</b> – Comparing Rounds Two and Three Rankings (French Firm).....	53
<b>Table 22</b> – Comparing Rounds Two and Three Rankings (Norwegian Firm).....	54
<b>Table 23</b> – Firm Comparison – General Analysis.....	55

## TABLE OF CONTENT

<b>1. INTRODUCTION</b> .....	9
<b>2. LITERATURE REVIEW</b> .....	10
2.1 KNOWLEDGE SHARING (KS).....	12
2.2 FACTORS INFLUENCING KNOWLEDGE SHARING.....	14
2.3. SUCCESS FACTORS IN TACIT KNOWLEDGE SHARING.....	17
<b>3. METHODOLOGICAL PROCEDURES</b> .....	25
3.1. THE DELPHI METHOD.....	25
3.2 RESEARCH DESIGN.....	29
3.2.1. RESEARCH SETTING.....	29
3.2.2. DATA COLLECTION.....	30
3.3. DATA ANALYSIS.....	31
<b>4. RESULTS</b> .....	33
4.1 DESCRIPTIVE STATISTICS.....	33
4.2 FIRST ROUND DELPHI METHOD RESULTS.....	34
4.3 SECOND ROUND DELPHI METHOD RESULTS.....	36
4.4 CONVERGENCE CHECK—COMPARING ROUNDS ONE AND TWO.....	38
4.5 THIRD ROUND DELPHI METHOD RESULTS.....	39
4.6 CONVERGENCE CHECK—COMPARING ROUNDS TWO AND THREE.....	41
4.7 RANK BASED ON FIRM NATIONALITY.....	41
<b>5. DISCUSSION</b> .....	45
<b>6. CONCLUSION</b> .....	55
6.1 ACADEMIC IMPLICATIONS.....	57
6.2 MANAGERIAL IMPLICATIONS.....	57
6.3 RESEARCH LIMITATIONS.....	58
6.4 FURTHER RESEARCH.....	58
<b>REFERENCES</b> .....	59
<b>ANNEX 1 First Round Email to Participants</b> .....	69
<b>ANNEX 2 First Round Questionnaire—Delphi Method</b> .....	70
<b>ANNEX 3 Second Round Email to Participants</b> .....	75
<b>ANNEX 4 Second Round Questionnaire—Delphi Method</b> .....	76
<b>ANNEX 5 First Round Ranking Based on Participant</b> .....	79
<b>ANNEX 6 First Round Individual Factor Results</b> .....	80



## 1. INTRODUCTION

One may strongly argue that knowledge without the possibility of being transferred is both useless and valueless to the firm (Nooshinfard and Nemati-Anaraki, 2014; Glazer, 1998). As such, the creation of knowledge alone is not enough; irrespective of how unique this knowledge is.

Unquestionably, human participation is always present in knowledge sharing. Perhaps this fact serves as the reason to why firms often face difficulties in diffusing knowledge from person A to person B. Regardless of how explicit knowledge can become, there will always be a tacit factor present. For this reason, as pointed out by Nooshinfard and Nemati-Anaraki (2014), knowledge is perceived as one of the main drivers in the world today.

Considering this, the factors that enable knowledge sharing (KS) are of high importance both to practitioners as well as the academic world. Although several studies, which will be further explored under the literature review section, have generated an incremental understanding regarding knowledge sharing, there has been no rank regarding relevance of the key success factors that lead to knowledge sharing based on firm nationality.

The purpose of this research is to understand knowledge sharing in the context of Oil and Gas (O&G) within firms of different nationalities—a setting with a highly-specialized workforce where knowledge is essential. More specifically, this study will investigate this phenomenon from a Exploration and Production (E&P) professionals' perspective—an area also referred as upstream—of four major O&G firms from four different nationalities (American, Brazilian, French and Norwegian).

The E&P area is highly intricate in terms of its produced and utilized knowledge. In this context, no single O&G unit operates alone nor within a sole location. Often, headquarters are in major capitals, while oil platforms and drilling systems are located in the middle of nowhere. Although this is the case, knowledge must be shared in its totality amongst the different units, departments and partners in a timely, effective and efficient manner.

Therefore, in its essence, this study seeks to answer the following research question: How are the key success factors for intrafirm knowledge sharing in the O&G industry ranked vis-à-vis firm nationality?

To answer this question, the main objective for this research is to rank the existing key success factors for intrafirm knowledge sharing by means of the Delphi method.

More specifically, the desired deliverables for this study go as follows:

- i) Identify factor relevance in intrafirm knowledge sharing by means of expert opinions within the E&P area of O&G firms;
- ii) Develop a ranking of the key success factors for intrafirm knowledge sharing divided by firm nationality;

This master thesis is divided into three major sections. The first part entails the literature review and the fifteen key success factors for knowledge sharing accrued from the extant literature review. Following, the research methodology will be explained. Lastly, the results and the discussions will be set forth.

## **2. LITERATURE REVIEW**

In this section, the extant relevant literature on knowledge sharing is analyzed.

Before anything else, the concept of knowledge as well as the different types of knowledge will be explained. Then, the levels of knowledge sharing and factors that lead to knowledge sharing will be examined. Lastly, fifteen chosen key success factors that lead to intrafirm knowledge sharing will be explored, setting the stage for the research at hand.

### *Concept of Knowledge*

A concept as abstract as knowledge has had several definitions and interpretations. Regardless of the context, knowledge is viewed as a resource with an immense capacity for change. As proposed by the Knowledge Based View (KBV), resources linked to knowledge bases are more likely to contribute to the firm's gaining and sustaining of superior knowledge than tangible resources (Wang et al., 2014; Bogner and Bansal, 2007). Moreover, for firms to fully exploit the possibilities derived from knowledge, understanding how to create it is not sufficient; the firm's ability to share and use knowledge is also essential (Nooshinfard and Nemati-Anaraki, 2014). As such, knowledge is not the end nor a simple consequence of a process, instead, it is an element within a much more complex evolution.

An interesting and very dominating definition of knowledge is provided by Nonaka and Takeuchi (1995). According to them, knowledge is the justified belief that increases an entity's capacity for effective action. In line with this definition, Xiong and Deng (2008) perceive knowledge as the combination of experts' experiences, beliefs, and perceptions that

are pivotal to assessing and enclosing new information. Complementing this thought, as pointed out by Nooshinfard and Nemati-Anaraki (2014, p. 242), “knowledge can be understood as a skill, intuition, and experience that can influence decision making.”

Adding to the previously well-established definitions within the field, the classification of the knowledge process presented by Davenport and Prusak (1998) is also well propagated, illustrating the complex nature of knowledge itself. Davenport and Prusak (1998) point to four knowledge process classifications: knowledge generation, knowledge codification, knowledge sharing, and knowledge application. These processes comprise two major types of knowledge as well as different levels wherein knowledge sharing takes place.

### *Types of Knowledge*

In this section, the two main types of knowledge will be further explained as defined by the extant literature.

According to Grant (2013), the literature of knowledge management (Nonaka, 1994; Kogut and Zander, 1992; Grant, 1996) distinguishes the different types of knowledge based on the extent of which knowledge can be transferred. More precisely, there are essentially two main types of knowledge (Polanyi, 1966; Saint-Onge, 1996; Nooshinfard and Nemati-Anaraki, 2014): tacit and explicit.

*Tacit Knowledge:* Described as “soft” knowledge, tacit knowledge is composed of insights, intuitions, and hunches. Highly related to the cognitive dimension of human perception and understanding, tacit knowledge is extremely difficult to be expressed or even formalized; thus, it is not easily shared amongst the different members of the firm. The above cited authors also argue that this type of knowledge is developed over time and includes one’s know-how and personalized skills rooted in the present organizational practices. Tacit knowledge exists within employees’ minds—something not easily expressed or identified (Grant, 2013). This is consistent with what is demonstrated by Nonaka et al. (1995), Adhikari (2010) and Nooshinfard and Nemati-Anaraki (2014), who expressed that tacit knowledge includes mental models, beliefs and perceptions intensely rooted in one’s own psyche.

*Explicit Knowledge:* May also be referred to as “hard” knowledge. Explicit knowledge is expressed as numbers and words, shared by formal means as well as through a systemic way; including data, manuals, etc (Nooshinfard and Nemati-Anaraki, 2014). Complementing this idea, Grant (2013) explains that the more visible the knowledge is, the

higher the number of accessible sources will be, mainly through information technology systems.

In this study, tacit knowledge will be the primary focus.

## 2.1 KNOWLEDGE SHARING (KS)

Complementing the definitions of the two different types of knowledge previously presented, the concept of knowledge sharing will be further explored.

A major issue, as depicted by Nooshinfard and Nemati-Anaraki (2014), is that firms primarily focus on systems and tools, and not necessarily on the core concerns of knowledge sharing within and across firms. Knowledge sharing, as stated by Antonova et al. (2011), serves to create new knowledge through the combination of already existing knowledge in an improved manner.

McAdam et al. (2012) and Wang et al. (2014) define knowledge sharing as the activity that permits knowledge, in its various forms, to be transferred or exchanged from one person, group or organization to another. Haas and Hansen (2007) defined it as a process of interaction, communication and coordination of knowledge or expertise. Wang et al. (2014) view it as the shared understanding related to providing individuals with the appropriate access to relevant information, whilst using the pre-existing available knowledge within the firm. Enhancing the perception of knowledge sharing, Ardichvilli et al. (2003) defend that KS encompasses both the supply and demand of new knowledge. The presence, as well as the need, for knowledge are essential sources for knowledge sharing; all of which are fundamental elements to create firm advantages.

Taking it a step further, KS can also grant the right people access to the most appropriate knowledge as well. This can easily be attributed to the fact that tacit knowledge, that of which cannot be codified, is highly entrenched within the individual. Even when firms are capable of codifying some of the knowledge it so arduously generates, firms often depend on the individual interpretation, perception, applicability and sharing of such knowledge.

### *Levels of Knowledge Sharing*

Building on the previous section, the different levels of knowledge sharing will be explained under this section.

Knowledge sharing is extremely dynamic, occurring at different levels. As pointed out by Wang et al. (2014), knowledge sharing occurs amongst individuals, teams, units, and firms. Jansen Van Vuuren (2011) defines knowledge sharing at the individual level as a voluntary act that has the potential of creating a new experience or even a novice understanding for the knowledge sharing recipient (Wang et al., 2014). Wang et al. (2014) and Willem (2003) complement this idea by stating that at least two parties must be present for knowledge sharing to take place; in this case, being a reciprocal process yielding the reshaping and sense-making of knowledge in the new context. In the team level, as Nooshinfard and Nemati-Anaraki (2014) point out, project teams can be very effective in knowledge sharing when there is a timely integration of knowledge across organizations.

Intrafirm knowledge sharing, one that occurs within the boundaries of the firm, is the focus of this study. Thus, Argote and Ingram (2000) state that the intrafirm level literature on knowledge sharing has been primarily well developed under the individual psychology literature; however, it has also started gaining momentum within the strategic management and organizational theory literature.

There are several ways to share knowledge as it will be presented below.

#### *Knowledge Sharing (KS) Means*

As depicted by Nonaka and Takeuchi (1997, p.64) and Joia and Lemos (2010, p.411) “knowledge is essentially related to human action.” As firms are fundamentally the combination of both its tangible and intangible assets, KS can be vital to the firm’s existence, expansion and survival. The importance and impact of the implemented knowledge sharing strategies depend not only on the firm’s chosen path, but also upon the collective predisposition to share, receive and apply the acquired knowledge.

As the literature on knowledge sharing has taken several directions, Nooshinfard and Nemati-Anaraki (2014) summarized five major emerging themes regarding how knowledge sharing is accomplished:

1. Information Technology—allows for the presence of both explicit and tacit knowledge (with different levels of intensity);
2. Human interactions—seen as the most basic line to knowledge sharing;
3. Knowledge management strategies—adaptable to firm’s needs;

4. Motivation—including rewards, recognition, and praise as means to entice individuals to share knowledge (Wang et al., 2014; Husted et al., 2012);
5. Trust—powerful element alluring knowledge sharing behavior.

Complementing these five major emerging themes, Wang et al. (2014) also highlight that previous studies have attempted to understand KS practices from several additional angles. These include, but are not limited to: tacit and explicit KS (Quickley et al., 2007; Reychav and Weisberg, 2010; Wang and Wang, 2012), management practices, technology, and business models (McEvily et al., 2000), formalized and informal KS (Taminiau et al., 2009; Zahra et al., 2007), exploratory and exploitative KS (Im and Rai, 2008), solicited and voluntary KS (Teng and Song, 2011), and full and partial KS (Ford and Staples, 2010).

## 2.2 FACTORS INFLUENCING KNOWLEDGE SHARING

Several major factors that influence KS have been identified within the literature, of which may be divided into two major streams: tangible issues, such as technologies and tools (Chennamaneni, 2006; Kim and Lee, 2005; Van den Hooff and De Ridder, 2004) and intangible issues, such as motivation (Cheng et al., 2009; Taylor and Murthy, 2009), communication environment (Moffett et al., 2003; Van den Hooff and De Ridder, 2004), and trust (Aulawi, 2009; Choi et al., 2008).

Different angles have been tackled in terms of the literature regarding the knowledge sharing factors. In fact, these factors vary greatly; however, all have a noticeable impact on one's willingness to share his/her knowledge. These factors go as follow:

*Trust:* Trust has been shown to have an impact on how individuals share knowledge. Several authors have shown that the combination of trust and the presence of good relations amongst individuals within the firm are key to knowledge sharing (Al-Alawi et al., 2007; Zakaria et al., 2004; Cheng et al., 2008; Das and Teng, 1998; Kramer, 1999; Lucas, 2005; Wu et al., 2009). Complementing this idea, Dulaimi (2007) also states that mutual trust can work as an enabler for knowledge sharing, while also increasing collaboration amongst the different parties.

In addition, Fathi, Eze, and Goh (2011) explain that individuals will not share knowledge unless it is certain that such knowledge sharing will not threaten them; namely,

trust has an impact on the communication process. In climates of low trust, employees will not share knowledge to its full potential (Goh, 2002).

*Individual characteristics:* Constant et al. (1996) empirically demonstrated that individuals with a higher expertise level had a greater propensity to share knowledge when asked. Additionally, individuals with a higher level of confidence in their abilities to share knowledge were more likely to share the knowledge they possessed (Lin, 2007).

*Intention:* One's intention to share knowledge has a direct impact on knowledge management (Chatzoglou and Vraimaki, 2009). Essentially, an individual's intention is pivotal for knowledge sharing to take place (Gupta and Govindarajan, 2000).

*Individual attitudes:* Studies have shown that both individual and organizational attitudes impact one's willingness to share knowledge. According to Bock and Kim (2002), an individual's expectation of their knowledge usefulness, as well as the act of sharing such knowledge, can improve the relationship among individuals. As such, this has a direct link with one's intention and behavior towards knowledge sharing.

*Power and job security:* Some individuals believe that by sharing knowledge, they can essentially lose power. Those who believe that knowledge is power (Chong and Besharati, 2014) do not usually share their knowledge, often keeping it to themselves (King, 2006).

*Lack of communication:* Lindsey (2006) and Chong and Besharati (2014) listed several communication source barriers, these being: know-it-all attitude (Golen & Boissoneau, 1987); appropriateness and effectiveness of a channel (Westmyer, Dicioccio, & Rubin, 1998); unsuitable feedback (Golen & Boissoneau, 1987); dislike to listen (Golen, Burns, & Gentry, 1984); receiver evaluation tendency (Rogers & Roethlisberger, 1991); distance among employees of an organization (Blagdon & Spataro, 1973).

*Culture and organizational climate:* Organizational culture can be an instrument in shifting organizational behavior (Chaudhry, 2005). As such, one's reaction to a given event may be a response to a dominant organizational culture.

*Motivation:* Knowledge within the firm is essentially a consequence of individual cognition, as such, firms depend on the employees' willingness to share what they know. Consequentially, as proposed by Nooshinfard and Nemati-Anaraki (2014, p. 248), "knowledge sharing can be managed through the enthusiasm that excites the deepest parts of the employee's opinions". In other words, if individuals are not motivated to share what they know, nothing else can make them share it.

*Reward and Recognition:* There is a link between rewards and recognition in knowledge sharing (Al-Alawi et al., 2007; Xiong and Deng, 2008). In the presence of both, individuals tend to share more of what they know.

*Management leadership and support:* As pointed out by Kyriakidou (2004), leadership is central in the successful use and application of knowledge sharing. More specifically, management support impacts an employee's willingness to share his/her knowledge within the firm (Connelly and Kelloway, 2003; Lin, 2007). Complementing this idea, Lee et al. (2006) found that top management support has a direct impact on the quantity and quality of the shared knowledge.

*Organizational Structure:* The more flexible and informal organizational structures are, the more knowledge is shared (Riege, 2005; Nooshinfard and Nemati-Anaraki, 2014). This is also illustrated in the study completed by Syed-Ikhsan and Rowland (2004), where the authors argue that knowledge sharing will most likely increase in quantity in the presence of structures that support the ease of information flow and lesser boundaries across the different areas. Several studies have pointed out that an open and flexible structure yields the best knowledge sharing results (Nonaka and Takeuchi, 1995; De Long and Fahey, 2000; Probst et al., 2000; Riege, 2005). Interestingly, in environments where the structure is more decentralized, interaction amongst employees is encouraged, thus leading to higher levels of communication amid the different areas (Kim and Lee, 2006; Nooshinfard and Nemati-Anaraki, 2014). Supporting this idea, as pointed out by Riege (2005) p. 23, "the use of a strong hierarchy, position-based status and formal power can be a source of knowledge sharing barrier". In the absence of a formal distance, employees can better interact with one another, and thus share their knowledge (Rivera-Vazquez, Ortiz-Fournier, & Flores, 2009).

