

Does Polanyi's Tacit Knowledge Dimension Exist?

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ABSTRACT

Currently, Polanyi's tacit dimension only exists in a philosophical environment. Polanyi's assertions that tacit knowledge exists are in fact true has not been empirically tested. This is because the tacit dimension is considered highly personal and un-expressible. An empirical proof of theory test has been conducted using graduate students in a management. The results indicate that the tacit dimension exists and it was the primary source of the survey respondent's explicit knowledge. Both test had an effect size greater than 0.8 [one-tail t-Test - alpha = 0.05].

INTRODUCTION

Overview

In an effort to use Polanyi's personal/individual tacit and explicit knowledge theory to improve management practices, many authors modified Polanyi's tacit knowledge characteristics to provide a more meaningful application of the theory. The issue of this knowledge being highly personal and not easily shared is a major obstacle to sharing tacit knowledge in the organization. Haldin-Herrgard (2003) in the paper Titled "Diving under the Surface of Tacit Knowledge" reviewed academic books and articles on knowledge and tacit knowledge during the period of 1956 to 2002. Haldin-Herrgard research included concepts used to expand the explanation of

tacit knowing. This research reported finding 23 different definitions of tacit knowledge.

Because of the diversity of options on what is tacit knowledge, this research was directed toward the original source (Polanyi) of the tacit knowing/knowledge concept.

This paper provides a literature review that establishes the foundation and understanding of Polanyi's tacit knowledge dimension. The literature review includes tables of the characteristics of tacit and explicit knowing and a concept map of his theory. The Polanyi tacit knowledge dimension and associated characteristics have been discussed extensively in a philosophical and theory environment. An extensive literature search, including synonyms, was performed. The results of this search found no evidence of empirical research on Polanyi's tacit dimension. Rice and Rice (2005), in a paper titled: "The Applicability of the SECI Model to Multi-Organisational Endeavors: An Integrative View", sub-section titled "Empirical research regarding tacit knowledge" provides insight into why no evidence was found. They state the following: "Research in the field of tacit knowledge management is very diverse. Empirical research in the field is challenging for, as Polanyi (1958) has noted, the development of a skill tends to be accompanied by the development of a deeper understanding of the skill that defies articulation. While the key theoretical principles are ascribed to Polanyi (1958) and Ryle (1945), thinking on tacit knowledge tended to be philosophical in nature for many decades."

The primary research question addressed in this paper is:

Does Polanyi's tacit knowledge dimension exist?

Polanyi and various scholars, who have written papers on or about Polanyi's knowledge theory, use knowledge and knowing interchangeably. In this paper, these words will have the same meaning.

A REVIEW OF POLANYI'S LITERATURE ON TACIT KNOWLEDGE

The definition of knowledge has evolved over time from what is true and a process to determine that it is true or not, to the search for the structure of knowledge. In his book "The Study of Man" (1959), Michael Polanyi presented two fundamentally different kinds of knowledge. First was explicit knowledge. Words, numbers, diagrams, and other symbols can be used to express this knowledge. The second type of knowledge was tacit knowledge. Individuals possessing it are not aware that it exists. Therefore, tacit knowledge cannot be expressed explicitly (Hill & Von Ende, 1994).

In 1966, Polanyi stated, "We can know more than we can tell". What is expressed in words and numbers is only a small part of the actual knowledge that an individual has. His theory of tacit knowing lies at the center of his writing on personal/individual knowledge. Chomsky in his paper titled "Aspects of the Theory of Syntax" first labeled tacit knowing as tacit knowledge (Sanders, 1988).

Polanyi makes three main claims:

1. A set of wholly explicit rules or algorithms (explicit knowledge) for finding or testing theories cannot adequately account for the true discovery provided by the progress of science.

2. Knowledge, though public and social, is in varying degrees also inherently personal.
3. Not only is it impossible to make all knowledge personal, but the knowledge that cannot be specified is more fundamental than explicit knowledge.

(Sanders, 1988)

In using these claims to support the concept of Tacit Knowing (Also called Tacit Knowledge in his 1966 writings), Polanyi derives the following characteristics of Tacit Knowledge:

- It is unspecified. The things of which one has tacit knowledge are unspecified.
- It is intentional. It has a directional quality (main characteristic of consciousness).
- It is dynamic. The dynamics of striving for or coming to know new knowledge are primary.
- Tacit knowing is personal. The mental act of knowing is inherently personal
- It is a-critical. Tacit knowing and particularly the mental act of integration, which constitutes it, cannot be critical to personal activities
- Tacit knowledge is fallible. It is like other human capacities, inherently fallible, and is NOT some kind of immediate knowledge or intuition.

(Sanders, 1988)

In Polanyi's writings titled: "Personal Knowledge" (1962), "Knowing and Being" (1969), "The Tacit Dimension" (1966), "Science Faith and Society" (1946), "Meaning" (1975), and "The Study of Man" (1959), he searches for the common structure of knowledge and provides the following two dimensions of knowledge:

1. Tacit dimension, which is highly personal and hard to formalize, makes it difficult to communicate or share with others. This dimension has two sub-categories: focal awareness and subsidiary awareness.
 - a. The focal awareness is the knowledge about the phenomenon in focus, when using a personal skill; Example: Knowing how to do something like driving a nail. The focal is the driving of the nail
 - b. The subsidiary awareness is the activities that are NOT in focus when using personal skills or knowledge. Subsidiary awareness facilitates the “*knowing how*” to do things. Example: Holding the hammer, swinging the hammer, holding the nail without hitting your fingers or hand, etc.