Kwan and Cheung (2006) argue that equipment has a major influence in the transfer of knowledge within the organization. In fact, the means as well as the workforce's ability to properly use equipment, as depicted by Nooshinfard and Nemati-Anaraki (2014), are essential to knowledge sharing. Information and communication technology (ICT) is an intricate, and often embedded element, within the knowledge sharing process.

Additionally, Han, Zhou, and Yang (2011) highlight the necessity of proper technological means to find, disseminate and utilize knowledge to its highest potential. As such, some of the possible technological barriers mainly highlighted by Riege (2005, p.29) and Chong and Besharati (2014) are: lack of integration of technology, systems and actions; refusal and unwillingness to fully use the IT system due to lack of experience with it; lack of



IT training; missing knowledge of IT features and advantages; and unpractical technology expectations. The presence of a adequate infrastructure is essential to knowledge sharing (Coleman, 1999; Schlegelmilch and Chini, 2003; Riege, 2005). In fact, in the absence of an appropriate infrastructure, knowledge sharing, as pointed out by Gold et al. (2001), is destined to fail.

### 2.3 SUCCESS FACTORS IN TACIT KNOWLEDGE SHARING

As can be seen, there are several success factors that lead to intrafirm knowledge sharing. However, the focus of this study is on tacit knowledge sharing, fifteen factors accrued from the extant literature on it are presented below.

#### *(F1) Individual time availability*

Time has always been a limited resource; even more so now. As a scarce resource, time should not be wasted, and investing time in any activity needs to bring compensation to the firm (Davenport and Prusak, 2003). Individuals are often caught up in their own tasks, as such, taking the time to help, converse or even teach someone a new skill is time-consuming. The diffusion of tacit knowledge involves the presence of time, something that is not so easily found in today's reality (Haldin-Herrgard, 2000). As presented by Joia and Lemos (2010) p. 413, "tacit knowledge is a direct result of experience, reflection and dialogue—three activities that require time."

Thus, the first factor presented in this study is the availability of time (or lack thereof) to share tacit knowledge within the firm.

#### *(F2) Shared technical jargon*

Having a common language is key to tacit knowledge sharing. When tacit knowledge sharing occurs, there is well established communication between the receiver and the knowledge source. An element that minimizes a communication collapse is the familiarity with both terminology and jargons used (Joia and Lemos (2010); Davenport and Prusak, 2003; Disterer, 2003; Haldin-Herrgard, 2000).

As pointed out by Joia and Lemos (2010), tacit knowledge is often stored in non-verbal forms, as such, individuals are unaware of what they know, and consequentially incapable of properly expressing something that, to them, may seem to be second nature (Davenport and Prusak, 2003; Haldin-Herrgard, 2000; Leonard and Sensiper, 1998; Stenmark, 2001, Bou-Llusar and Segarra-Cipre, 2006).

Therefore, an additional factor of success in tacit knowledge sharing is the common technical language amongst individuals.

*(F3) Trust on Technical abilities*

There must be a relationship of trust between the individuals for tacit knowledge to flow within the firm; a type of trust that is developed through a social and cultural context (Joia and Lemos, 2010; Joia, 2006; Foos et al., 2006). In the presence of higher levels of trust, risks and uncertainties in tacit knowledge transfer are reduced (Davenport and Prusak, 2003; Roberts, 2000). As presented by Roberts (2000) p. 434, “the trust and mutual understanding that developed in a social and cultural context are prerequisites for tacit knowledge transfer.”

Accordingly, trust among individuals is another success factor in tacit knowledge sharing.

*(F4) Network connections*

As presented by Joia and Lemos (2010) p. 414, “the communication process within the company depends on an internal relationship network.” In fact, there is an immense difficulty in knowing where the needed knowledge is (Szulanski, 1996). This tends to occur as people are often unaware of those who may be interested in the knowledge they have and vice-versa (Joia and Lemos, 2010). This can potentially be a consequence of one’s inability to fully gauge the worth of the types of knowledge they possess (Disterer, 2003).

Consequently, an additional success factor in tacit knowledge sharing is the link between those who own type A knowledge and those who need type A knowledge.

*(F5) Acknowledgement*

Properly rewarding individuals is a great way to encourage them to share what they know (Disterer, 2003; Szulanski, 1996). Additionally, as pointed out by Joia (2006) and Joia and Lemos (2010), it is of high relevance to establish performance appraisal systems that embrace knowledge sharing. As stated by Davenport and Prusak (2003) p. 53: “To establish a consistent culture of knowledge sharing, the use of financial incentives, such as substantial gratuities, wage increases, promotion and so forth are necessary.”

Rewards systems with a focus on expertise recognition without the acknowledgement of time dedication to share knowledge do not encourage knowledge dissemination (Hansen et al., 1999; Leonard and Sensiper, 1998; O’Dell and Grayson, 1998).

Thus, another success factor in tacit knowledge sharing is that the acknowledgement included in reward systems values the action of sharing knowledge.

*(F6) Personalized training*

The often-transitory nature of employees' relocation as well as the entrance of newcomers to the firm require suitable training for the familiarization of the new activities (Joia and Lemos, 2010; Joia 2000). As such, training can be an indication of the firm's propensity to disseminate knowledge (Joia and Lemos, 2010).

The traditional formal training provided by firms through means of classes and presentations simplifies the exchange of explicit knowledge (Nonaka and Takeuchi, 1997; Murray and Peyrefitte, 2007). Individuals are encouraged to read pamphlets as well as manuals where tests are given to measure the necessary knowledge (Joia and Lemos, 2010; Joia, 2007). In this case, a more standardized and less personalized training becomes the norm.

However, a more intricate way of transferring tacit knowledge is more appropriate; this being done through coaching or even mentoring (Disterer, 2003; Leonard and Sensiper, 1998). Under this type of training, more experienced individuals transmit their tacit knowledge to the less experienced. As pointed out by Joia and Lemos (2010) and Joia (2007), such type of training focuses primarily on work activities. This personalized type of training varies tremendously, and essentially is an element that enables tacit knowledge sharing, as individuals are placed together for purposeful sharing.

Therefore, another success factor in tacit knowledge sharing is the presence of personalized training.

*(F7) Knowledge sharing strategy*

According to Hansen et al. (1999), a firm's knowledge transferring strategy can be one that focuses on people or on the reuse of codified knowledge. Regarding the people focus strategy, the emphasis is on the dialogue as well as relationship developed between the different individuals; which is essentially achieved through social contact (Joia and Lemos, 2010; Joia, 2007; Hansen et al., 1999; Leonard and Sensiper, 1998; Nonaka and Takeuchi, 1997). In the case of a reuse strategy, it "presupposes that knowledge be stored in a database to which all those within the organization have access and may use it" p. 415 (Joia and Lemos, 2010; Hansen et al., 1999). As such, the presence of a proper technical support is

necessary, although a human interaction must be also present for its success (Joia and Lemos, 2010; Joia, 2007, O'Dell and Grayson, 1998).

For that reason, another success factor in tacit knowledge sharing is a knowledge sharing strategy that involves primarily people's interactions.

*(F8) Knowledge reservoirs*

Knowledge can be stored in several ways. In the case of explicit knowledge, the focus tends to be on the databases available across the firm (Hansen et al., 1999). Under this strategy, as pointed out by Joia (2007) and Joia and Lemos (2010), using an information technology approach warrants high investments in database systems.

In the case of a more personalized strategy, firms depend on the accumulated experience of their employees, especially since the knowledge gathered is directly related to those who develop it (Joia and Lemos, 2010; Joia, 2007; Hansen et al., 1999; Leonard and Sensiper, 1998; Nonaka and Takeuchi, 1997).

Thus, another success factor in tacit knowledge sharing is the effective storage of organizational knowledge in people.

*(F9) Status*

Knowledge can be a source of empowerment for both the individual as well as the group within the firm (Joia and Lemos, 2010). For individuals that are sharing what they know, this could mean a loss of influence, dominance and job security (Davenport and Prusak, 2003; Disterer, 2003; Szulanski, 1996). As the value of knowledge lies in its accessibility and use instead of its ownership and control (Joia and Lemos, 2010; Glazer, 1998), knowledge may be perceived as a source of power that leads to better status within the firm.

Therefore, an additional success factor in tacit knowledge sharing is when knowledge is understood as a source of power that leads to status—the presence of self-benefit being a consequence of sharing knowledge.

*(F10) Open door policy*

An environment less than favorable to questions is one that may kill an atmosphere of knowledge sharing. The presence of a safe psychological environment to self-express as well to give new opinions and ideas fosters knowledge sharing (Joia and Lemos, 2010). In an ambiance where individuals can get to know each other, and trust is then achieved, conflicts and conflicting ideas are better handled, consequentially enriching the level of available

knowledge (Sun and Scott, 2005). From an open, sincere and receptive mind to reach new perspectives (Fahey and Prusak, 1998) to having the possibility of agreeing to disagree is key to one's willingness to share what (s)he knows.

Thus, another success factor in tacit knowledge sharing is the openness within the firm regarding the tolerance level of questioning and criticism.

*(F11) Personal knowledge relevance*

Some of the different types of tacit knowledge, such as intuition and personal skills, may not be considered relevant in specific organizations (Joia and Lemos, 2010). In fact, pending on the firm, certain types of knowledge are more appreciated than others. For instance, several firms value technical knowledge and knowledge acquisition more than knowledge sharing and knowledge disseminating within the firm (O'Dell and Grayson, 1998).

Hence, an additional success factor in tacit knowledge sharing is the acceptance level of suggestions and ideas that are not supported by data within the organization (i.e intuition, personal abilities, etc.).

*(F12) Knowledge sharing means*

As identified by Joia and Lemos (2010), the firm's chosen media can contribute to tacit knowledge sharing. The nature of knowledge as well as the type of information to be shared are great influencers on what media firms choose to use (Daft and Lengel, 1986; Murray and Peyrefitte, 2007).

Ambiguity as well as uncertainty are at the base of knowledge sharing; both should be minimized within the organization (Daft et al., 1987). More precisely, the type of chosen means to share knowledge must enable the diffusion of an individual's vision, insights and understanding. The means must also integrate the possibility for the knowledge to be used in different languages (Daft and Lengel, 1986; Daft et al., 1987).

According to Roberts (2000) and Joia and Lemos (2010), the presence of a rich means of communication is very important in knowledge sharing. Personal conversations yield the highest level of communication as it encompasses several elements relevant to enabling proper knowledge sharing (Haldin-Herrgard, 2000; Leonard and Sensiper, 1998). On the other hand, that of which is low in communication richness is deemed more appropriate for explicit knowledge sharing (Murray and Peyrefitte, 2007).

Hence, another success factor in tacit knowledge sharing is the use of means of communication between individuals within an organization.

*(F13) Knowledge mapping- who knows what*

As stated by Wegner (1987), Lewis and Herndon (2011), and Argote and Guo (2016), Transactive Memory System (TMS) is a collective system of encoding, storing and retrieving information within a social system. In other words, it gives an individual the ability to go beyond the boundaries of the knowledge (s)he possesses by having access to a third party's knowledge base. It is also known as "who-knows-what", having two key components: specialized knowledge present within the individual's mind and the transactive processes that link individuals while allowing for the coordination of their specialized knowledge and skills (Wegner, Giuliano, Hertel and Ickes, 1985; Argote and Guo (2016). Argote and Guo 2016 simplify this by stating that "TMS enables groups and organizations to match tasks to the most qualified members". Although compatible with shared mental models (Klimonski and Mohammed, 1994; Argote, 2016), it is fundamentally different with a much more narrower scope, while also having a "cognitive division of labor where group members specialize in remembering knowledge in different areas" (Argote and Guo, 2016).

The benefit of TMS is one that leads to the performance of tasks to be completed more efficiently (Argote and Guo, 2016), consequently becoming a knowledge sharing amplifier.

As a result, another success factor in tacit knowledge sharing is knowing who the experts of specific knowledge sources are.

*(F14) Combination of formal and informal company routines*

Routines are essential for the execution of daily tasks. More specifically, Levitt and March (1988) as well as Argote and Guo (2016) state that "routines are independent of the individual actors who execute them, and are capable of surviving considerable turnover in the organization (p. 320)." Also, by means of routines, firms can give continuity, at least to some extent, to their work in a sustainable fashion. For this study, routines are defined as a "repetitive pattern of independent tasks performed by multiple members of the organization" p. 2 (Argote and Guo, 2016). In other words, it is "the recurring sequence of tasks performed by different organization members" p. 2 (Argote and Guo, 2016). Consequentially, there are several benefits when well-established routines are present within the firm. As the above-mentioned authors discuss, it is a way to reduce uncertainty, provide a foundation for

coordination, intensify efficiency and furnish stability. All of which enable knowledge sharing.

Thus, another success factor in tacit knowledge sharing is when the procedures within the firm in terms of standardized steps of action are known by the individuals.

*(F15) Agile workforce*

An agile workforce is one that possesses a positive attitude towards learning and self-development, an ability of problem-solving while also generating innovative ideas, accepting new responsibilities, and being comfortable with change, new ideas and technology (Plonka, 1997; Al-Faouri et al., 2014). Additionally, an agile workforce is also defined as an employee's ability to attempt to solve problems on a daily basis (Vanstone, 2009) and to respond strategically to uncertainty" (Batten Institute, 2012; Al-Faouri et al., 2013). Based on the models proposed by Griffin & Hesketh (2003), Dyer & Shafer (2003) and Sherehiy et al. (2007), the attributes of the agile workforce have been grouped into three dimensions: proactivity, adaptability and resiliency.

Therefore, an additional success factor in tacit knowledge sharing is the ability to deal with emerging problems in a proactive, adaptable and resilient manner.

A summary of these fifteen factors along with the supporting literature is presented in Table 1.

**Table 1 – Success Factors and Supporting Literature**

<b>SUCCESS FACTORS IN INTRAFIRM TACIT KNOWLEDGE SHARING</b>	
<i>Factors</i>	<i>Bibliographical References</i>
Individual Time availability (F1)	Leonard and Sensiper (1998), Roberts (2000), Fahey and Prusak (1998), Haldin-Herrgard (2000), Grover and Davenport (2001), Davenport and Prusak (2003); Joia and Lemos (2010)
Shared technical jargon (F2)	Reber (1989), Segarra-Cipre´s (2006), Stenmark (2001), Leonard and Sensiper (1998), Haldin-Herrgard (2000), Disterer (2003), Davenport and Prusak (2003); Joia and Lemos (2010)
Trust on Technical abilities (F3)	Davenport and Prusak (2003), Joia (2006), Foos et al. (2006); Joia and Lemos (2010)
Network connections (F4)	Disterer (2003), O´Dell and Grayson (1998), Szulanski (1996), Davenport and Prusak (2003) Joia (2006), O´Dell and Grayson (1998), Disterer (2003), Fahey and Prusak (1998), Szulanski (1996), Sun and Scott (2005); Joia and Lemos (2010)
Recognition (F5)	Haldin-Herrgard (2000), O´Dell and Grayson (1998), Leonard and Sensiper (1998), Hansen et al. (1999), Szulanski (1996), Davenport and Prusak (2003), Joia (2006), Disterer (2003); Joia and Lemos (2010)
Personalized Training (F6)	Leonard and Sensiper (1998), Disterer (2003), Joia (2007), Stewart (1998), Murray and Peyrefitte (2007), Nonaka and Takeuchi (1997); Joia and Lemos (2010)
Knowledge sharing strategy (F7)	O´Dell and Grayson (1998), Nonaka and Takeuchi (1997), Joia (2007), Leonard and Sensiper (1998), Hansen et al. (1999); Joia and Lemos (2010)
Knowledge Reservoirs (F8)	Leonard and Sensiper (1998), Joia (2007), Hansen et al. (1999), Nonaka and Takeuchi (1997), Disterer (2003), Cross et al. (2001), Sun and Scott (2005), Fahey and Prusak (1998)
Status gain (F9)	Davenport and Prusak (2003), Disterer (2003), Szulanski (1996), Drucker (1993), Haldin-Herrgard (2000), Sun and Scott (2005), Haldin-Herrgard (2000), Leonard and Sensiper (1998), Glazer (1998); Joia and Lemos (2010)
Open door policy (F10)	Sun and Scott (2005), Disterer (2003), Fahey and Prusak (1998), Cross et al. (2001); Joia and Lemos (2010)
Personal knowledge relevance (F11)	Haldin-Herrgard (2000), Leonard and Sensiper (1998), O´Dell and Grayson (1998)
Knowledge sharing means (F12)	Daft and Lengel (1986), Roberts (2000), Leonard and Sensiper (1998), Murray and Peyrefitte (2007), Haldin-Herrgard (2000), Daft et al. (1987); Joia and Lemos (2010)
Knowledge mapping- who knows what (F13)	Wegner, Argote and Guo (2016); Lewis and Herndon (2011); ); Klimonski and Mohammed (1994); Giuliano, Hertel and Ickes (1985); Wegner (1987)
Combination of formal and informal company routines (F14)	Argote and Guo (2016); Feldman and Pentland (2003); Levitt and March (1988)
Agile Workforce (F15)	Al-Faouri et al. (2014); Al-Faouri et al. (2013); Batten Institute (2012); Vanstone (2009); Sherehiy et al (2007); Griffin & Hesketh (2003), Dyer & Shafer (2003); Plonka (1997)



### 3. METHODOLOGICAL PROCEDURES

In this section, the used methodology as well as the reasons for its selection will be explained first. Following, the data collection and analysis process will be set forth.