2. Explicit (Propositional) dimension, which is personal/individual knowledge that has been codified or structured in a formal and systematic way; It can be expressed in written words, pictures and/or numbers and can be readily shared; Rule based knowledge

Polanyi first explained these dimensions in terms of the following personal cognitive elements:

- a. Beliefs: “A set of understandings that reflect our perspective of the world” (Haldin-Herrgard, 2003); Requires an acceptance of something as true
- b. Values: that which is important to a person in their interaction with others;
Example: Honesty
- c. Ideas: logical concepts of the mind (Polanyi, 1975)

As Polanyi’s tacit knowledge theory matured, he moved from a discussion of cognitive elements to logical structure in his writings. Therefore, he supported his theory with both the cognitive and logical structures [skills] (Jha, 1995).

Polanyi sees language (verbal or physical) as a means of communicating between the mind and the external environment (external from the individual) and the external environment to the individual/person (Sanders, 1988). Therefore, Polanyi did NOT view spoken language (verbal or physical) as explicit knowledge (Sanders, 1988).

Post Modern View of Polanyi's Work

Some authors view Polanyi's tacit knowledge work from a more functional viewpoint by using knowing how as an analysis tool. On the other hand, Gill (2000) believes that one should view his work from a perspective of the "interplay between explicit and tacit components of human experience". It should be noted that "since the main emphases and concern of explicit knowing have received such thorough treatment in the history of Western thought, especially the modern period, Polanyi devotes the majority of his effort to expounding and exploring the nature of tacit knowing" (Gill, 2000). Therefore, Gill's approach in analyzing Polanyi's writing is to include the modern version of explicit knowing. By doing this, the analysis provides a greater understanding of the interaction between Polanyi and his peers, regarding the viability of tacit knowing at that time. Jha (1995) arrived at a similar conclusion and suggested that Polanyi's tacit knowing should encompass explicit knowing, to provide a more complete presentation of it. In his approach, Gill (2000) views this work from multiple dimensions with complex interaction based on experience, cognitive activities, and dimensional structure. This will enhance the individual understanding of the "nature of meaning at all levels" (Gill, 2000). His analysis tool, used to provide an understanding of Polanyi's papers, is in the following complex vectorial model:

Gill's Model for Understanding Polanyi's Writings

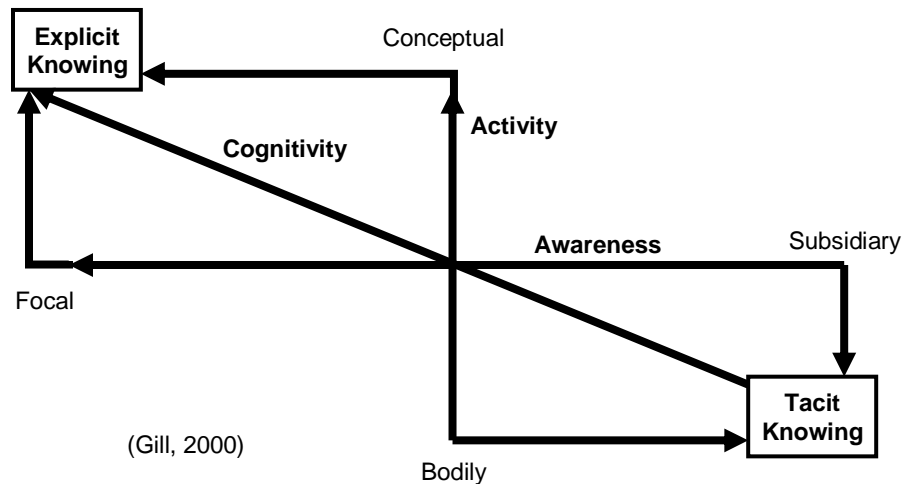


Figure 1

In Gill's diagram, a horizontal line called Awareness dimension represents the focal and subsidiary sub-categories. Awareness dimension has two endpoints or poles: Focal and Subsidiary. The Activity dimension is the vertical line that crosses the horizontal Awareness dimension line at its center. This dimension has two endpoints or poles: Conceptual and Bodily. All human activity takes place between the Conceptual and Bodily poles. These two dimensions cover the range of human experiences, with awareness acting as the input and activity as the output. The third dimension is cognitivity. Be sure to note that this dimension only moves in one direction (See arrow). The arrow shows that cognitivity flows in one direction from the tacit to the explicit pole. The focal pole of the awareness dimension and the conceptual dimension pole of the activity dimension combine to create what Polanyi would call explicit knowing. The

subsidiary pole of the Awareness dimension and the Bodily pole of the Activity dimension combine to create what he refers to as Tacit Knowing. The tacit and explicit knowing become the poles of human experience (Cognitivity). This dimensional model provides greater richness in understanding the wholeness of the human experience by handling both the cognitive and physical world. (Gill, 2000) One could also say that this diagram provides the Polanyi schema for seeing human experience.

The cognitivity dimension arises from the interaction between focal awareness and conceptual activity thus facilitating explicit knowing and the interaction of bodily activity and subsidiary awareness. Therefore, the interplay between the explicit and tacit poles of human experience creates the cognitivity dimension. The cognitivity dimension uses Polanyi's indwelling to create explicit knowing (Kane, 1982). Gill (2000) defines Polanyi's indwelling as "the process of immersing oneself in the particulars of a subsidiary awareness by means of embodied activity until these particulars come together as a meaningful whole as an interactive act." In this process, Polanyi claims that physical and conceptual skills and understanding are achieved (Kane, 1982). Gill (2006) stated that "Polanyi's view is tacit knowing is the primary source of all knowledge". He goes on to state that it is logically impossible to have explicit knowledge apart from some form of tacit knowing, then it follows that tacit knowing (in the body) is the source of all knowledge. In other words, Polanyi sees the primary source of knowledge as beginning at the tacit knowing (knowledge) pole. This is the cognitivity dimension in Gill's model, which starts at the tacit knowing pole and ends at the explicit knowing pole. Therefore,

in Polanyi’s view, tacit knowing is personal or is an individual activity. (Jha, 1995; Gill, 2000; Kane, 1982)

What are the Characteristics of Polanyi’s Tacit and Explicit Knowledge?

Polanyi presented his theory of knowledge in cognitive and logic-based arguments. In the early days, he used beliefs, ideas, and values (cognitive argument) to explain his tacit knowing. To provide a better understanding of his theory, Polanyi started using a logic-based argument, with a focus on personal skills (knowing how). This argument demonstrated that his tacit knowledge theory applied to the real world (Jha, 1995). The tacit and explicit dimension characteristics are in Table 1.

Polanyi’s Knowledge Dimension Characteristics

<u>Characteristics</u>	Tacit Knowing	Explicit Knowing
Personal/Individual/Self	X	X
Expressible		X
Codifiable		X
Primary Source of All Knowledge	X	

Table 1

Summary

Figure 2 is a concept map of Polanyi's view of personal knowledge. He sees Personal Knowledge constructed of two (2) components: Tacit and Explicit Knowing (Dimension).

Polanyi's Personal Knowledge Theory Concept Map

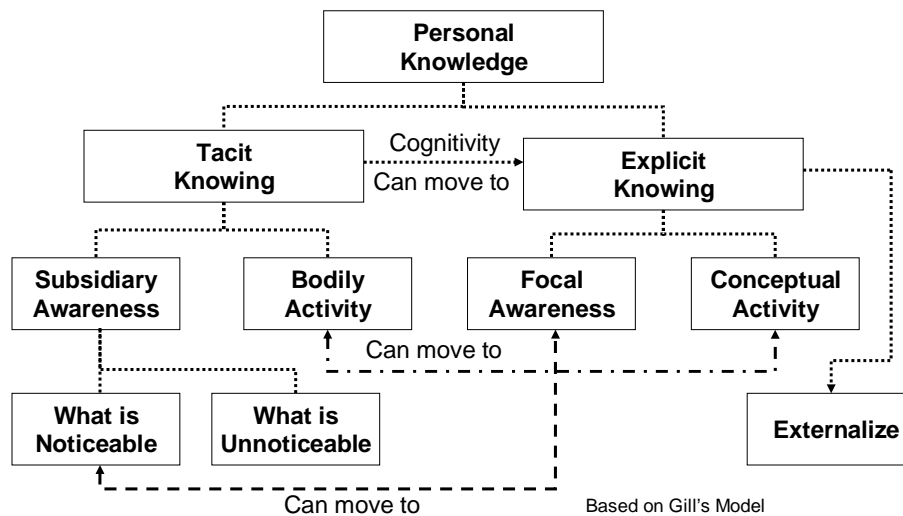


Figure 2

The tacit dimension (Knowing) is composed of Subsidiary Awareness and Bodily Activity. The subsidiary awareness has two sub-components: What is noticeable & what is unnoticeable.

Polanyi's second dimension is Explicit Knowing. The explicit is composed of Focal Awareness and Conceptual Activity. Explicit knowing can be externalized by various means since it is in focus and easily expressible. If a person externalizes their explicit knowing, then the externalized knowing is only personal knowledge to the author. This is because the author has the complementary tacit dimension that is required to make it personal knowledge. Many

scholars call the externalized explicit knowing, information, when viewed by the non-originator, since it does not contain the tacit sub-components that are required for useable personal knowledge. Polanyi sees the tacit and explicit knowing interacting to create all personal knowledge. He believes that all personal knowledge originates in the tacit dimension and moves to the explicit dimension via the indwelling process. The indwelling process finds noticeable subsidiary knowledge and identifies it. Once identified and in focus, the knowledge and its associated bodily activity then move to the explicit dimension.

In summary, Polanyi sees personal knowledge as having two components tacit and explicit. Externalization can only occur with the component in focus (explicit). The associated tacit component, which is subsidiary and unnoticeable, is required to have useable personal knowledge. He believes that tacit knowing is the primary source of all knowledge.