#### 3.1 THE DELPHI METHOD

For this study, the Delphi method was the chosen methodology. It is a method that in the presence of incomplete information becomes highly appropriate (Skulmoski et al., 2007). The Delphi method is a way to collect as well as refine the accrued expert anonymous opinions of a given area. This is done in an intercalated fashion where feedback is given to those participating in each round; requiring at least two rounds of participation.

The Delphi method was originally presented in the 1950's by Norman Dalkey and Olaf Helmer, both researchers at Rand Corporation, for an American military project (Estes, Kuespert, 1976). With time, the Delphi method was down-streamed to other areas.

According to Rowe and Wright (1999) and Assis (2016), the classic Delphi Method has four major characteristics:

- Anonymous participation—encouragement of one's free and open expression of opinion without interferences;
- Interactions that improve and clarify participants' own opinions throughout the different survey rounds;
- Controlled feedback with all participants' anonymous opinions regarding the topic. This can potentially give further clarification on the research topic as well as the possibility to change opinions based on a controlled feedback mechanism;
- Statistical clustering of the responses, allowing for a quantitative analysis and interpretation of the data.

As pointed out by Assis (2016), some authors argue that only studies that meet the four characteristics above can be considered Delphi studies (Rowe and Wright, 1999), while others have argued that modifications can be made to meet a given study's specific necessities (Adler e Ziglio, 1996; Delbeq et al., 1975; Linstone e Turloff, 2002).

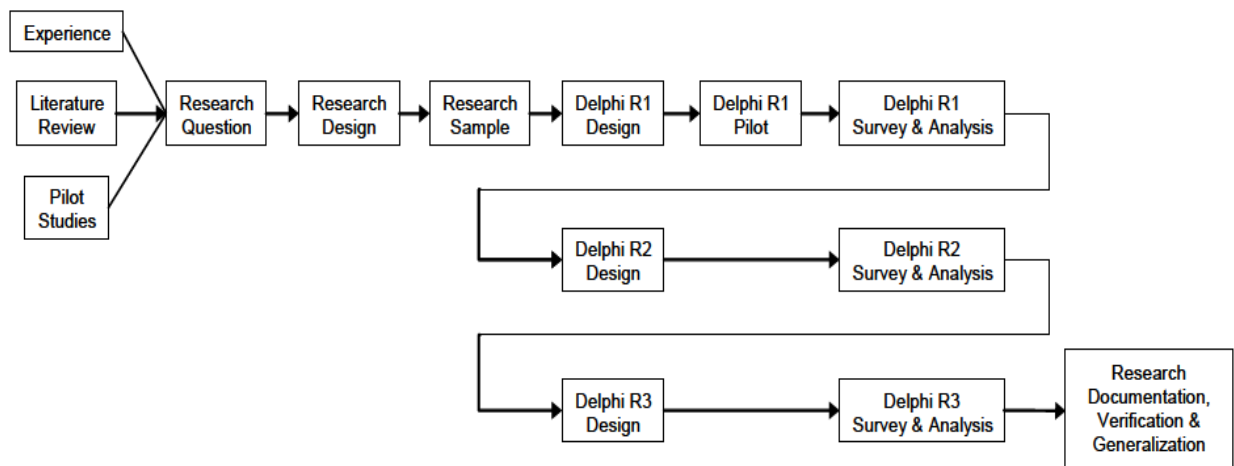
For this research, the classic definition of the Delphi Method shall be used. As such, according to Skulmoski et al. (2007) and Assis (2016), the successful application of the Delphi method must encompass the following in a research project:

- Methodological choices: Although the Delphi method uses a quantitative approach, it can also utilize a qualitative approach that respects research rigor. As such, it is the type of method that can successfully be structured under a qualitative, a quantitative or even a mixed method;
- Broad or narrow initial question: Often the initial questions are broad when the goal is to seek a wider range of answers. However, more structured and punctual questions guide participants towards a specific objective. As such, the types of questions to be asked (broad or narrow) must be well-established in the initial phase of the research project;
- Specialist choice criteria: experts must have know-how and experience with the analyzed subject; must have the ability and willingness to participate; must have enough time to participate in the different rounds of the study; and must be good communicators;
- Number of participants: there is no clear set number of participants in any given study. However, the following must be considered: in the case of group homogeneity (smaller sample size is enough, 10-15 individuals) and heterogeneity (requires a larger sample size);
- Number of rounds: pending on the research goal, the number of rounds varies. In general terms, two to three rounds are usually enough for most studies;
- Means of interaction: there are several ways for participants to interact; these being via paper and pen, email, and online surveys.

In general, a survey is passed around across experts in several rounds, this being done until a convergence of answers occurs across the group (Linstone and Turoff, 2002; Assis, 2016). As previously stated, participants remain anonymous in all rounds. According to Giovinazzo and Fischmann (2001) and Assis (2016), the rationale for that is based on the very fact that a group's judgment is far better than an individual one. In this case, the collective opinion of the given group is central to answering the research question.

The Delphi process flow is one with a specific, planned and organized sequence of actions. Figure 1 shows the overall flow of the Delphi process used in academic research. In the specific example proposed by Skulmoski et al. (2007), the authors illustrate how a three-round survey is executed.

**Figure 1- A 3 round Delphi Process**  
Source: Skulmoski et al. (2007)



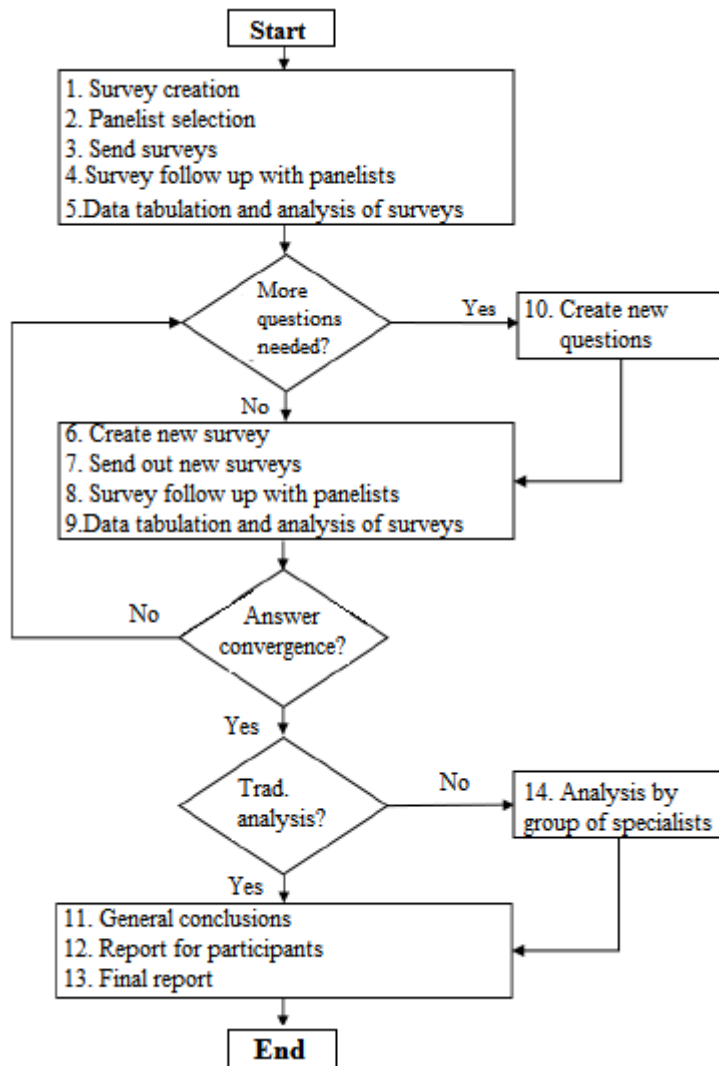
As presented in Figure 1, a research question can emerge from several potential sources: the experience an individual possesses, a literature gap or pilot studies that may point out to a given phenomenon. In the study here presented, the 15 key factors to successful tacit knowledge sharing were derived from an extensive body of literature – the starting point of the Delphi process for this research.

Illustrated in Figure 2, Prado (2016) also proposes the use of the Delphi method with a few modifications; specifically showing the expert groups' different behaviors. These modifications are also seen in Skulmoski et al. (2007), as the authors understand that there is no single Delphi method format – the circumstances and the research question determine the applicability of the method. This is shown in Figure 2 where another format with the presence of different expert groups is presented (Prado, 2016).

Regarding this study, the units of analysis for data analysis will be the firm nationality instead of the individual expert alone.

**Figure 2- Delphi research process-- Expert group analysis**

Source: Adapted from Prado (2016) and Assis (2016)



Furthermore, Brady (2015) sees the Delphi method as being pragmatic, often used in mixed study designs. However, as pointed out by Assis (2016), under qualitative studies, this pragmatic method is:

- Flexible and appropriate for quantitative as well as qualitative data;
- Accessible due to its low cost in survey application (with a range of open-ended and more structured questions);
- With a relatively low level of complexity in comparison to other methods that require specific types of configuration, technology, and knowledge.

As such, the Delphi method is appropriate for the current study as it leads to the gathering of expert opinion on knowledge sharing success factors.

## 3.2 RESEARCH DESIGN

### 3.2.1. Research Setting

Knowledge has a major role in the oil and gas industry context. As stated by Grant (2013, p.92), “the oil and gas industry has been at the forefront of the deployment of knowledge management techniques”. Several factors have caused this:

- The presence of both technological as well as market change in the petroleum segment have become highly intensified as of the 1990’s. As pointed out by Grant (2013, p.92), “the pressures resulting from the depletion of established fields, the need to explore in frontier locations (especially in deep waters) and demand for greater environmental responsibility provided massive impetus for technological advance. Upstream technologies have moved especially rapid in the areas of seismology, drilling technologies, and offshore E&P.”
- “The fast improvements in information and communication technologies (ICT) have enabled firms to gather and process unprecedented quantities of data while providing the means for globally dispersed employees to communicate and collaborate closely” (Grant 2013, p. 93).
- Extremely costly projects, typically long-term in nature, require extraordinary “careful analysis of the risks involved necessitating a marshalling of the full range of available information and knowhow relevant to the project” (Grant, 2013, p.93).
- A change of mindset from tangible assets to “knowledge-based business where superior performance is achieved through the early identification and appraisal of opportunities and their speedy exploitation” (Grant, 2013, p.94).

Essentially, tacit knowledge became a game-changer in this highly complex and fast shifting environment. Timing is key, as such, a timely response to problems leads to competitive advantages amongst the different firms. Local laws tend to favor firms up to a certain extent due to local protectionism. However, without the right technologies and know-how, firms may suffer from slower processes, higher costs, and an overall inability to push beyond its own limitations to seek new oil fields.

Furthermore, specific conditions found within the oil and gas industry suggest that the presence of solid knowledge management practices can generate the appropriate solutions for this industry. As pointed out by the Society for Petroleum Engineers (SPE), between the

years 2000 and 2010, an estimated “231,000 years of cumulative experience and knowledge would be lost in this industry in the following 10 years due to retirement of petroleum engineers and other technical staff” (Grant, 2013, p. 94). As such, adequate knowledge management practices serve to mitigate the negative impact of knowledge loss due to retirement and downsizing (Drain, 2001). In addition, finding methods to properly and fully share tacit knowledge has become standard practice in the O&G business realm to date.

### 3.2.2 Data Collection

The participants of this study are experts within the upstream area of operating firms, namely those that are responsible for oil field management and day-to-day operations.

For this specific study, in the first round, there were a total of 41 participants. They were divided into four main clusters based on their firm nationalities: 11 American participants, 10 French participants, 10 Brazilian participants, and 10 Norwegian participants. In rounds two and three, there were 39 returning participants (2 participants dropped out).

The respondents are professionals with at least seven years of experience in the upstream segment. The career areas include, but are not limited to: geology, geophysics, petrophysics, reservoir engineering, well engineering, chemistry, electrical engineering, and administrative areas.

#### a. Round One of the Delphi Method

In the first round, participants were given a survey to be answered individually and anonymously via email. The answers provided were of a quantitative nature and supported by specific justifications in the form of qualitative information (Assis, 2016). As proposed by Estes and Kuespert (1976) and Assis (2016), the answers for the quantitative questions must be tabulated using basic statistics, being the results given back to the participants as supporting feedback for the following rounds. In the case of qualitative data (justifications and opinions) related to quantitative questions, the former was listed accordingly and sent back to the participants as well.

More specifically, in this given survey, participants were asked to mark their level of agreement with each of the key success factors (refer to Annex 1 and 2 for Participant Letter and First Round Survey). This was accomplished by using a Likert-type scale (ranging from 1-strongly disagree to 5-strongly agree; and an “I do not understand the statement” option). Additionally, participants were asked to provide any supplementary comments as an

explanation of their scoring of each factor. Once participants concluded the Likert-type scale questions, they were also asked to supply any supplementary factors they thought would be important for knowledge sharing not listed within the 15 proposed in this study. There was a total of five additional new factors emerging from the participants, however, only one was included in the following round (“organizational culture” - F16). The other four factors were actually subgroups of the already presented factors.

In accordance with the given answers, a ranking of the key factors for tacit knowledge sharing emerged; from the highest to the lowest agreeance level. For the next round, a total of 16 factors were considered.

#### b. Round Two and Subsequent Rounds of the Delphi Method

Upon the conclusion and analysis of the first round results, a decision must be made on whether new complementary questions are necessary for the following round. Per the Delphi method, with every new round, the same questions are repeated, and participants reevaluate their answers using the information given from the previous rounds (Assis, 2016).

Going in line with the abovementioned, the gathered information from the first round was presented along with the new survey to the same participants. More specifically, a ranking of the key factors from round one was given to the participants, with the comments in order from the most agreed to the least agreed factors. A percentage breakdown of the agreement level was also provided for each of the 15 factors (Annex 5 and 6).

With the provided information from round one, participants were asked to carefully review the results from the previous round and rank the factors in order of the most important (1) to the least important (16) (Refer to Annex 3 and 4 for the Letter to Participants and Second Round Survey).

The same procedure was repeated in round three. Participants were given the results of round 2 and asked to rank the 16 factors in terms of their relevance.

### 3.3 DATA ANALYSIS

The rounds within the Delphi Method build on each other. The goal is to transform the given answers into a sensible set of information participants can easily read, understand, and use in the subsequent rounds.

In round one, an answer average (where 1=strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; and 5=strongly agree) for each of the 15 factors was calculated. From this average, the key success factors were ranked in terms of the most agreed to the least agreed. The “I did not understand” option was not accounted for in the average calculation. An additional factor emerged in this round based on participant comments, leading to 16 total key success factors. The compilation of the results was then provided to the participants in the second-round survey.

In the second round, after reading the results, participants were asked to rank, in terms of relevance, the factors in a 1 to 16 scale; where 1 was the most relevant and 16 the least relevant factor. Based on the participants’ answers, a new ranking was then calculated.

According to Mitchel (1992), the provided feedback in the different rounds through this method leads to the exchange of information amongst the different participants. This in essence allows for the convergence of answers.

To ensure a satisfactory group convergence level, Kendall’s coefficient of concordance (Kendall’s W) was used in the second round, when participants were explicitly asked to rank the 16 factors. According to Okoli and Pawlowski (2004), several metrics can measure ranking, however, Kendall’s W is acknowledged as being the best alternative.

As stated by Schmidt (1997), the value of W varies from 0 to 1, where 0 means there is no consensus and 1 means full consensus. As shown in Table 2, an interpretation and the confidence levels of the ranks are presented.

**Table 2-Interpretation of Kendall’s W**

<b>W (Ranges)</b>	<b>Interpretation</b>	<b>Confidence in Ranks</b>
Below 0.1	Very weak agreement	None
Above 0.1 to 0.3	Weak agreement	Low
Above 0.3 to 0.5	Moderate agreement	Fair
Above 0.5 to 0.7	Strong agreement	High
Above 0.7 to 1	Unusually strong agreement	Very High

*Source: Adapted from Assis (2016).*



Once Kendall's W was calculated and interpreted, a  $\chi^2$  statistics was then calculated to attain a p-value to determine W's significance level. The critical value was then interpreted based on the table provided by Prado (2016) (Table 3).

**Table 3 – Interpretation of Kendall's W p-value**

<b>p-value range</b>	<b>Meaning</b>
Above 0.05	Low significance
Above 0.01 to 0.05	Significant
Above 0.001 to 0.01	Very significant
Inferior to 0.001	Extremely significant

*Source: Adapted from Assis (2016) and Prado (2016)*

In this specific study, when calculating Kendall's W, as there were 16 key factors analyzed, with 15 degrees of freedom, any  $\chi^2$  above 25.00 would classify W's value as being significant since its p-value would be below 0.05 (95% confidence level). Any  $\chi^2$  above 39.72 would be considered extremely significant (p-value below 0.001).