METHODS

Research Hypothesis

Does Polanyi's individual/ personal tacit knowledge dimension exist? To answer this question, we can hypothesize that Polanyi's tacit knowledge dimension does NOT exist, and then perform research to test this assertion. The null hypothesis is:

Hypothesis 1. Polanyi's tacit knowledge dimension does NOT exist

The testing of this null hypothesis requires an answer to the following question. How does one measure tacit knowledge? This knowledge is un-expressible and highly personal (Polanyi,

1958). The key to measuring it may be presented in *Gill's Model for Understanding Polanyi's Writing* (Figure 1). The Cognitivity Dimension in this model explains Polanyi's belief that the source of a person's knowledge is in the tacit dimension and then moves to the explicit dimension. Polanyi views tacit knowledge as highly personal. A person could use the Polanyi indwelling process on their tacit knowledge to create their explicit knowledge. The indwelling process is an individual activity (Polanyi, 1958; Gill, 2000; Kane, 1982). Therefore, one could conclude that in Polanyi's model of personal knowledge, the individual is the source of their tacit and explicit knowledge. Polanyi did not provide any exceptions (people, groups, beliefs, values, ideas, skills, etc.) to his theory. He views his theory as true for all people. If the source of a person's explicit knowledge is measured and the results are the self/individual, then Polanyi's tacit knowledge exists. Therefore, to test for the existence of the tacit dimension, the source of a person's explicit knowledge must be determined. In addition, Polanyi's view is that the tacit knowledge dimension is not just a source of knowledge. It is the primary source of all knowledge (Gill, 2006). Therefore, we can hypothesize that per Polanyi: The primary source of a person's explicit knowledge is the tacit knowledge dimension. The null hypothesis is:

Hypothesis 2. The primary source of a person's explicit knowledge is NOT the tacit knowledge dimension.

Procedure

A survey was developed based on the discussion of the research hypotheses. The survey gathered data from respondents on the relationship of the independent variables and the values (sources) associated with it. The data obtained from all respondents was used to support or reject

the research hypothesis. The independent variable is the source of a respondent's explicit knowledge. The values are: 1. Documents, 2. Self (respondent completing the survey), and 3. Others. The respondent will indicate which value is the primary source of their explicit knowledge by placing an X next to it.

Example:

Documents _____ **Self** **X** **Others** _____
(1) (2) (3)

The survey uses Polanyi type examples: Beliefs [**The earth is NOT flat**], Values [**Honesty**], Ideas [**Do you have any ideas**] and Skills (knowing how) [**Driving a car**]. Based on their reflection, the respondent provides the primary source of the knowledge for each hypothesis linked question. At the end of the survey, the respondent has a question as to whether or not they have knowledge of tacit and explicit knowledge. This question is used to determine if the respondent has the knowledge required to modify their schema to ensure that their answer conforms to Polanyi's theory. Aronson and Reilly (2005) in "Personality Validity: The Role of Schemas and Motivated Reasoning" demonstrated that a person can modify their schema based on their knowledge.

The subjects used to test the survey instrument meet all the criteria for survey respondent requirements, except for one. The test subjects were not Stevens Institute of Technology, Howe School of Technology Management students. The test subjects took the survey. After completing the survey, they were debriefed to provide feedback on any problems with the

reading, interruptions, and answering of questions. Based on the test results, the survey was revised and retested until all of the issues were eliminated.

The issue of survey respondents not remembering the primary source of knowledge that the survey questions asked about was a concern during the testing and the actual study. It should be noted that the survey did not require the respondents to indicate who was the source of the knowledge other than the three categories to be checked. In place of using a X to indicate a selection of a category, 24 % of the respondents used the name (mother, father, teacher, uncle, magazines, etc.) of the source.

The following is the sample question that was included in the survey:

1.0 Beliefs = A set of understandings that reflect our perspective of the world; an acceptance of something as true.

Given the following belief: **The sun will rise in the morning.**

1.1 Do you believe that the sun will rise in the morning? Yes No (Circle One)

1.2 How long have you had this belief? _____ Year(s)

1.3 Please place an X next to the primary source of knowledge about this belief:

Documents _____	Self _____	Others _____
(Text, Pictures, etc.)	(You decided that it was true)	(Mother, Father, Teacher, etc.)

The gathering of personal data on values, beliefs, etc does have the potential of having some bias in the responses. To reduce response bias the respondents were told that there are “No” correct answers to the survey questions. Examples and/or definitions (i.e. 1.0 beliefs definition) were used to achieve a standard understanding of the terms and question structure across all respondents to reduce method variance between respondents. (Podsakoff & Organ, 1986), (Podsakoff, MacKenzie, Lee & Podsakoff, 2003) Questions 1.1 through 1.2 were used to stimulate the cognitive process prior to the hypothesis linked question, the respondents were asked one or two questions regarding the knowledge being measured. This additional cognitive activity should reduce the covariance in the study. (Podsakoff, et al. , 2003)

In question 1.3 the primary source of the respondents belief on **The sun will rise in the morning**, the survey respondent’s were instructed to evaluate the three (3) alternatives based on the logic provided and to choose one of the three alternatives as the primary source of their knowledge about the belief . The requested selection can take place no matter what the answer is in question 1.1. To evaluate the three (3) alternatives, the respondents were instructed to use of the definition of beliefs provided as well as the following logic. If the source of the knowledge is Documents (text, pictures, etc) and the respondent accepts the document statement that the belief is true, then select Documents. If the source is Others (mother, father, teacher, etc.) and the respondent accepts the statement as true, then select Others. If the source is Documents or Others, but the respondent (Self) determines that the belief is true via observation, experimentation, reasoning, indwelling, etc, then select Self. If the respondent determined on

their own via observation, experimentation, reasoning, indwelling, etc the belief and that it is true, then select Self.

Sample Size Determination

If Polanyi's theory is correct and the theory applies to all people, then the smallest effect size worth detecting is large (0.8 per Cohen, 1988). Either Polanyi's theory is applicable to all people or it is not worthy of further discussion. In this study, a medium effect size of 0.50 (Cohen, 1988) was used to calculate the sample size to ensure that the boundary area between medium and large was covered in the estimated sample size. This effect size (0.50) was used to calculate the sample size requirement (N) to ensure that there is 90 % probability of correctly rejecting a False H_0 . This probability value is called Power.