Once this was accomplished, the ranking of both rounds one and two were statistically compared. For this purpose, Kendall's correlation coefficient (Kendall's Tau) was calculated. This specific coefficient is used to measure the order of two measured quantities. More specifically, Kendall's tau focuses on the relative order of the different items, and not the difference in their classifications (Schmidt, 1997; Assis, 2016). The closer it is to 1, the higher the consensus in the rankings, thus ensuring the conclusion of the classification.

Upon this comparison, as the convergence level between rounds one and two was not satisfactory, a third round was necessary. The abovementioned procedures were repeated and a new statistical comparison using Kendall's Tau-b and Kendall's W were calculated considering the obtained answers from rounds two and three.

## **4. RESULTS**

### **4.1 DESCRIPTIVE STATISTICS**

The sample for the presented study is composed of 41 professionals in the first round and 39 in the second and third rounds (with a minimum of six years of experience in Oil & Gas). The firm nationalities are as follow: American, Brazilian, French and Norwegian (Table 4).

In the first round, from the 41 participants involved in this research, 22 were female (53.66%) and 19 were male (46.34%). For the second and third rounds, out of the 39 respondents (2 dropouts: one participant left the firm for another job and the other was on a medical leave of absence), 21 were female (53.85%) and 18 were male (46.15%). The average age of the participants is 38.51, being that the youngest participant was 29 and the oldest 58 years old. Regarding the years of experience in the upstream segment, the group presented an average of 12.41 years of experience, 6 years being the lowest and 32 the highest.

Additionally, the group was mostly made up of individuals with graduate degrees (22 individuals with Master’s degrees and 2 with PhDs) making up 58.54%. The remaining participants had undergraduate degrees (17 participants with a 4-year bachelor degree), making up 41.46%. As there were two less participants on the second and third rounds, there were a few minor differences. In these rounds, individuals with a graduate degree accounted for 51.28% (20 individuals with Master degrees and 2 with PhDs) and those with an undergraduate degree accounted for 43.59% (17 participants with a 4-year bachelor degree). This is illustrated in Table 4.

**Table 4– Delphi Panel Participants: Educational Background and Firm Nationality Breakdown**

	<b>Round 1</b>		<b>Round 2</b>		<b>Round 3</b>	
<b>Educational Level</b>	<i>% of Total</i>	<i>Number of Participants</i>	<i>% of Total</i>	<i>Number of Participants</i>	<i>% of Total</i>	<i>Number of Participants</i>
4-Year Bachelor’s Degree	41.5	17	43.6	17	43.6	17
Master's Degree	53.7	22	51.9	20	51.9	20
PhD	4.9	2	5.1	2	5.1	2
<b>Firm Nationality</b>	<i>% of Total</i>	<i>Number of Participants</i>	<i>% of Total</i>	<i>Number of Participants</i>	<i>% of Total</i>	<i>Number of Participants</i>
American	26.8	11	23.1	10	23.1	10
Brazilian	24.4	10	25.6	9	25.6	9
French	24.4	10	25.6	10	25.6	10
Norwegian	24.4	10	25.6	10	25.6	10

#### 4.2 FIRST ROUND DELPHI METHOD RESULTS

The results of the first round were treated using basic statistics. Table 5 illustrates the results (not in order of relevance) for each key factor divided into three categories: Total Agree (composed of “strongly agree” and “agree” answers); Total Neither Agree nor

Disagree; and Total Disagree (composed of “strongly disagree” and “disagree answers). Not included were those who chose the alternative “I did not understand the item”.

**Table 5- First Round Antecedent Evaluation**

Key Success Factors in KS	Total Agree	Total Neither Agree nor Disagree	Total Disagree
(F1) Individual time availability	95%	2.50%	2.50%
(F2) Shared technical jargon	90.25%	2.44%	7.32%
(F3) Trust on technical abilities	97.56%	2.44%	0%
(F4) Network connections	97.56%	2.44%	0%
(F5) Acknowledgement	85.92%	9.76%	7.32%
(F6) Personalized training	87.8%	7.32%	4.88%
(F7) Knowledge sharing strategy	82.50%	7.50%	10%
(F8) Knowledge reservoirs	72.74%	7.32%	19.94%
(F9) Status	72.50%	12.5%	15%
(F10) Open door policy	92.68%	2.44%	4.88%
(F11) Personal knowledge relevance	70.72%	12.20%	17.08%
(F12) Knowledge sharing means	87.80%	9.76%	2.44%
(F13) Knowledge mapping- who knows what	97.56%	2.44%	0%
(F14) Combination of formal and informal company routines	82.50%	10%	7.50%
(F15) Agile workforce	82.93%	2.44%	14.63%

The average for each of the 15 proposed key success factors was also calculated using the method explained under section 3.2.2; generating an average result rank. Additionally, the comments provided by the participants were compiled and can be found under Annex 6.

Round one’s rank can be found in Table 6 from the highest average score (most agrees) to the lowest average score.

**Table 6 – First Round Rank Based on Average Scores**

Rank	Key Success Factor in Knowledge Sharing (Round 1)	Average Score (From 1 to 5)
1	Open door policy (F10)	4.39
1	Network connections (F4)	4.39
2	Knowledge mapping- who knows what (F13)	4.37
3	Trust on technical abilities (F3)	4.34
4	Individual time availability (F1)	4.30
5	Knowledge sharing means (F12)	4.22
6	Personalized training (F6)	4.12
7	Shared technical jargon (F2)	4.10
8	Acknowledgement (F5)	4.05
9	Agile workforce (F15)	4.00
10	Combination of formal and informal company routines (F14)	3.98
11	Knowledge sharing strategy (F7)	3.95
12	Knowledge reservoirs (F8)	3.73
13	Status (F9)	3.70
14	Personal knowledge relevance (F11)	3.59

In round one, the 41 participants’ top choices were: “open door policy” (F10) with a 92.68% agreement rate and “network connections” (F4) with a 97.56% agreeance rate. Both factors obtained an average score of 4.39 (see Table 6). This means that on average, participants felt that a firm’s open door policy (firm openness regarding the tolerance level for questioning and critique) as well as the presence of a network connection (the link between those who own type A knowledge and those who need type A knowledge) led individuals to more likely share what they knew with their fellow colleagues.

The runner up factor was “knowledge mapping-who knows what” (F13), with a 97.56% total agreement rate (summation of strongly agree and agree answers), with an average score of 4.37 (Tables 5 and 6). In third place, with an average score of 4.34 (Table 6) and a 97.56% agreeance rate was “trust on technical abilities” (F3), which meant that individuals trusted their co-workers’ abilities.

Moreover, the three key factors with the lowest average scores were: “knowledge reservoirs” (F8) with an average score of 3.73 (12<sup>th</sup> place rank); “status” (F9) with an average score of 3.70 (13<sup>th</sup> place rank); and “personal knowledge reference” (F11) with an average score of 3.59 (14<sup>th</sup> place rank).

#### 4.3 SECOND ROUND DELPHI METHOD RESULTS

In this round, as previously stated, participants were asked to review the first-round average score ranking and create a re-rank the key factors ranging from 1 to 16, in terms of

relevance (1 most relevant and 16 the least). Organizational culture was an additional factor proposed by the participants, changing the total of proposed factors from 15 to 16. With the provided answers, an average score was calculated for each factor leading to a new rank (Table 8). The lower the factor score in this round, the more relevant the factor was seen in terms of knowledge sharing. Additionally, in this case, the logic behind the ranking requires participants to rank each factor taking all others into account. For example, by placing a “1” next to a factor, such rank could no longer be used again. This is a bit different from the first round where the results served essentially to validate the proposed key factors as well as gather any additional factors proposed by the participants.

To ensure that the overall rank obtained in the second round represented the convergence of the group vision, Kendall’s W was calculated. In this round, Kendall’s W value was 0.289, which equates to a low level of concordance among the participants (refer to Table 2 for interpretation). This is also illustrated in Table 7 via additional relevant information. The  $\chi^2$  value was also calculated (168.93) along with its p-value (0.000). This means that the obtained Kendall’s W is classified as being highly significant.

**Table 7 – Second Round Delphi Statistics**

<b>Delphi Panel Stats</b>	<b>Second Round</b>
Number of Factors	16
Number of Participants	39
Kendall’s Coefficient of Concordance (W)	0.289
$\chi^2$	168.93
p-value	.000

Regarding the overall ranking of the key factors, as illustrated on Table 8, the top three ranked factors were as follow: “open door policy (F10)” remained as the number one key factor, “organizational culture (F16)” came in second place and “knowledge mapping-who knows what (F13)” also remained as the third contender. Interestingly, “status (F9)” was ranked in last place this time around.

An interesting aspect presented in this second round was that several of the top contenders on the first round ended up ranking much lower. Partially, this is due to the added proposed factor. This additional factor (“organizational culture” - F16) came in second place overall (Table 8) and remained as one of the top 5 factors in all four firms.

**Table 8 – Second Round Overall Key Factor Rank**

Rank	Convergence of Key Success Factor in Knowledge Sharing (Round 2)	Average Score (1 to 16)
1	Open door policy (F10)	3.38
2	Organizational culture (F16)	3.50
3	Knowledge mapping- who knows what (F13)	3.75
4	Trust on technical abilities (F3)	3.88
5	Network connections (F4)	5.50
6	Knowledge sharing means (F12)	6.50
7	Agile workforce (F15)	7.63
8	Knowledge sharing strategy (F7)	8.63
9	Combination of formal and informal company routines (F14)	9.25
10	Personal knowledge relevance (F11)	9.63
11	Knowledge reservoirs (F8)	10.00
12	Personalized training (F6)	10.50
13	Individual time availability (F1)	10.75
14	Acknowledgement (F5)	13.38
15	Shared technical jargon (F2)	14.25
16	Status (F9)	15.50

#### 4.4 CONVERGENCE CHECK—COMPARING ROUNDS ONE AND TWO

According to the Delphi method, a certain level of convergence must be present between the different rounds. A high enough convergence level means that data gathering in further rounds is not necessary.

Upon following the procedures depicted under section 3.2.2 (Data Analysis), where the results of rounds one and two were statistically compared, the convergence check results were as follow (Table 9):

**Table 9 - First & Second Round Convergence Check**

Delphi Panel Stats	First & Second Round Comparison
Number of Factors	15
Kendall's Coefficient of Correlation (Tau-b)	- 0.476
z-score	0.0152

When comparing the results from rounds one and two, Kendall's Tau-b was -0.4785, showing a very low convergence rate between both rounds.

A possible explanation for the results is that a comparison between rounds one and two may not have been appropriate for the following reasons. Round one served as a validation for the 15 proposed factors. It also gave a chance for participants to add any other key factors. In round two, participants were asked to rank the 16 key factors in terms of

relevance. More specifically, in round two, each factor was ranked while taking the others into account. Although a rank naturally emerged in round one, the rationale behind the first round is fundamentally different from what is proposed in round two. Both lead to a rank, however, using different thought processes. Consequently, most of the factors ranked with low averages (high relevance) in round one score higher (lower relevance) in round two. Furthermore, the additional 16<sup>th</sup> factor ranked in second place in terms of relevance in the second round, thus impacting the entire ranking system.

As a result of Tau-b’s score and Kendall’s W value, a third round was necessary, and the scores will be further explained in the next section.

#### 4.5 THIRD ROUND DELPHI METHOD RESULTS

Following the data analysis procedures explained in section 3.2.2, to ensure a group convergence rate of the group vision within round three, Kendall’s W was calculated for the third round. In this round, Kendall’s W value was 0.980, equating to a very high concordance confidence (refer to Table 2 for interpretation). This is also illustrated in Table 10 via additional relevant information. The  $\chi^2$  value was also calculated (513.314) along with its p-value (0.000). The resulting W value was very high and significant, illustrating a high opinion agreement level of participant answers within round three.

**Table 10 – Third Round Delphi Statistics**

<b>Delphi Panel Stats</b>	<b>Third Round</b>
Number of Factors	16
Number of Participants	39
Kendall’s Coefficient of Concordance (W)	0.980
$\chi^2$	513.314
p-value	.000

In terms of the overall ranking of the key factors, as illustrated in Table 11, the top three ranked factors were as follow: “open door policy” (F10) remained as the number one key factor, “organizational culture” (F16) came in second place and “trust on technical abilities” (F3) moved up from fourth to third place. In last place, “status (F9)” was seen as the least relevant factor in knowledge sharing.

**Table 11 – Third Round Overall Key Factor Rank**

Rank	Convergence of Key Success Factor in Knowledge Sharing (Round 3)	Average Score (1 to 16)
1	Open door policy (F10)	1.26
2	Organizational culture (F16)	2.03
3	Trust on technical abilities (F3)	3.54
4	Knowledge mapping- who knows what (F13)	3.51
5	Network connections (F4)	4.67
6	Knowledge sharing means (F12)	6.28
7	Agile Workforce (F15)	6.79
8	Knowledge sharing strategy (F7)	8.15
9	Combination of formal and informal company routines (F14)	8.90
10	Personal knowledge relevance (F11)	10.15
11	Knowledge Reservoirs (F8)	11.21
12	Personalized Training (F6)	12.10
13	Individual Time availability (F1)	12.44
14	Acknowledgement (F5)	14.23
15	Shared technical jargon (F2)	14.77
16	Status (F9)	15.97

**Table 12 – Rank Comparison Between Rounds Two and Three**

Rank Round 2	Key Success Factor in Knowledge Sharing	Rank Round 3
1	Open door policy (F10)	1
2	Organizational culture (F16)	2
3	Knowledge mapping- who knows what (F13)	4
4	Trust on Technical abilities (F3)	3
5	Network connections (F4)	5
6	Knowledge sharing means (F12)	6
7	Agile Workforce (F15)	7
8	Knowledge sharing strategy (F7)	8
9	Combination of formal and informal company routines (F14)	9
10	Personal knowledge relevance (F11)	10
11	Knowledge Reservoirs (F8)	11
12	Personalized Training (F6)	12
13	Individual Time availability (F1)	13
14	Acknowledgement (F5)	14
15	Shared technical jargon (F2)	15
16	Status (F9)	16

Overall, the key factors ranked the same as round two; the exceptions were “trust on technical abilities” (F3) and “knowledge mapping-who knows what” (F13), where they flipped in terms of positioning. F3 moved up to third place and F13 moved down to fourth place (Table 12).

A comparison between the individual factor ranking for rounds two and three is shown on Table 12.



To ensure a consistent preference among the participants in terms of their choices in rounds two and three, a convergence check was done. This is further explained in the next section.

#### 4.6 CONVERGENCE CHECK—COMPARING ROUNDS TWO AND THREE

To certify that the level of confidence on the rank results satisfies the requirements, as depicted in Table 2, a statistical comparison between rounds two and three was done. This was accomplished via the calculation of Kendall’s Tau-b, where its value was equivalent to 0.950 (Table 13). In other words, rounds two and three show a high consistent opinion preference among the different participants.

**Table 13 - Second & Third Round Convergence Check**

<b>Delphi Panel Stats</b>	<b>Second &amp; Third Round Comparison</b>
Number of Factors	16
Kendall’s Coefficient of Correlation (Tau-b)	0.950
p-value	0.000

As previously stated, Kendall’s Tau is used to measure the order of two measured quantities. More specifically, Kendall’s tau focuses on the relative order of the different items and not the difference in their classifications (Schmidt, 1997; Assis, 2016). The closer it is to 1, the higher the consensus in the rankings, thus ensuring that the classification process is concluded. As such, based on these results, there is a high enough level of agreement between rounds two and three, thus signaling no need for further rounds.

#### 4.7 RANK BASED ON FIRM NATIONALITY

The last two rounds (rounds two and three) were divided into four major clusters based on firm nationality (American, Brazilian, French and Norwegian). Additionally, the respective key factor average scores were also calculated, leading to a general rank as well as a rank based on firm nationality for rounds two (Table 14) and three (Table 15). This was done specifically for rounds two and three, since an acceptable level of convergence achieved.

The “overall” column refers to the general average scores for all four firm nationalities. In this specific column, the results were ranked in order from the most to the least relevant factors in terms of knowledge sharing. The other four columns (American, Brazilian, French and Norwegian) refer to firm nationality.

Regarding the general results, the top five factors were the same for rounds one and two. In first place was “open door policy” (F10), which refers to the “firm tolerance level for questioning and critique”. On the other hand, the least relevant factor also remained the same for rounds one and two; “status” (F9), which is defined as “knowledge seen as a source of power that leads to status—self-benefit as consequence of sharing knowledge”.

In round two, the correlation between each firm and the general rank was as follows: the American firm had the highest similarity in preference in comparison to the general choices (0.7448), followed by the Norwegian firm (0.6611), French (0.6276), and lastly the Brazilian firm (0.5714) (Table 14).