- Power: $\delta = \gamma \sqrt{N}$ (Howell , 1999 [Table lookup])
- Sample size: $N = (\delta/\gamma)^2$
- This Power calculation assumes a medium effect size of 0.50 and an alpha = .05, one-tail test
- Sample size: $N = (\delta/\gamma)^2 = (2.90/.50)^2 = 33.64$ (Howell, 1999)

This study will require a minimum of 33.64 subjects, who complete all items on the survey correctly. Because of the possibility of unrecoverable errors in completing the survey, the size of the sample size was increased. If the error rate is no larger than 10%, then the minimum sample size should be 1.10 times 33.64 = 37.00 or 37.

Target Population and Research Respondent Selection

The selected target population for conducting the survey was a group of graduate students attending the Stevens Institute of Technology, Howe School of Technology Management. The students participating in the survey were 18 years old or older and expressed a willingness to take a survey.

Definitions of Demographics and Control Variables

The survey respondents demographics were describe using the following variables:

- Age in years
- Sex
- Cultural background
- Highest level of education obtained

In the case of the respondent demographic data collection, the items are verifiable through other sources. In principle, the respondent would not manipulate it for socially desirable reasons.

Therefore, this data is factually accurate. (Podsakoff & Organ, 1986)

The following variable was used to detect the ability of a person to modify their schema based on their knowledge: Does the respondent have knowledge of tacit and/or explicit knowledge? This will be a Yes or No answer. A T-test will be conducted to determine if the means for the measurement questions for the respondents answering yes and the respondents answering no are equal, If they are found to be unequal, then the respondents answering yes to this question will

be removed from the survey data. New samples will be taken and evaluated until the minimum number of subjects criteria is met.

Analysis Methodology

For the hypothesis analysis, recoding of the respondent's answers to the questions Belief (survey question 5.3), Value (survey question 6.3), Ideas (survey question 7.2), and Skill [Knowing How] (survey question 8.3) was required. The recoding was to address the hypothesis in the analysis process directly, since the data does not have any overlapping pieces of information and the hypothesis analysis is only interested in the variable Self. The selection of Self was coded as a one (1) and Documents & Others was coded as a zero (0). When testing a proposition of the existence of the tacit knowledge dimension, a mean significantly greater than zero (0) is required to reject the null hypothesis. Each question's data stream was tested for a mean of zero (0) (one-tail, α of 0.05) using T-Test methodology (Howell, 1999). Since this research is a proof of theory, only one out of the four hypotheses linked questions greater than zero (0) is required to reject the null hypothesis. If **Belief** $\mu(5.3)$ and **Value** $\mu(6.3)$ and **Idea** $\mu(7.2)$ and **Skill** $\mu(8.3)$ are NOT > 0 , then accept the null hypotheses:

Hypothesis 1. Polanyi's tacit knowledge dimension does not exist

Question on Belief (5.3):

$H_0: \mu_{5.3} \leq 0$; Accept the Null Hypothesis

$H_1: \mu_{5.3} > 0$; Reject the Null Hypothesis

Question on Values (6.3):

$H_0: \mu_{6.3} \leq 0$; Accept the Null Hypothesis

$H_1: \mu_{6.3} > 0$; Reject the Null Hypothesis

Question on Ideas (7.2):

$H_0: \mu_{7.2} \leq 0$; Accept the Null Hypothesis

$H_1: \mu_{7.2} > 0$; Reject the Null Hypothesis

Question on Knowing How [Skill] (8.3):

$H_0: \mu_{8.3} \leq 0$; Accept the Null Hypothesis

$H_1: \mu_{8.3} > 0$ Reject the Null Hypothesis

When testing the proposition that the primary source of a person's explicit knowledge is from the tacit knowledge dimension, a mean significantly greater than 0.5 is required to reject the null hypothesis. In other words, 62.5 % of the survey respondents must select self to reject the null hypothesis on the hypothesis-linked questions. Each question's data stream will be tested for a mean of 0.5 (one-tail, α of 0.05) using T-Test methodology (Howell, 1999). Since this research is a proof of theory, only one hypothesis linked question greater than 0.5 is required to reject the null hypothesis. If **Belief** $\mu(5.3)$ and **Value** $\mu(6.3)$ and **Idea** $\mu(7.2)$ and **Skill** $\mu(8.3)$ are NOT > 0.5, then accept the null hypotheses:

Hypothesis 2. The primary source of a person's explicit knowledge is

NOT the tacit knowledge dimension.

Question on Belief (5.3):

$H_0: \mu_{5.3} \leq 0.5$; Accept the Null Hypothesis

$H_1: \mu_{5.3} > 0.5$; Reject the Null Hypothesis

Question on Values (6.3):

$H_0: \mu_{6.3} \leq 0.5$; Accept the Null Hypothesis

$H_1: \mu_{6.3} > 0.5$; Reject the Null Hypothesis

Question on Ideas (7.2):

$H_0: \mu_{7.2} \leq 0.5$; Accept the Null Hypothesis

$H_1: \mu_{7.2} > 0.5$; Reject the Null Hypothesis

Question on Knowing How [Skill] (8.3):