**Table 14 – Round Two- Key Factor Rank by Nationality Based on Average Scores**

Key Success Factor in Knowledge Sharing	Rank Based on Firm Nationality (Round 2)				
	Overall	American	Brazilian	French	Norwegian
Open door policy (F10)	1	1	1	3	7
Organizational culture (F16)	2	5	4	1	2
Knowledge mapping- who knows what (F13)	3	3	3	2	6
Trust on Technical abilities (F3)	4	2	3	8	1
Network connections (F4)	5	8	2	5	5
Knowledge sharing means (F12)	6	7	7	3	6
Agile Workforce (F15)	7	6	8	10	3
Knowledge sharing strategy (F7)	8	4	11	7	8
Combination of formal and informal company routines (F14)	9	9	9	11	4
Personal knowledge relevance (F11)	10	4	13	6	11
Knowledge Reservoirs (F8)	11	10	12	4	9
Personalized Training (F6)	12	11	6	9	12
Individual Time availability (F1)	13	12	5	12	10
Acknowledgement (F5)	14	13	8	15	13
Shared technical jargon (F2)	15	14	10	14	14
Status (F9)	16	15	14	13	15
<b>Kendall's Correlation Coefficient (Tau-b) for individual nationality compared to the overall.</b>	1.000	0.7448	0.5714	0.6276	0.6611

In round three, as expected under the Delphi method, there was a much higher answer convergence rate. This is partially due to the participants’ continuous exposure to the topic at hand. All four participating firms ranked “open door policy” (F10) as the most relevant factor and “organizational culture” (F16) as the second most relevant one (Table 15). “Trust on technical abilities” (F3) was the third most relevant factor for the Brazilian and Norwegian firms, whereas “knowledge mapping-who knows what” (F13) was the third most relevant for the French firm, and “knowledge connections” (F4) for the American firm. In all, although in different positions, all four firms had the same top five factors as the overall ranks.

**Table 15 – Round Three - Key Factor Rank by Nationality Based on Average Scores**

Key Success Factor in Knowledge Sharing	Rank Based on Firm Nationality (Round 3)				
	Overall	American	Brazilian	French	Norwegian
Open door policy (F10)	1	1	1	1	1
Organizational culture (F16)	2	2	2	2	2
Trust on Technical abilities (F3)	3	5	3	4	3
Knowledge mapping- who knows what (F13)	4	4	4	3	4
Network connections (F4)	5	3	5	5	5
Knowledge sharing means (F12)	6	6	6	6	6
Agile Workforce (F15)	7	7	6	7	7
Knowledge sharing strategy (F7)	8	8	7	8	8
Combination of formal and informal company routines (F14)	9	9	8	9	9
Personal knowledge relevance (F11)	10	10	9	10	10
Knowledge Reservoirs (F8)	11	12	10	11	11
Personalized Training (F6)	12	13	11	12	12
Individual Time availability (F1)	13	11	12	13	13
Acknowledgement (F5)	14	14	13	14	14
Shared technical jargon (F2)	15	15	14	15	15
Status (F9)	16	16	15	16	16
<b>Kendall's Correlation Coefficient (Tau-b) for individual nationality compared to the overall.</b>	1.000	0.917	0.996	0.983	1.000

The statistics regarding the final round are presented on Table 16. Kendall's W value in all four firm nationalities as well as the overall ranking are significantly higher than 0.900. This illustrates a high agreement level between the participants within their respective groups (Table 2).

For the third round of this study,  $\chi^2$  was calculated and used to measure the significance level of the calculated Kendall's W value. In this case, as is shown in Table 16, on average, Kendall's W values, in all four groups as well as for the overall rank, are highly significant.

In terms of the correlation (Tau-b) between the individual firm rankings with the overall ranking, as shown in Table 15, the Norwegian firm presented the highest consensus on average (1.000). On average, in the Norwegian firm, participants ranked the key factors in the same order as the overall ranking. The second highest similarity of preference with the overall ranking was the Brazilian firm (0.996), followed by the French firm (0.983), and lastly the American firm (0.917).

When comparing the convergence level between the overall rankings in rounds two and three, Kendall's Tau-b value was 0.950 (Table 17). The closer Tau-b's value is to one, the higher the similarity in ranking preferences amongst the distinct groups (Table 17). When looking from an individual firm perspective, the values differed when compared to the overall

scores. The overall sample size is much bigger than the individual cluster samples sizes. As such, due to the small country sample size, the variances are much more noticeable. Additionally, when comparing the ranking preferences from round two (Table 14) and round three (Table 15), the opinions changed expressively, as such, impacting the within convergence rate values, consequentially, impacting Tau-b`'s value. Even though this is the case, the results are still enough to illustrate a sufficient level of convergence.

In terms of the highest correlation among the different firms in the last round, the Brazilian and Norwegian ranking had a Kendall's Tau- b value of 0.996 (Table 18). This meant that both firms had the most similarity in terms of opinion preferences.

**Table 16 – Third Round—W Value Based on Firm Nationality**

Delphi Panel Stats	Rank Based on Firm Nationality (Round 3)				
	Overall	American	Brazilian	French	Norwegian
Number of Factors	16	16	16	16	16
Number of Participants	39	9	10	10	10
Coefficient of Concordance (W)	0.980	0.969	0.995	0.988	0.987
$\chi^2$	573.31	130.79	149.23	148.27	148.07
p-value	0.000	0.000	0.000	0.000	0.000

**Table 17 - Second & Third Round Convergence Check Based on Firm Nationality**

	Nationality Clusters				
	Overall	American	Brazilian	French	Norwegian
Kendall's Correlation Coefficient (Tau-b)	0.950	0.678	0.532	0.628	0.678
p-value	0.000	0.000	0.004	0.001	0.000
Number of Factors	16	16	16	16	16

\*Individual nationality cluster comparison between rounds two and three.

**Table 18 – Kendall's Correlation Coefficient (Tau-b)—Third Round Comparisons Between Firm**

	American x Brazilian	American x French	American x Norwegian	Brazilian x French	Brazilian x Norwegian	Norwegian x French
Kendall's Correlation Coefficient (Tau-b)	0.912	0.913	0.917	0.979	0.996	0.983
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Number of Factors	16	16	16	16	16	16

## 5. DISCUSSION

The main objective of this work is to obtain, via Delphi Method, a rank of the key success factors for intrafirm knowledge sharing. As such, based upon the obtained results, the final rank of the key success factors in knowledge sharing (in order of relevance) is:

- 1) Open Door Policy (F10): Firm openness regarding the tolerance level for questioning and critique;
- 2) Organizational Culture (F16): Daily firm encouragement to share knowledge as a corporate norm; initiatives such as “learning by sharing”;
- 3) Trust on Technical Abilities (F3): Trust in co-workers’ abilities;
- 4) Knowledge Mapping- who knows what (F13): Knowing who the experts in specific knowledge sources are;
- 5) Network Connections (F4): The systems in place and the link between those who own type A knowledge and those who need type A knowledge;
- 6) Knowledge Sharing Means (F12): The way communication takes place between individuals within an organization;
- 7) Agile Workforce (F15): Individual ability to deal with emerging problems in a proactive, adaptable and resilient way;
- 8) Knowledge Sharing Strategy (F7): focus on people's interactions--conversations, face to face talk, etc;
- 9) Combination of Formal and Informal Company Routines (F14): Knowing the procedures within the firm in terms of standardized steps of actions;
- 10) Personal Knowledge Relevance (F11): The acceptance level of suggestions and ideas that are not supported by data within the organization [i.e. intuition, personal abilities etc];
- 11) Knowledge Reservoirs (F8): Individuals as primary sources of knowledge, not computers, manuals and databases;
- 12) Personalized Training (F6): The prioritization of personalized training with the participation of experienced employees--shadow programs, mentoring programs etc;
- 13) Individual Time Availability (F1): Having time to share knowledge within the firm;
- 14) Acknowledgement (F5): Reward systems that acknowledge and reward knowledge sharing actions;
- 15) Shared Technical Jargon (F2): The common technical language among individuals;

16) Status (F9): Knowledge seen as a source of power that leads to status--self-benefit as consequence of sharing knowledge.

Upon the analysis of the general results, several interpretations can be made. These will be discussed for each of the above ranked factors.

Based on the participants' answers, **open door policy** was selected as the most relevant factor when it comes to knowledge sharing. This is precisely aligned with what was stated by Joia and Lemos (2010). Joia and Lemos (2010) express that the presence of a safe psychological environment to self-express as well to give new opinions and ideas fosters knowledge sharing. Having an environment that enables individuals to know one another, conflicts and conflicting ideas are better handled, consequentially enriching the level of available knowledge (Sun and Scott, 2005).

In fact, a place where individuals feel safe to express what they know leads them to be willing to share what they know. In other words, this factor can be understood as the foundation for knowledge sharing.

**Organizational culture** was selected by the participants as the second most relevant key factor. Interestingly, this factor was proposed by the participants in round one, and included for rounds two and three surveys. The concept of organizational culture is often misunderstood when in the real world. Culture refers to what supports and guides the behavior, not necessarily the execution of behavior itself (Alvesson and Sveningsson, 2015). Smircich (1985) explains that as such, organizations are systems in which there are "continuing organized activities so that interaction can take place without constant interpretation and re-interpretation of meaning" (p. 64). As depicted by Alvesson and Sveningsson (2015) and Hofstede et al. (1990), there are seven major characteristics regarding organizational culture:

- Involves groups of individuals;
- Historically related, expressed through traditions and customs;
- Inert and hard to change;
- Socially constructed phenomenon;
- It is soft, ambiguous, and difficult to catch;
- Terminology such as ritual and symbols often are used to categorize culture;

-Relates to the way of thinking, values, and ideas of things rather than solid, objective, and a more visible aspect of the organization.

Interestingly, the more one identifies with the organization, the more distinct the emerging organizational culture tends to be (Alvesson and Sveningsson, 2015). Through a well-established culture, individuals may then develop a sense of identity with the firm. This in turn impacts knowledge sharing within the firm.

Following in line within the top five contenders, **trust on technical abilities** ended up as the third most relevant factor. Several authors have shown the combination of trust and good relations amongst individuals within the firm are key to knowledge sharing (Al-Alawi et al., 2007; Zakaria et al., 2004; Cheng et al., 2008; Das and Teng, 1998; Kramer, 1999; Lucas, 2005; Wu et al., 2009). In fact, mutual trust can work as an enabler for knowledge sharing while also increasing collaboration amongst the different parties (Dulaimi, 2007).

Supported by the findings of Wegner et al., (1985) and Argote and Guo (2016), **knowledge mapping** is understood as the fourth most relevant factor. Also known as TMS, knowledge mapping allows groups and organizations to match tasks to the most qualified members. The benefit of TMS is one that leads to the performance of tasks to be completed more efficiently (Argote and Guo, 2016). Firms deal with an immense amount of information where time is central. This efficiency of knowing who the experts are is one that leads individuals to share what they know, as they are perceived as the primary source of such knowledge.

**Network connections** was the fifth most relevant key factor in this study. As stated by Joia and Lemos (2010) p. 414, “the form of communication within the company depends on an internal relationship network.” This internal relationship network has a direct impact on how and to what extent individuals share what they know. The more hurdles in place, the more negative impact on knowledge sharing. As such, the link between those who own type A knowledge and those who need type A knowledge are extremely relevant to knowledge sharing.

Complementing the fifth most relevant factor, as the sixth most relevant key factor is **knowledge sharing means**. The systems are indeed important and require a thoughtful selection for best results. According to Roberts (2000) and Joia and Lemos (2010), the presence of a rich communication media is central in knowledge sharing. One of the most powerful means of communication is face to face conversation. This method yields the

highest level of communication as it encompasses several elements relevant to enabling proper knowledge sharing (Haldin-Herrgard, 2000; Leonard and Sensiper, 1998). In contrast, these are not always possible as firms are present across borders. As such, specific systems must be in place to allow for the proper level of knowledge sharing.

Another poignant factor is an individual's ability to deal with emerging problems in a proactive, adaptable and resilient manner. **Agile workforce** was selected as the seventh most relevant key factor in knowledge sharing. An agile workforce is one with a positive attitude regarding learning and self-development, ability of problem-solving while also generating innovative ideas, accepting new responsibilities, being comfortable with change, new ideas and technology (Plonka,1997; Al-Faouri et al., 2014). The individual's own drive to diagnose problems and seek solutions is one that leads to KS.

The eighth most relevant factor was **knowledge sharing strategy**. The two main choices are: a people-focused strategy (dialogue as well as relationship developed between the different individuals; which is essentially achieved through social contact) (Joia and Lemos, 2010; Joia, 2007; Hansen et al., 1999; Leonard and Sensiper, 1998; Nonaka and Takeuchi, 1997); and a reuse strategy (knowledge databases to be accessed and used by individuals) (Joia and Lemos, 2010; Hansen et al., 1999). These two distinct strategies are necessary for knowledge sharing to take place within the firm.

The **combination of formal and informal company routines** was the ninth most relevant factor in knowledge sharing according to the participants. Knowing the procedures within the firm in terms of standardized steps of actions is a part of getting individuals to share what they know. In fact, order and repetition of action are only a few of the components that enable continuous results. Also, through routines, firms can give continuity, at least to some extent, to their purpose.

**Personal knowledge relevance, knowledge reservoirs, and personalized training** came in tenth, eleventh, and twelfth place respectively. These three factors specifically deal with the individuals as a central element to the mix of KS, however, in a more abstract fashion. Here, a more tacit approach is key, and yet, individuals ranked these three factors among the least relevant factors.

Surprisingly, in thirteenth place was **time availability**. Although time is considered a limited resource, individuals did not perceive it as a deterring factor in sharing knowledge. Individuals are often caught up in their own tasks, as such, taking the time to help, converse



or even teach someone a new skill is time-consuming. Yet, individuals did not rank time availability as an issue regarding sharing what they knew.

The rewards systems, or **acknowledgement** is the third least relevant factor. It ranked in fourteenth place. Although Al-Alawi et al. (2007) and Xiong and Deng (2008) argue that the more acknowledgment, the more individuals tend to share, the reality is that, within this specific group of participants, this fact was not seen as a top priority one. It is a source of encouragement to share knowledge (Disterer, 2003; Szulanski, 1996), but when compared to the other fifteen proposed factors, it did not rank as a top contender.

In fifteenth place, **shared technical jargon** was viewed as one of the least relevant key factors from the sixteen proposed ones. In fact, in the context of O&G, professional backgrounds and language diversity are second nature to most employees. As such, a shared language can be understood to be present as a base for daily activities, and such environment does not exist without it. It is no longer considered a differentiating fact in a context where language difference and multidisciplinary backgrounds are the norm.

In last place was **status**. Status here is defined as having knowledge seen as a source of empowerment for both the individual as well as the group within the firm (Joia and Lemos, 2010). The idea that as individuals shared what they knew, they gained power within the firm was not seen as a highly relevant cause for sharing knowledge. In fact, this was also the case in the second round.

A comparison between the overall rankings of rounds two and three (Table 12) shows an agreement level for almost all factors between rounds two and three. The top five most relevant factors were the same in both rounds two and three. The same can be said about the least relevant five factors. However, within the top five most relevant factors, there was a flip between the third and fourth place going from second round to third round. Participants, on average, saw that “trust on technical abilities” (F3) was more relevant than “knowledge mapping- who knows what” (F13) on the third round. This was achieved via Delphi method, where participants are able to reevaluate their previously given opinion by means of confirmation (ranking as is) or negation (re-ranking if necessary) of previous results.

From an overall rank perspective to a more nationality cluster analysis, the ranks varied slightly. Below, the results will be explored based on firm nationality.

*American*

In round two, although there was a total of sixteen factors, the rank ranged from one to fifteen. The reason for this is that “knowledge sharing means” (F12) and “personal knowledge reference” (F11) were both ranked in fourth place. This means that, on average, individuals within the American firm understood that “knowledge sharing means” and “personal knowledge reference” had the same weight in relevance. Also, when comparing the results for round two based on firm nationality and the overall rank (Table 14), the only identical factor rank is “open door policy” (F10). The remaining factor rankings differed from the overall scores.

When comparing the American firm rankings in rounds two and three, the results varied a great deal. In fact, as is expected by Delphi method, the answers converged towards a higher consensus in the last round. The reason for this is that, with each round, participants had the opportunity to look over the ranking generated in the previous round and essentially reevaluate their own opinions. Hence a higher alignment of opinions, on average, when comparing round three in the American firm rankings and overall rankings.

Although such is the case, there are still some slight differences when it comes to the opinions of the participants within the American firm and the general ranking. “Open door policy” (F10) and “organizational culture” ranked the same as the overall ranking (Table 19). However, “network connections” (F4) was the third most relevant factor, differing from the general opinion. The fourth factor, “knowledge mapping-who knows what” (F13), ranked in the same spot as the general scores. In fifth place, differing from the general ranking, “trust on technical abilities” (F3) moved down in terms of relevance from second place in the second round.

The last five factors (rankings eleven through sixteen), although in slightly different order, were the same factors seen as least relevant in KS in the overall ranking (Table 19). In rounds two and three, “shared technical jargon” (F2) and “status” (F9), are seen as having the smallest impact on knowledge sharing within the firm.

**Table 19 – Comparing Rounds Two and Three Rankings (American Firm)**

Key Factor	Final Overall Rank	American Round Two Rank	American Round Three Rank
Open door policy (F10)	1	1	1
Organizational culture (F16)	2	5	2
Trust on Technical abilities (F3)	3	2	5
Knowledge mapping- who knows what (F13)	4	3	4
Network connections (F4)	5	8	3

Knowledge sharing means (F12)	6	7	6
Agile Workforce (F15)	7	6	7
Knowledge sharing strategy (F7)	8	4	8
Combination of formal and informal company routines (F14)	9	9	9
Personal knowledge relevance (F11)	10	4	10
Knowledge Reservoirs (F8)	11	10	12
Personalized Training (F6)	12	11	13
Individual Time availability (F1)	13	12	11
Acknowledgement (F5)	14	13	14
Shared technical jargon (F2)	15	14	15
Status (F9)	16	15	16

### *Brazilian*

In both rounds two and three, there was a total of sixteen ranked factors. However, the rankings varied from one to fourteen in round two and one to fifteen in round three. The reason for this discrepancy is that some factors tied in terms of relevance. In round two, “trust on technical abilities” (F3) and “knowledge mapping – who knows what” (F13) were equally ranked as the third most relevant factor in knowledge sharing. Also tied in the second round in eighth place were “agile workforce” (F15) and “acknowledgement” (F5). In terms of the third round, “knowledge sharing means” (F12) and “agile workforce” (F15) stood out as the sixth most relevant factor in knowledge sharing. For this reason, many of the factor rankings in round two and three do not match in terms of their numerical placing. However, in a more generalist view, those that ranked low in relevance in round two also remained low in round three and those that ranked with a high relevance in round two remain high in round three.