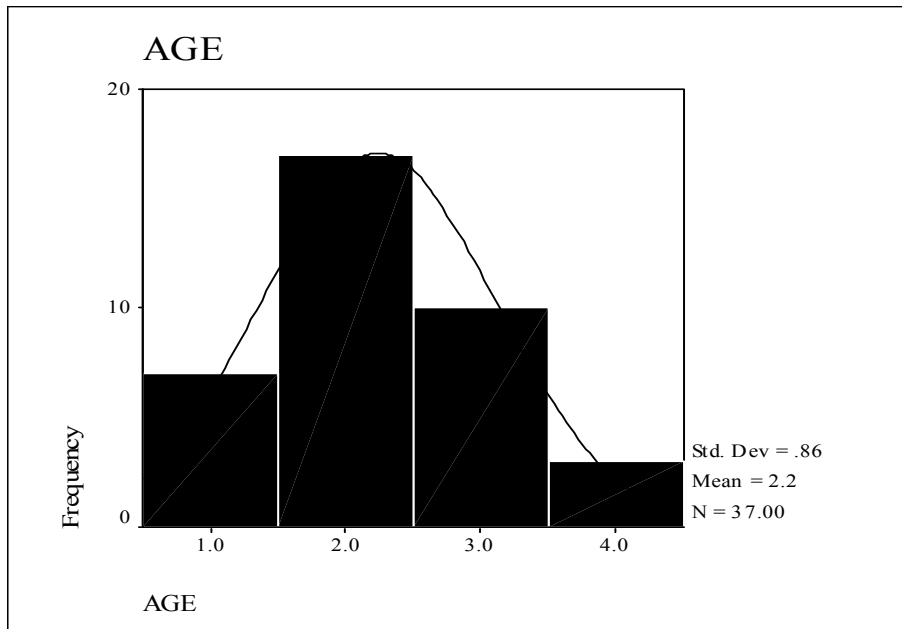
$H_0: \mu_{8.3} \leq 0.5$; Accept the Null Hypothesis

$H_1: \mu_{8.3} > 0.5$ Reject the Null Hypothesis

Analysis and Results

The study required a minimum of 34 respondents to complete the survey correctly. The actual number of surveys used in the study was 37. The selected target population for conducting the survey was the graduate students attending the Stevens Institute of Technology, Howe School of Technology Management. In fact, the students participating in the survey were all from the Executive Masters in Technology Management program. The following figures display the survey respondent's demographics for age, sex, cultural background, and highest level of education obtained:

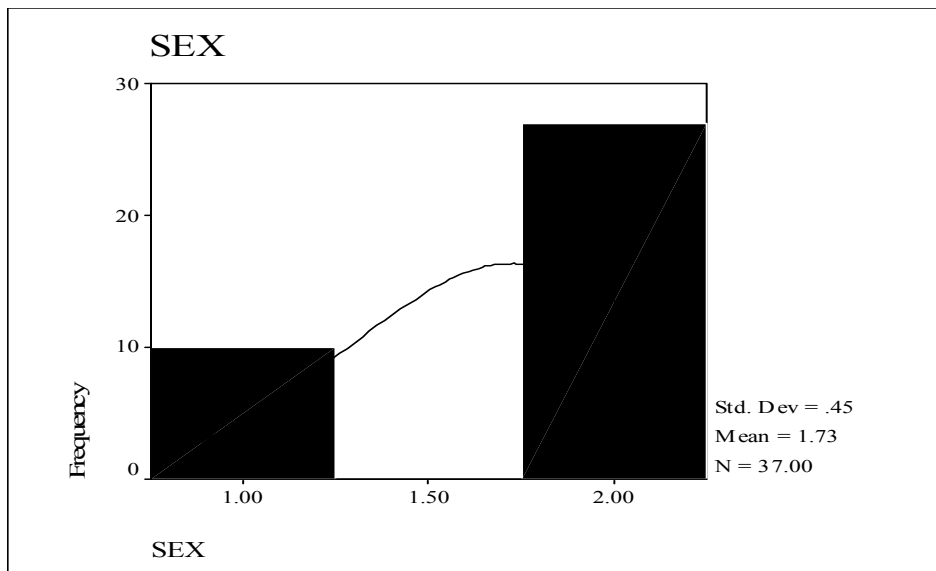
Age in Years



Legend: 1 (18 - 29), 2 (30-39), 3 (40-49), 4 (50-59), 5 (60-69) & 6 (70 or older)

Figure 3

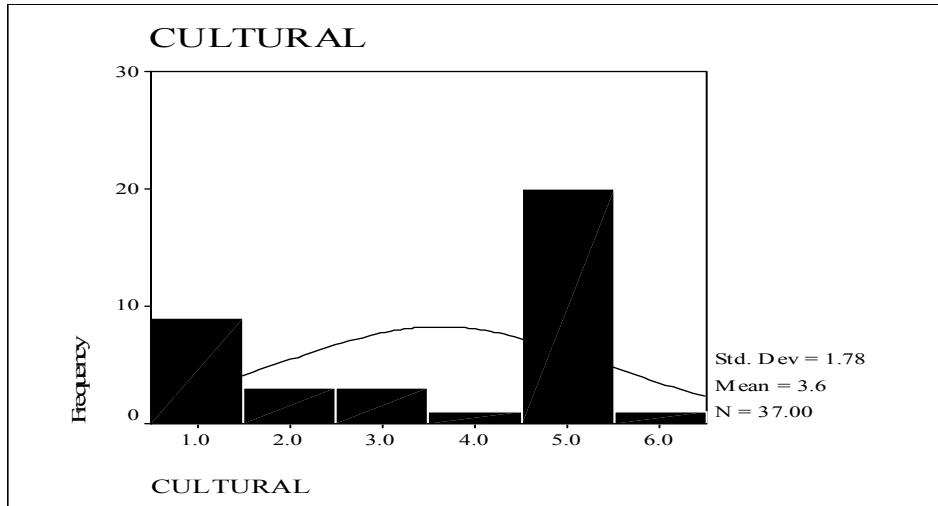
Sex



Legend: 1 (Female) & 2 (Male)