As is shown on Table 14, differences also emerged when comparing the Brazilian firm and overall rankings of round two. Although such was the case, “open door policy” (F10) was the most relevant factor in rounds two and three (Table 20). “Network connections” (F4) was the second most relevant factor in round two while it was ranked fifth in the third round.

As was expected in the Delphi method, upon analyzing the results of round two, participants had the opportunity to confirm their preferences in a third round (Table 20). In this case, although not perfectly aligned, most factors matched their placing with the overall rankings (Table 20). As was previously mentioned, there was a tie for sixth place in this round. Consequentially impacting the subsequence ranking and their comparison to the general ranking.

All in all, individuals in round three concurred with the ranking results of round two. Essentially fortifying a higher level of overall group consensus. Those factors ranked high in relevance in the general ranking were also for the Brazilian firm. The same can be said about the factors of lower relevance.

**Table 20 - Comparing Rounds Two and Three Rankings (Brazilian Firm)**

Key Factor	Overall Final Scores	Brazilian Round Two	Brazilian Round Three
Open door policy (F10)	1	1	1
Organizational culture (F16)	2	4	2
Trust on Technical abilities (F3)	3	3	3
Knowledge mapping- who knows what (F13)	4	3	4
Network connections (F4)	5	2	5
Knowledge sharing means (F12)	6	7	6
Agile Workforce (F15)	7	8	6
Knowledge sharing strategy (F7)	8	11	7
Combination of formal and informal company routines (F14)	9	9	8
Personal knowledge relevance (F11)	10	13	9
Knowledge Reservoirs (F8)	11	12	10
Personalized Training (F6)	12	6	11
Individual Time availability (F1)	13	5	12
Acknowledgement (F5)	14	8	13
Shared technical jargon (F2)	15	10	14
Status (F9)	16	14	15

### *French*

A comparison of the firm specific ranking with the overall ranking in round two show that none of the factors' relevance positioning matched. Numerically speaking, the French firm ranked the factors in a way that was not aligned with the general opinion of the firms all together (Table 14). However, the five most and least relevant factors were the same for the French and overall rankings in round two. The exceptions were: "trust on technical ability" (F3), ranking in eighth place; essentially not making the top five most relevant factors; and "personalized training" (F6) ranking in ninth place; essentially ranking in a position of more relevance than in the general ranking (Table 14).

In regard to the third round results, the ranking obtained for the French firm were much more aligned with the overall ranking (Table 21). All factors were ranked as the general ranking except: "knowledge mapping – who knows what" (F13), coming in third place for the French cluster and fourth position in the overall ranking; and "trust on technical abilities" (F3), coming in fourth place for the firm and third in the general ranking (Table 21).

Round three results depict a much higher agreeance level with the ranking results of round two. Essentially fortifying a higher level of overall group consensus. The factors ranked high in relevance in the general ranking were also ranked high for the French firm. The same can be said about the factors of lower relevance.

**Table 21 - Comparing Rounds Two and Three Rankings (French Firm)**

Key Factor	Overall Final Scores	French Round Two	French Round Three
Open door policy (F10)	1	3	1
Organizational culture (F16)	2	1	2
Trust on Technical abilities (F3)	3	8	4
Knowledge mapping- who knows what (F13)	4	2	3
Network connections (F4)	5	5	5
Knowledge sharing means (F12)	6	3	6
Agile Workforce (F15)	7	10	7
Knowledge sharing strategy (F7)	8	7	8
Combination of formal and informal company routines (F14)	9	11	9
Personal knowledge relevance (F11)	10	6	10
Knowledge Reservoirs (F8)	11	4	11
Personalized Training (F6)	12	9	12
Individual Time availability (F1)	13	12	13
Acknowledgement (F5)	14	15	14
Shared technical jargon (F2)	15	14	15
Status (F9)	16	13	16

### *Norwegian*

The general view of the Norwegian firm participants changed for all factors except two (“organization culture” and “personalized training”) when comparing rounds two and three (Table 22).

More specifically, the factor rankings in round two did not match the general view of all participating firms for that same round. On average, the most relevant factor in round two was “trust on technical abilities” (F3), whereas “open door policy” ranked as the most relevant factor in the overall ranking. As was seen with the other three firms, “organizational culture” (F16) ranked as one of the top two most relevant factors in knowledge sharing within the firm.

Comparing rounds two and three results, changes also emerged in terms of participant ranking preferences. Based on the comparison of rounds two and three between the Norwegian firm ranking with the general ranking, a higher consensus within and across group emerged (Tables 16 and 18). In fact, on average, it was the firm most closely aligned with the overall third round ranking.

**Table 22 - Comparing Rounds Two and Three Rankings (Norwegian Firm)**

Key Factor	Overall Final Scores	Norwegian Round Two	Norwegian Round Three
Open door policy (F10)	1	7	1
Organizational culture (F16)	2	2	2
Trust on Technical abilities (F3)	3	1	3
Knowledge mapping- who knows what (F13)	4	6	4
Network connections (F4)	5	5	5
Knowledge sharing means (F12)	6	6	6
Agile Workforce (F15)	7	3	7
Knowledge sharing strategy (F7)	8	8	8
Combination of formal and informal company routines (F14)	9	4	9
Personal knowledge relevance (F11)	10	11	10
Knowledge Reservoirs (F8)	11	9	11
Personalized Training (F6)	12	12	12
Individual Time availability (F1)	13	10	13
Acknowledgement (F5)	14	13	14
Shared technical jargon (F2)	15	14	15
Status (F9)	16	15	16

#### *Individual Firm Comparison – General Analysis*

Round three results portrayed a much higher level of opinion agreeance among the four different nationality clusters in terms of the overall rankings. Table 23 shows the following breakdown: (a) all four firms in complete agreeance with the overall ranking of the highlighted factor; (b) three out of the four firms in complete agreeance with the overall ranking of the highlighted factor; and (c) two out of the four firms in complete agreeance with the overall ranking of the highlighted factor.

There was a 100% consensus between all four nationality clusters in ranking “open door policy” (F10) in first place, “organizational culture” (F16) in second place, and “knowledge sharing means” (F12) in sixth. These are represented with the (a) demarcation (Table 23).

In regard to “knowledge mapping – who knows what” (F13), “network connections” (F4), “agile workforce” (F15), “knowledge sharing strategy” (F7), “combination of formal and informal company routines” (F14), “personal knowledge relevance” (F11), “acknowledgement” (F5), “shared technical jargon” (F2), and “status” (F9), 75% (three out of four) of the firms ranked these specific factors as in the overall ranking. These are marked with a (b) as is illustrated on Table 23.

Lastly, demarcated with a (c) are the factors with 50% (two out of four) of the firms ranking these highlighted factors the same as the general rank. These are: “trust on technical

abilities” (F3), “knowledge reservoirs” (F8), “personalized training” (F6), and “individual time availability” (F1).

**Table 23 – Firm Comparison – General Analysis**

Key Success Factor in Knowledge Sharing	Overall	American	Brazilian	French	Norwegian
Open door policy (F10) <sup>a</sup>	1	1	1	1	1
Organizational culture (F16) <sup>a</sup>	2	2	2	2	2
Trust on technical abilities (F3) <sup>c</sup>	3	5	3	4	3
Knowledge mapping- who knows what (F13) <sup>b</sup>	4	4	4	3	4
Network connections (F4) <sup>b</sup>	5	3	5	5	5
Knowledge sharing means (F12) <sup>a</sup>	6	6	6	6	6
Agile workforce (F15) <sup>b</sup>	7	7	6	7	7
Knowledge sharing strategy (F7) <sup>b</sup>	8	8	7	8	8
Combination of formal and informal company routines (F14) <sup>b</sup>	9	9	8	9	9
Personal knowledge relevance (F11) <sup>b</sup>	10	10	9	10	10
Knowledge reservoirs (F8) <sup>c</sup>	11	12	10	11	11
Personalized training (F6) <sup>c</sup>	12	13	11	12	12
Individual time availability (F1) <sup>c</sup>	13	11	12	13	13
Acknowledgement (F5) <sup>b</sup>	14	14	13	14	14
Shared technical jargon (F2) <sup>b</sup>	15	15	14	15	15
Status (F9) <sup>b</sup>	16	16	15	16	16

As in shown on Table 23, the opinions did not differ much amongst the different nationality clusters. In fact, although there were some differences in terms of the individual cluster rankings, the results show that all in all, such differences were minimum. All four firms showed very similar opinions in the grouping of top and bottom success factors. All high-ranking success factors were the same for all four firms (even if in slight different order). The same can be said about the least relevant factors.

Pushing a step further, as is shown on Table 17, a comparison between the different nationality clusters also shows an interesting result. There were six possible combinations: American x Brazilian; American x French; American x Norwegian; Brazilian x French; Brazilian x Norwegian; and Norwegian x French. The highest correlation, with a Tau-b value of 0.996, was the Brazilian firm and Norwegian firm. In terms of opinions regarding the ranking, both firms illustrated the highest likeness in opinion preference. This is an interesting finding as the two observed firms had very similar organization structures—both are government owned O&G giants.

## 6. CONCLUSION

The firm openness regarding the tolerance level for questioning and critique (“open door policy”) and the conceptualization of a norm that goes beyond mere routines of executable actions (“organizational culture”) set the stage as top contenders in relevance. Individuals felt that by having an environment that makes one feel comfortable and encouraged to share what they knew leads them to share knowledge more openly.

Even more thought-provoking is that during the validation phase in round one, open door policy was seen as the number one factor as well. Adding to this, although potentially seen as complementary to open door policy and organization culture, the “combination of formal and informal company routines” was not ranked among the top five factors. It came in as the 9<sup>th</sup> placed in the overall rank.

A participant from the Brazilian firm made a poignant critique that routines should “never be informal. This is where the risks become accidents, corruption occurs, and knowledge is no longer shared”. Perhaps the reason for this rationale accrues for Brazil’s current situation. The O&G industry is involved in potentially the largest corruption scandal in the history of Brazil (Carwash Operation). In fact, the investigations are still on going with politicians, executives and third parties often having jail time as well as having to pay hefty fines. Here, the participants associated informal routines with lack of transparency, perhaps leading them to rank this factor lower in terms of relevance. What remains true is that a firm is a compilation of all its routines, these being formal or informal ones. However, as the industry seeks to recover from both an economical and ethical crisis, much of its routines are also being revamped.

In regard to the least relevant factors, the two least relevant factors were mainly related to the individual. In fact, the common technical language among individuals (Shared Technical Jargon) and knowledge seen as a source of power that leads to status, a form of self-benefit as a consequence of sharing knowledge ranked as the least relevant among the overall rank. In the O&G sector, the common language across individuals is English, whereas, the technical terminology is very intrinsic across the board. Perhaps this could explain why this factor ranked so low. According to one of the participants, “[Technical Jargon] is not necessary, but it helps a lot”. It may facilitate the knowledge sharing process; however, it may not necessarily be a prerequisite. For instance, when it comes to an HR professional within the upstream area, his/her area of expertise as well as regulatory knowledge is highly specialized.



These individuals have a deeper knowledge in terms of the actual industry as a whole. These professionals are the ones planning and executing the hiring process to fill in specific technical positions. Additionally, this segment is highly regulated both by national and international entities, setting a very delimited standard across the board. Another example of this is related to professionals within the financial area. As the accounting is handled, their technical knowledge in terms of the industry specificity is also of the essence. It goes beyond knowing general accounting practice. The terminology ends up being embedded within and across the different players of the firm.

Moreover, a deeper look into the third round rank of the top five ranked factors is very telling. Four out of the five factors are firm based, whereas only one was deeply rooted on the individual (“trust on technical abilities”). This can be understood that the stage set by the firm is one that is required for employees to consider sharing what they know.

Moving beyond the technological setting, the environment and intellectual climate are indeed key. The willingness to share intellectual property is one that the environment can either enable or discourage.

## 6.1 ACADEMIC IMPLICATIONS

Several angles related to knowledge sharing and its impacting factors have been deeply studied. However, from an empirical perspective where a rank of relevance based on participant opinions had not been fully explored to date. As such, the chosen methodology used was one that not only enabled but also opened a door to future possibilities in terms of this phenomenon. The study here presented generated a ranking in which building on the already existing literature.

Additionally, the application of the Delphi method is one that truly collaborates to academia. In previous studies regarding knowledge sharing, such method had never been applied. As such, it is hoped that this study will provoke the desire for qualitative research with a central focus on the factor relevance level based on real world expert opinions.

## 6.2 MANAGERIAL IMPLICATIONS

The results of this study are also highly relevant and applicable to the managerial world. Decisions are often made without considering employees’ opinion and their perceptions of reality. Firms often invest in tools and methods of getting information to flow, not fully bearing in mind the human aspect. As such, issues often arise.

The rank of the sixteenth validated factor illustrates what individuals deem most relevant. Consequentially, having significant implications on firm policies.

Although tools and technology are highly important, the top five ranked factors were directly linked to interpersonal relationships—the individual and their interactions are essential. Inevitably, policies without taking these findings into consideration could fundamentally fail.

### 6.3 RESEARCH LIMITATIONS

As with any research method choice, the chosen method, Delphi, is not infallible. The limitations will be further discussed below.

The Delphi method requires a sequence of survey rounds, this ensures a suitable convergence rate of the participants' answers. Consequently, the larger the sample size, the less likely the execution of such project. This is because all rounds require the participation of the same participants. The larger the group, the more difficult it is to meet this requirement.

Additionally, following this same rationale, the sample utilized was not randomly assigned. In fact, it was a sample chosen based on the willingness and good will to participate in the research at hand. This in turn ensured that each participant would partake in all necessary rounds.

### 6.4 FURTHER RESEARCH

As was shown under the literature review section, knowledge sharing and the factors that lead to it have been widely researched. In fact, several angles have been explored with incredibly relevant findings. However, a more empirical perspective from those who share knowledge is still necessary.

This study started to fill a gap within the literature—a perspective not only based on the opinions of those who make KS a reality, but also what factors are deemed, at least to them, most relevant. Following this thought, potential further research can seek to understand how the different years of experience brackets can impact the ranking of these KS key success factors. Specifically related to the O&G industry, different generations equate to different schools of thought as well as unique acquired knowledge sources. Perhaps the rationale for the various levels of years of experience can also be different from those with still significant but fewer years of experience.

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## **ANNEX 1 First Round Email to Participants**

### **FIRST ROUND RESEARCH**

**SUBJECT:** Upstream Knowledge Sharing Success Factors — First Round

Dear Participant,

I would like to invite you to part take in a research on the key success factors in tacit knowledge sharing in the context of O&G professionals; more specifically those within Upstream. In essence, this research seeks to further understand, from your expert opinion, the factors, in a ranked order, essential for you to share what you know with the members of your organization.

The relevance of this research is one that impacts both academia as well as the firm's choice of strategy. Understanding which factors (in a ranked order) impact one's willingness to share what they know has several long-lasting repercussions.

The Delphi Method was the chosen methodology; a simple and straight forward one. It encompasses the consulting of a group of specialists about a given topic by means of questionnaire; several rounds are often utilized to attain the desired information. At the end of each round, a consolidation of the results is furnished to each participant. This in turn allows for each expert to know the direction of answers and comments emerging within the group.

This questionnaire will take you no more than 10 minutes. I would like to assure you that your answers are 100% anonymous, confidential, and collected for academic purposes only.

As there will be a subsequent round of questions, I kindly ask you to please have this questionnaire answered no later than May 12<sup>th</sup>, 2017.

Thank you in advance for your time and collaboration,

Att.,

**Thassia Conceição Almeida da Silva**

MSc Student—FGV—EBAPE-RJ

[thassiafgv@gmail.com](mailto:thassiafgv@gmail.com)

## ANNEX 2 First Round Questionnaire—Delphi Method

### Introduction:

I would like to assure you that your answers are 100% anonymous, confidential, and collected for academic purposes only. This survey is divided in two parts: a short initial section with demographic questions followed by the actual questionnaire seeking your opinion on whether the items presented are success factors in knowledge sharing or not. Thank you once again for your participation!