Figure 4

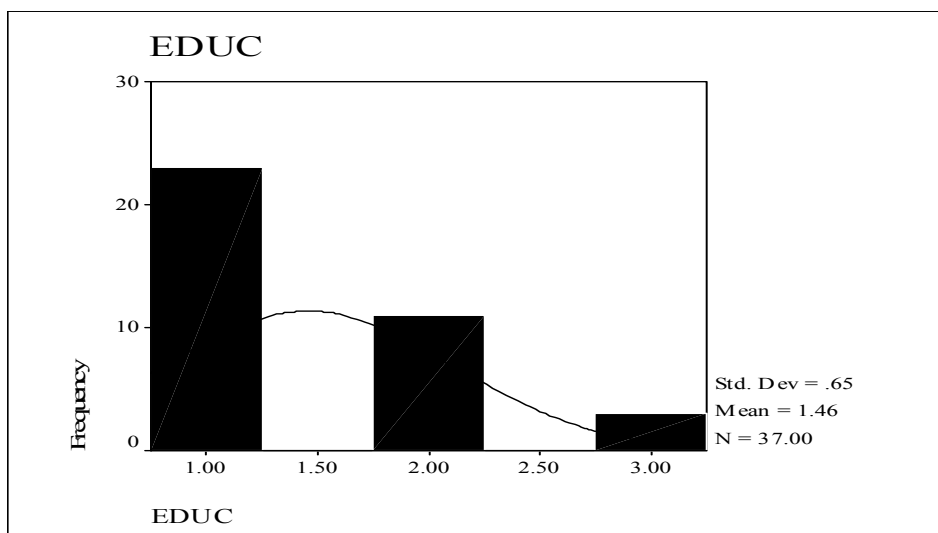
Cultural Background



Legend: 1 (Asian or Pacific Island); 2 (Black/African American); 3 (Hispanic/Latino); 4 (American Indian or Alaska Native); 5 (White/Caucasian); & 6 (Other)

Figure 5

Highest Level of Education Obtained



Legend: 1 (BA, BS or equivalent); 2 (Masters); & 3 (Doctorate)

Figure 6

In summary, the majority of the survey respondents were between the ages of 30 to 49. The male respondents outnumbered females almost 3 to 1. The primary cultural background of the respondents was Caucasian followed by Asian. Thirty-nine percent of the respondents had obtained a masters degree or higher. It should be noted that the demographics of the survey respondents do not mirror the population of the USA.

The first null hypothesis to be tested is: *Hypothesis 1. Polanyi's tacit knowledge dimension does not exist.* If **Belief** $\mu(5.3)$ and **Value** $\mu(6.3)$ and **Idea** $\mu(7.2)$ and **Skill** $\mu(8.3)$ are NOT > 0 , then accept the null hypotheses:

Hypothesis 1 Test Results

<u>Questions</u>	<u>Results</u>
Question on Belief (5.3):	
H ₀ : $\mu_{5.3} \leq 0$; Accept the Null Hypothesis	X
H ₁ : $\mu_{5.3} > 0$; Reject the Null Hypothesis	
Question on Values (6.3):	
H ₀ : $\mu_{6.3} \leq 0$; Accept the Null Hypothesis	
H ₁ : $\mu_{6.3} > 0$; Reject the Null Hypothesis	X
Question on Ideas (7.2):	
H ₀ : $\mu_{7.2} \leq 0$; Accept the Null Hypothesis	
H ₁ : $\mu_{7.2} > 0$; Reject the Null Hypothesis	X
Question on Knowing How [Skills] (8.3):	
H ₀ : $\mu_{8.3} \leq 0$; Accept the Null Hypothesis	
H ₁ : $\mu_{8.3} > 0$ Reject the Null Hypothesis	X

Table 2

Statistical tests (See Table 3 below) indicate that, three of the four questions rejected the null hypothesis: *Hypothesis 1. Polanyi's tacit knowledge dimension does not exist.*

Therefore, the test indicates that **Polanyi's tacit knowledge dimension does exist.**

Statistical Test Results for the First Hypothesis

<u>Hypothesis Test</u>	<u>Q5.3 Beliefs</u>	<u>Q6.3 Values</u>	<u>Q7.2 Ideas</u>	<u>Q8.3 Knowing How</u>
Sum (Q)=	2	16	31	9
No. of Obs (n)+	37	37	37	37
Means [Y(BAR)]=	0.05	0.43	0.84	0.24
Std. Dev. (s)=	0.23	0.50	0.37	0.44
Test mean =	0	0	0	0
<u>T-Value</u>	1.41	5.17	13.45	3.36
df	36			
One-tail test for Alpha of .05 for df:	1.69	1.69	1.69	1.69
Mean <= 0 Accept Ho if the mean is equal to or less than 0	Yes	No	No	No
Effect Size	0.24	0.86	2.24	0.56