Best,

Thassia da Silva  
MSc Student--FGV (Fundacao Getulio Vargas)

### Demographic Questions:

1. What is your educational level?

- Technical school (2 years)
- Bachelor's degree (4 years)
- Master's degree
- PhD degree

2. What is your company's nationality?

- Brazilian
- American
- French
- Norwegian

3. What area do you currently work in?

- Drilling
- Engineering
- Geology/geophys. prospecting
- R&D
- Administrative
- Others \_\_\_\_\_

4. What is your current position?

- Senior management
- Middle management
- Engineer/specialist
- Technician/analyst
- Others \_\_\_\_\_

5. Age (please scroll accordingly):

6. Years of experience in upstream (exploration and production area):

7. Gender:

- Male
- Female

## KNOWLEDGE SHARING WITHIN THE FIRM

II. INSTRUCTIONS: The items below are potential factors that lead to the sharing of knowledge amongst individuals within the firm. Please carefully read each item along with its short description then choose the alternative that best represents your opinion. The options range from strongly agree if you feel the item presented is unquestionably a key success factor for knowledge sharing to strongly disagree if you unquestionably do not think the item is a relevant factor in knowledge sharing. Also, feel free to comment or justify your choice. If you do not understand the item and description provided, kindly explain why not.

1. Individual time availability (the presence of time to share knowledge within the firm)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

2. Shared technical jargon (the common technical language among individuals)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

3. Trust on technical abilities (trust in co-workers' abilities)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

4. Network connections (the systems in place and the link between those who own type A knowledge and those who need type A knowledge)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

5. Acknowledgement (reward systems that acknowledge and reward knowledge sharing actions)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

6. Personalized training (the prioritization of personalized training with the participation of experienced employees--shadow programs, mentoring programs, etc)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

7. Differentiated knowledge sharing strategy (focus on people's interactions--conversations, face to face talk etc)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

8. Knowledge reservoirs (individuals as primary sources of knowledge, not computers, manuals and databases)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:



9. Status (knowledge seen as a source of power that leads to status--self-benefit as a consequence of sharing knowledge)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

10. Open door policy (firm openness regarding the tolerance level for questioning and critique)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

11. Personal knowledge relevance (the acceptance level of suggestions and ideas that are not supported by data within the organization [i.e intuition, personal abilities etc])

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

12. Knowledge sharing means (the way communication takes place between individuals within an organization)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

13. Knowledge mapping-who knows what (knowing who the experts in specific knowledge sources are)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

14. Combination of formal and informal company routines (knowing the procedures within the firm in terms of standardized steps of actions)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

15. Agile workforce (individual ability to deal with emerging problems in a proactive, adaptable and resilient way)

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree
- I did not understand the item

Comments:

III. Please list the additional factors you feel are of utmost importance in knowledge sharing not present in this survey.

### **ANNEX 3    Second Round Email to Participants**

#### **SECOND ROUND RESEARCH**

**SUBJECT:** Upstream Knowledge Sharing Success Factors — Second Round

Dear participant,

Thank you for your commitment in the first round of this research. Your participation has been of great appreciation and contribution to this study.

As previously informed, this second round includes the compilation of the first-round results. These can be found together with the second-round questionnaire in the link below.

Access the questionnaire

here: [https://fgvsocial.co1.qualtrics.com/jfe/form/SV\\_agCZWMQyIbKUL8F](https://fgvsocial.co1.qualtrics.com/jfe/form/SV_agCZWMQyIbKUL8F)

Please have this questionnaire answered no later than July 7th.

Thank you in advance for your participation,

**Thassia Conceição Almeida da Silva**

MSc Student—FGV—EBAPE-RJ

thassiafgv@gmail.com

## ANNEX 4 Second Round Questionnaire—Delphi Method

### Introduction:

I would like to assure you that your answers are 100% anonymous, confidential, and collected for academic purposes only. This survey is divided in three parts: a short initial section with demographic questions, the results of the first round of research followed by the actual questionnaire where you are asked to rank the factors in order of importance in knowledge sharing.

Thank you once again for your participation!

Best,

Thassia da Silva  
MSc Student--FGV (Fundacao Getulio Vargas)

### A. Demographic questions.

#### 1. What is your educational level?

- Technical school (2 years)
- Bachelor's degree (4 years)
- Master's degree
- PhD degree

#### 2. What is **your company's** nationality?

- Brazilian
- American
- French
- Norwegian

#### 3. What area do you currently work in?

- Drilling
- Engineering
- Geology/geophys. prospecting
- R&D
- Administrative
- Others \_\_\_\_\_

#### 4. What is your current position?

- Senior management
- Middle management
- Engineer/specialist
- Technician/analyst
- Others \_\_\_\_\_

5. Age (please scroll accordingly):

6. Years of experience working in upstream (exploration and production area):

7. Gender:

- Male
- Female

## B. Compilation of first round results

There was a total of 41 participants in the first round. Based on the participants' answers, an average was calculated using a 1 to 5 scale (where 1=Strongly disagree, 2=Disagree, 3=Neither disagree nor agree, 4=Agree, 5=Strongly agree). The option "I did not understand the item" was not considered in the average calculation.

Below you will find the factors ranked based on the score of the average in order of most to least relevant. As such, the "Open door policy" and "Network connections", both tied in first place, were ranked as most relevant for the participants in the first round. In contrary, "Personal knowledge relevance" was seen as least important when it came to sharing knowledge with co-workers.



C. Below you will find the individual compilation for the individual factors in order of most important to least important as well as the comments provided by the participants (when available)

*[In the actual questionnaire presented to the participants the individual factors presented along with percentage of answers for each option for each factor. Refer to the results section for the individual graphs]*

## D. Delphi Questionnaire - Second Round

The previous section entails the general compilation of the 15 presented factors as well as the breakdown of the individual results for each of these factors. Upon reading the presented results, please number in order of relevance the factors you feel are relevant for you to share your

knowledge with your co-workers. You are to rank these factors from 1 to 16. The number 1 represents the most relevance factor and 16 the least relevance one. Please feel free to comment or even justify the way you ranked these factors.

\_\_\_\_\_ Open door policy (firm openness regarding the tolerance level for questioning and critique)

\_\_\_\_\_ 2. Network connections (the systems in place and the link between those who own type A knowledge and those who need type A knowledge)

\_\_\_\_\_ Knowledge mapping-who knows what (knowing who the experts in specific knowledge sources are)

\_\_\_\_\_ Trust on technical abilities (trust in co-workers' abilities)

\_\_\_\_\_ Knowledge sharing means (the way communication takes place between individuals within an organization)

\_\_\_\_\_ Individual time availability (the presence of time to share knowledge within the firm)

\_\_\_\_\_ Personalized training (the prioritization of personalized training with the participation of experienced employees--shadow programs, mentoring programs etc)

\_\_\_\_\_ Shared technical jargon (the common technical language among individuals)

\_\_\_\_\_ Acknowledgement (reward systems that acknowledge and reward knowledge sharing actions)

\_\_\_\_\_ Agile workforce (individual ability to deal with emerging problems in a proactive, adaptable and resilient way)

\_\_\_\_\_ Combination of formal and informal company routines (knowing the procedures within the firm in terms of standardized steps of actions)

\_\_\_\_\_ Differentiated knowledge sharing strategy (focus on people's interactions--conversations, face to face talk etc)

\_\_\_\_\_ Knowledge reservoirs (individuals as primary sources of knowledge, not computers, manuals and databases)

\_\_\_\_\_ Status (knowledge seen as a source of power that leads to status--self-benefit as a consequence of sharing knowledge)

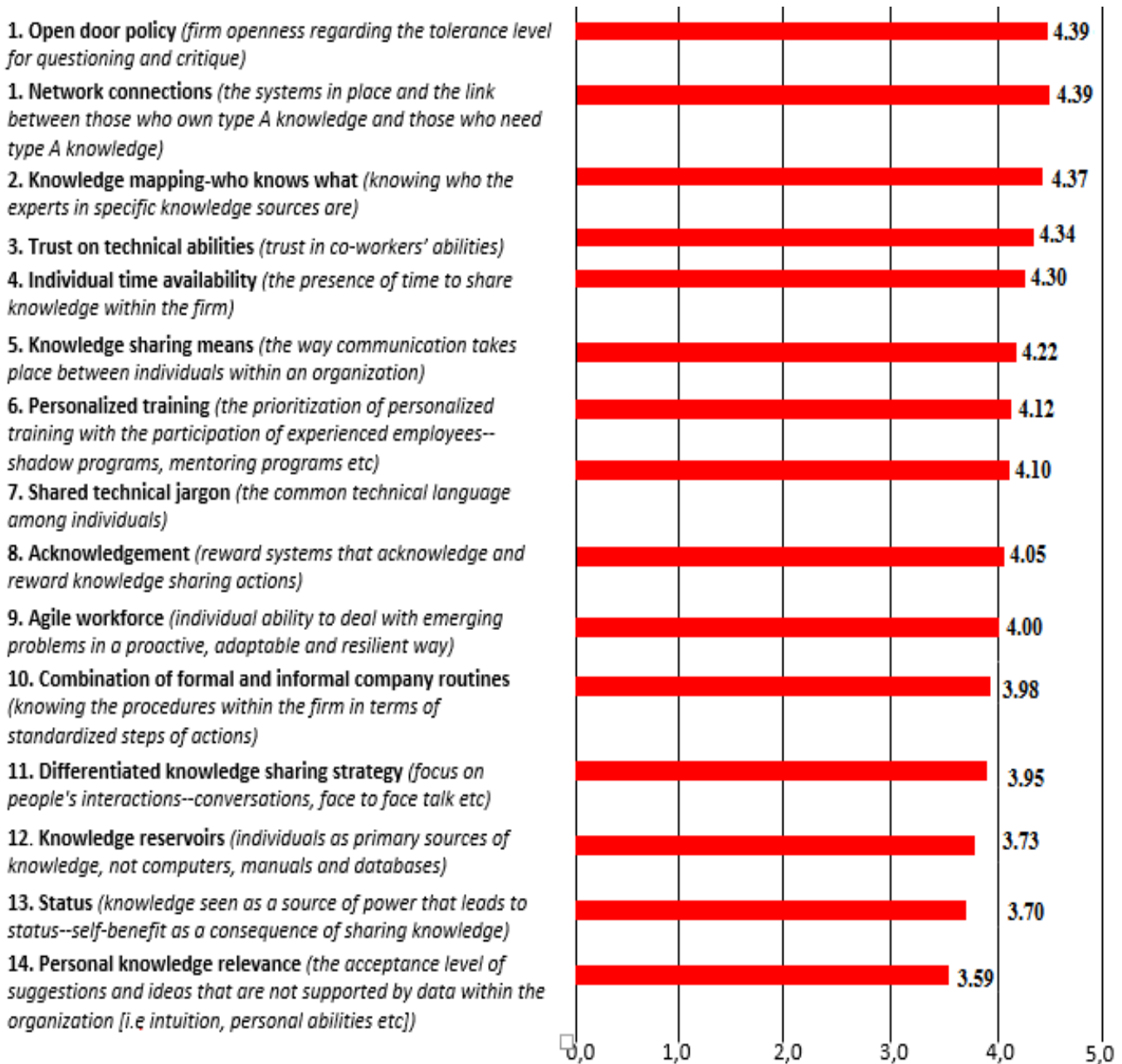
\_\_\_\_\_ Personal knowledge relevance (the acceptance level of suggestions and ideas that are not supported by data within the organization [i.e intuition, personal abilities etc])

\_\_\_\_\_ Organizational culture (daily company encouragement to share knowledge as a corporate norm; initiatives such as "learning by sharing")

E. If you have any further comments, justifications or specific reasons as to why you ranked these factors the way you did, please feel free to comment here (these comments can be in Portuguese if you feel more comfortable).

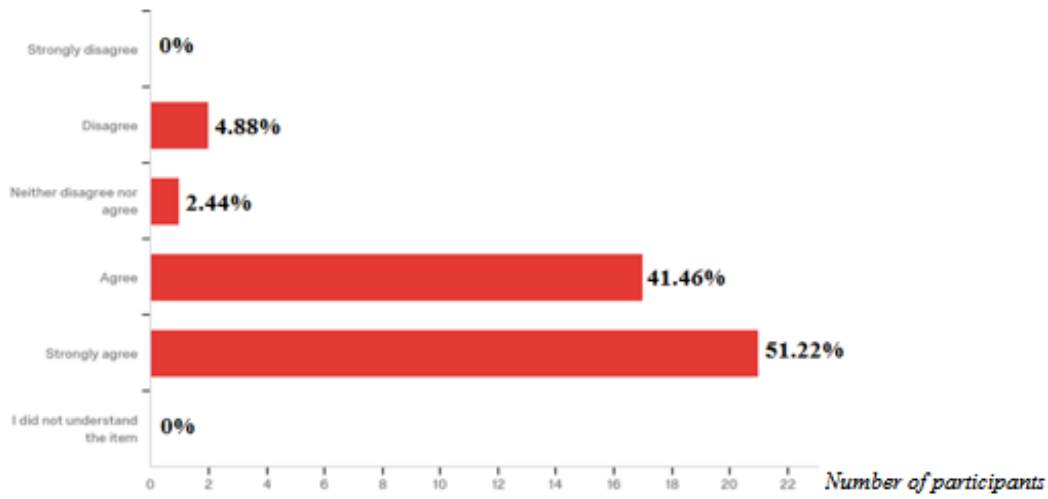
## RESULTS—ROUNDS 1

### ANNEX 5 First Round Ranking Based on Participant

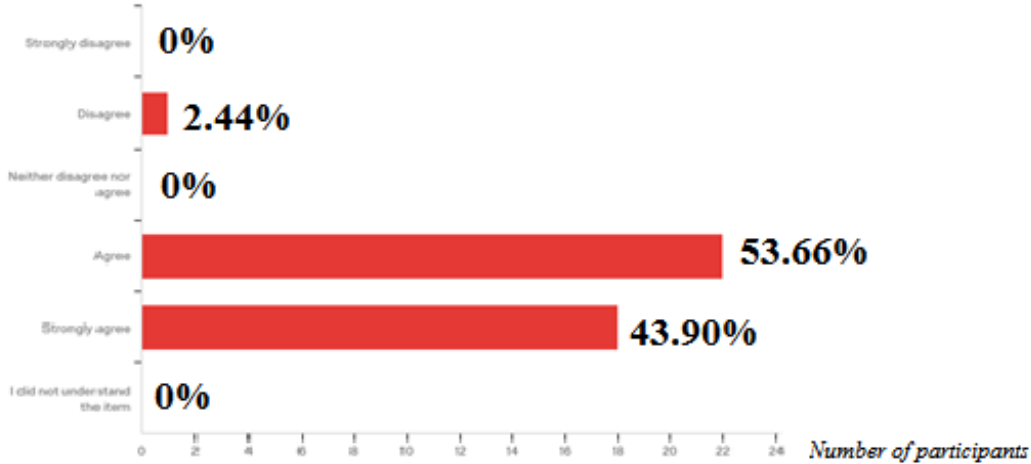


## ANNEX 6 First Round Individual Factor Results

### 1. Open door policy (firm openness regarding the tolerance level for questioning and critique)

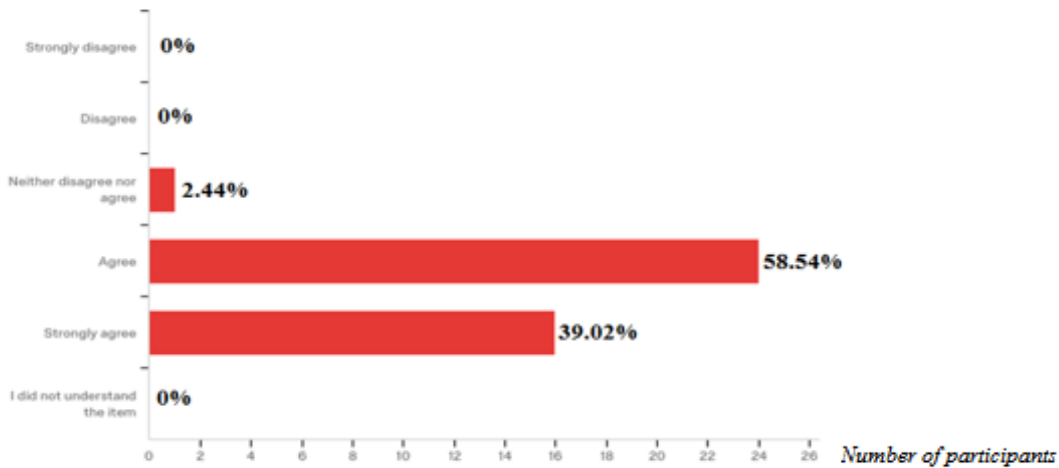


### 2. Network connections (the systems in place and the link between those who own type A knowledge and those who need type A knowledge)

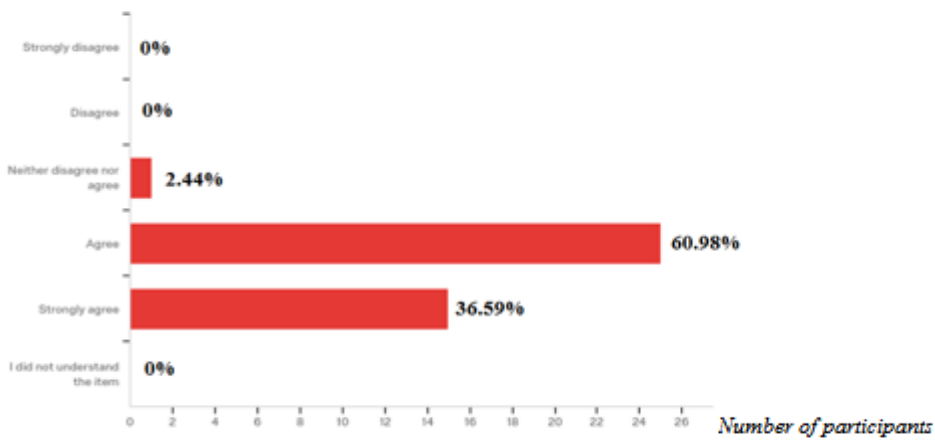




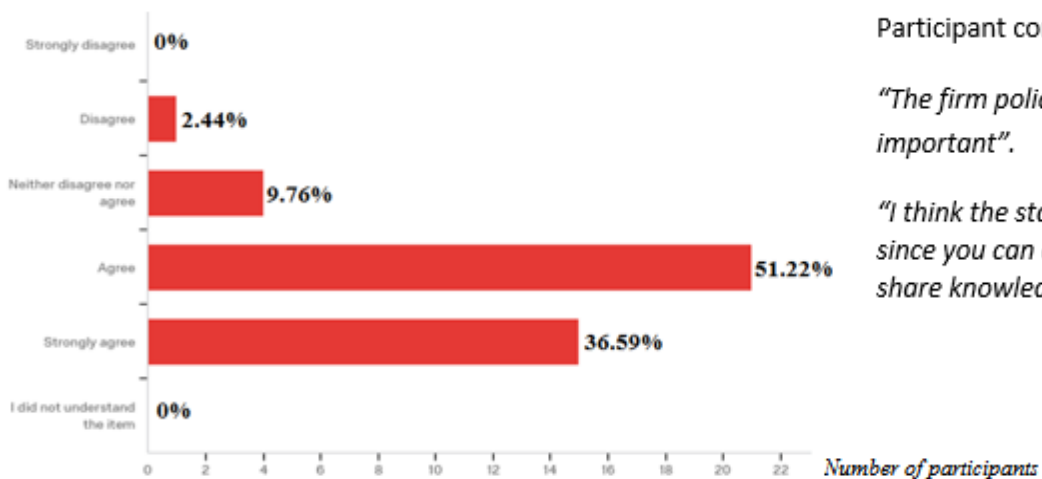
### 3. Knowledge mapping-who knows what (knowing who the experts in specific knowledge sources are)



### 4. Trust on technical abilities (trust in coworkers' abilities)



### 5. Knowledge sharing means (the way communication takes place between individuals within an organization)

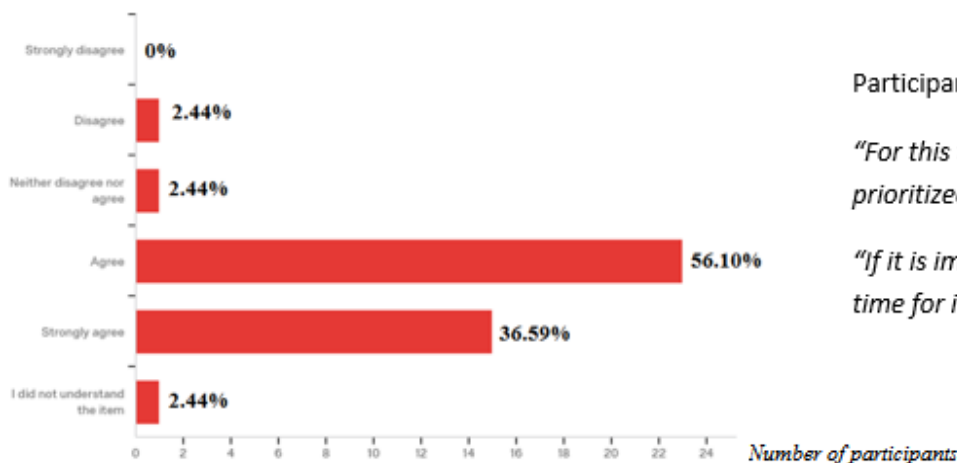


Participant comments:

*"The firm policies are more important".*

*"I think the statement is incomplete, since you can communicate and not share knowledge".*

**6. Individual time availability (the presence of time to share knowledge within the firm)**

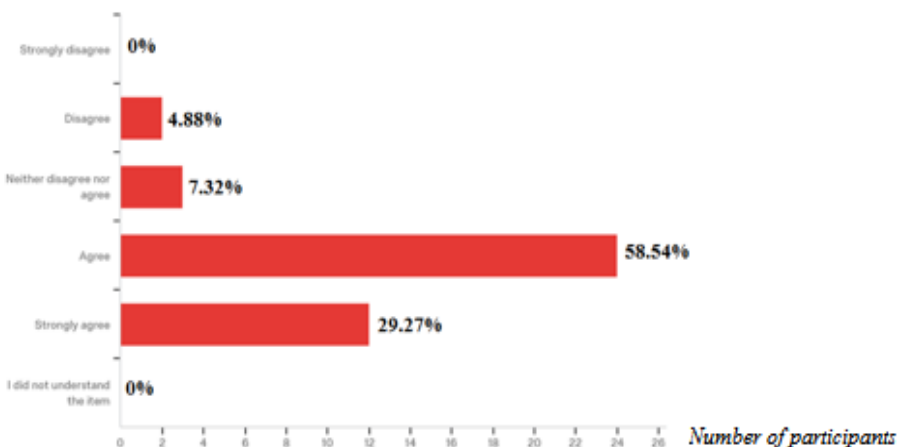


Participant comments:

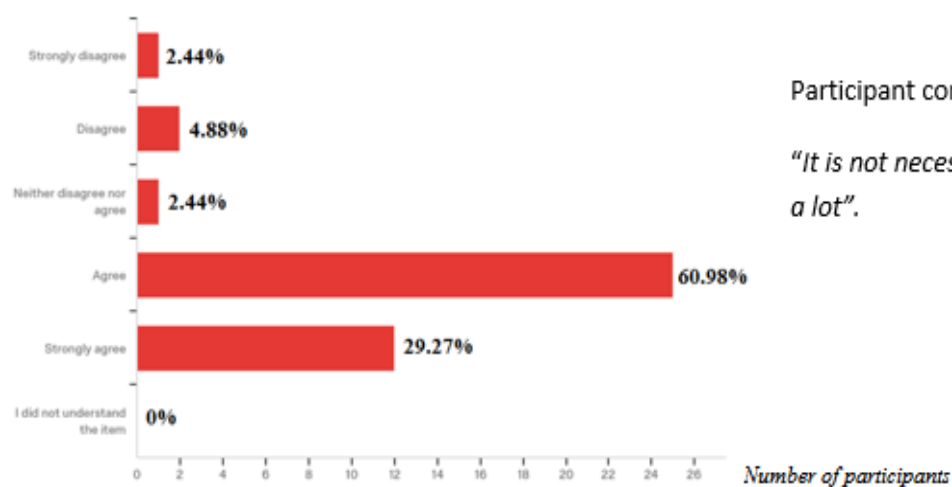
*“For this to happen, it needs to be prioritized by the individual”.*

*“If it is important, we can make the time for it”.*

**7. Personalized training (the prioritization of personalized training with the participation of experienced employees-- shadow programs, mentoring programs etc)**



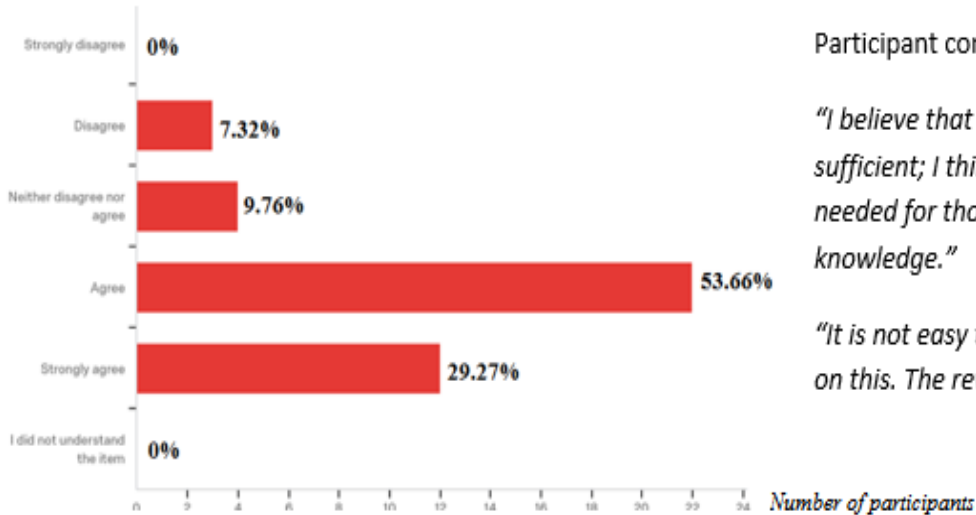
**8. Shared technical jargon (the common technical language among individuals)**



Participant comments:

*“It is not necessary per say, but it can help a lot”.*

**9. Acknowledgement (reward systems that acknowledge and reward knowledge sharing actions)**

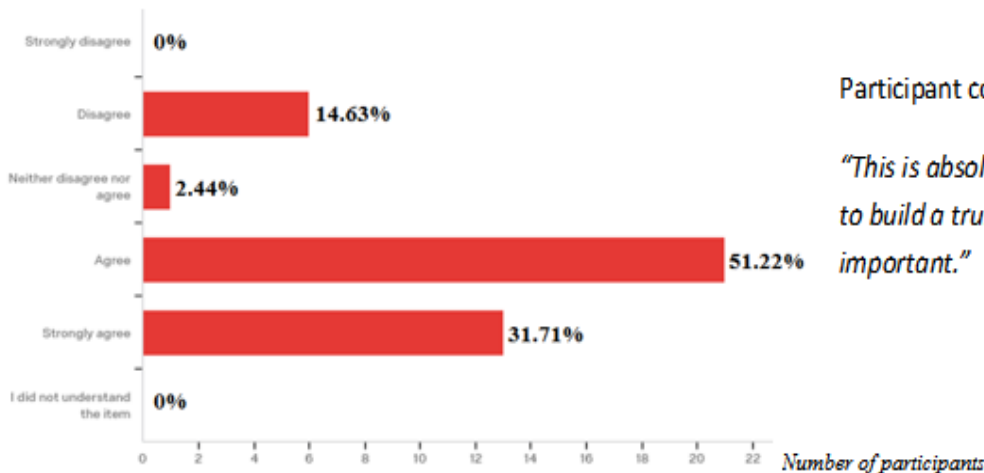


Participant comments:

*"I believe that the acknowledgement is sufficient; I think some punishment is needed for those who do not share knowledge."*

*"It is not easy to share and spend time on this. The reward is necessary."*

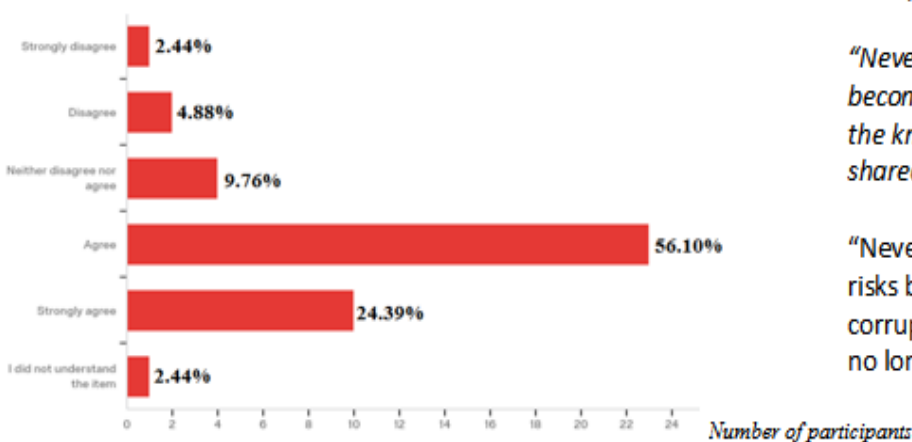
**10. Agile workforce (individual ability to deal with emerging problems in a proactive, adaptable and resilient way)**



Participant comments:

*"This is absolutely paramount. And to build a trust culture is very important."*

**11. Combination of formal and informal company routines (knowing the procedures within the firm in terms of standardized steps of actions)**

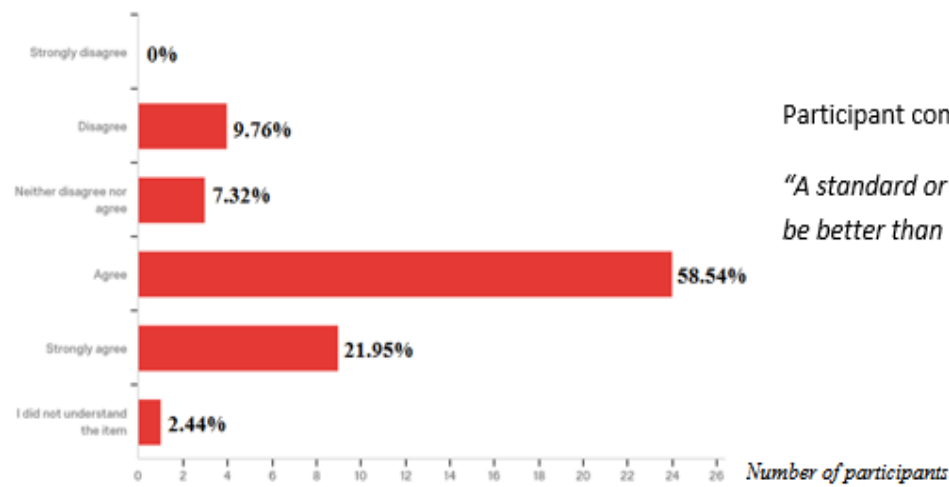


Participant comments:

*"Never informal, this is where it becomes risky (and corruption, and the knowledge stops to be shared)."*

*"Never informal, this is where the risks became accidents (and corruption, and the knowledge is no longer shared)."*

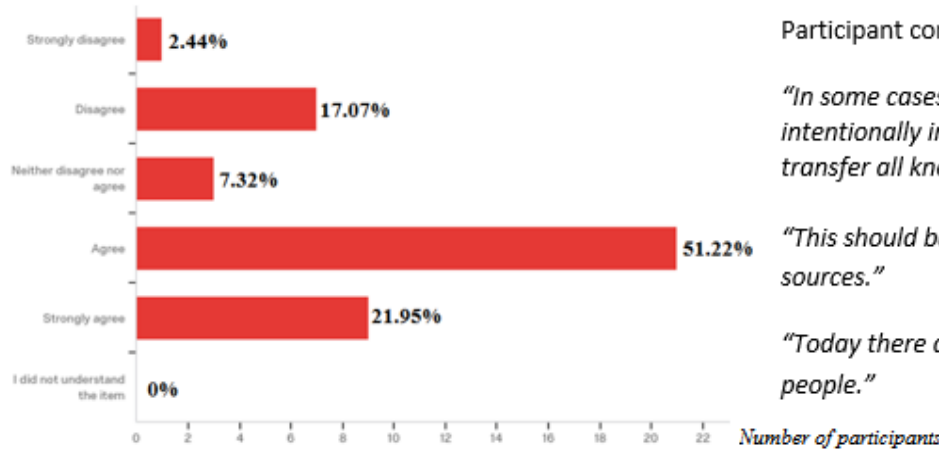
**12. Differentiated knowledge sharing strategy (focus on people's interactions--conversations, face to face talk etc)**



Participant comments:

*"A standard or a well written manual can be better than direct interactions".*

**13. Knowledge reservoirs (individuals as primary sources of knowledge, not computers, manuals and databases)**



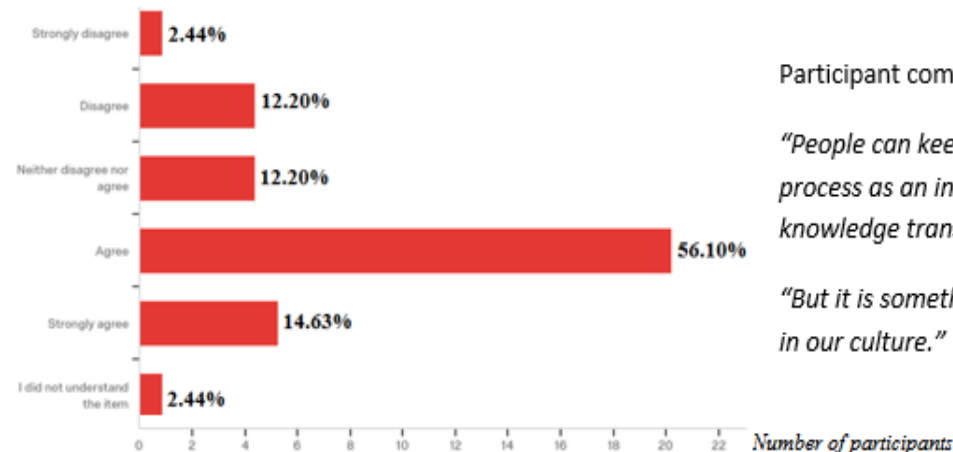
Participant comments:

*"In some cases, these registrations are intentionally incomplete so as not to transfer all knowledge."*

*"This should be used together with other sources."*

*"Today there are strong tools to train people."*

**14. Status (knowledge seen as a source of power that leads to status--self-benefit as a consequence of sharing knowledge)**



Participant comments:

*"People can keep the status making process as an incomplete one in terms of knowledge transferring."*

*"But it is something that is not embedded in our culture."*

**15. Personal knowledge relevance (the acceptance level of suggestions and ideas that are not supported by data within the organization [i.e intuition, personal abilities etc])**