Table 3

Two (2) out of the thirty-seven (37) respondents selected self as the knowledge source for the beliefs question. The mean (0.05) for this question was found NOT to be significantly greater than zero (0) [α of 0.05, one-tail]. Six-teen (16) out of the thirty-seven (37) respondents selected self as the knowledge source for the values question. The mean (0.42) for this question was

found to be significantly greater than zero (0) [α of 0.05, one-tail test]. Thirty-one (31) out of thirty-seven (37) respondents selected self as the knowledge source for the ideas question. The mean (0.84) for this question was found to be significantly greater than zero (0) [α of 0.05, one-tail test]. Nine (9) out of thirty-seven (37) respondents selected self as the knowledge source for the skills (knowing how) question. The mean (0.24) for this question was found to be significantly greater than zero (0) [α of 0.05, one-tail test]. The effect size was calculated for each of the questions by subtracting the Test Mean from the Study Mean [$Y(\text{BAR})$] and dividing the difference by the standard deviation (Howell, 1999). An example using the data from the values question is: $(0.43 - 0)/0.50 = 0.86$ effect size). Howell (1999) states that effect size is always expressed in absolute value. In the calculation of the sample size for the survey, the effect size used was 0.5 (or medium per Cohen, 1988) and the probability of correctly rejecting a False H_0 was 90 %. Therefore, any effect size of 0.5 or greater should have a high probability of correctly rejecting a False H_0 . In Table 3 the effect size for the values, ideas, and knowing how questions have an effect size that provides a high probability of rejecting a False H_0 .

The last question in the survey asked the respondents if they have knowledge of tacit and explicit knowledge. The question was used to determine if the respondents had the potential knowledge needed to modify their schema to ensure that their answer conformed to Polanyi's theory. Twenty (20) out of thirty-seven (37) of the survey respondents answered YES to this question. Therefore, a statistical test was conducted to determine if the means for each hypothesis linked question in the survey was statistically different for each schema group at an alpha = .05, for a two tail test.

The survey respondents that answered Yes to the schema question were grouped and referenced as the Schema 1 Group (S1G). The other survey respondents were grouped and referenced as Schema 2 Group (S2G). Therefore, the hypothesis is:

Hypothesis 3. The means for Schema Group 1 and Schema Group 2 are equal for each question below:

Test Results for the Schema Group Hypothesis

<u>Questions</u>	<u>Results</u>
Question on Belief (5.3):	
H ₀ : S1G $\mu_{5.3}$ = S2G $\mu_{5.3}$; Accept the Hypothesis	X
H ₁ : S1G $\mu_{5.3}$ \neq S2G $\mu_{5.3}$; Reject the Hypothesis	
Question on Values (6.3):	
H ₀ : S1G $\mu_{6.3}$ = S2G $\mu_{6.3}$; Accept the Hypothesis	X
H ₁ : S1G $\mu_{6.3}$ \neq S2G $\mu_{6.3}$; Reject the Hypothesis	
Question on Ideas (7.2):	
H ₀ : S1G $\mu_{7.2}$ = S2G $\mu_{7.2}$; Accept the Hypothesis	X
H ₁ : S1G $\mu_{7.2}$ \neq S2G $\mu_{7.2}$; Reject the Hypothesis	
Question on Knowing How [Skills] (8.3):	
H ₀ : S1G $\mu_{8.3}$ = S2G $\mu_{8.3}$; Accept the Hypothesis	X
H ₁ : S1G $\mu_{8.3}$ \neq S2G $\mu_{8.3}$; Reject the Hypothesis	

Table 4

Statistical tests (See Table 5 below) indicate that, NONE of the above questions rejected the hypothesis: *Hypothesis 3. The means for Schema Group 1 and Schema Group 2 are equal for each question.*

Statistical Test Results for the Schema Group Hypothesis

<u>Hypothesis Test</u>	<u>Q5.3</u>	<u>Q6.3</u>	<u>Q7.2</u>	<u>Q8.3</u>
	<u>Beliefs</u>	<u>Values</u>	<u>Ideas</u>	<u>Knowing How</u>
<u>S1G Schema =</u>	1	(Yes)		
Sum (Q)=	1	8	16	5
No. of Obs (n)+	20	20	20	20
Means [Y(BAR)]=	0.05	0.40	0.80	0.25
Std. Dev. (s)=	0.22	0.50	0.41	0.44
df	19			
<u>S2G Schema =</u>	2	(No)		
Sum (Q)=	1	8	15	4
No. of Obs (n)+	17	17	17	17
Means [Y(BAR)]=	0.06	0.47	0.88	0.24
Std. Dev. (s)=	0.24	0.51	0.33	0.44
df	16			
<u>Pooled Variance</u>	0.05	0.25	0.14	0.19
Schema 1 Means	0.05	0.40	0.80	0.25
Schema 2 Means	0.06	0.47	0.88	0.24
Std. Dev. (s)=	0.23	0.51	0.38	0.44
<u>T-Value</u>	-0.11	-0.41	-0.64	0.10
Pooled df	35			
Two-tail test for				
Alpha of .05 for df:	2.03	2.03	2.03	2.03
Mean are equal	Yes	Yes	Yes	Yes

Table 5

No adjustment to the sample is required.

The second null hypothesis to be tested is:

Hypothesis 2. The primary source of a person's explicit knowledge is NOT the tacit knowledge dimension.

If **Belief** $\mu(5.3)$ and **Value** $\mu(6.3)$ and **Idea** $\mu(7.2)$ and **Skill** $\mu(8.3)$ are NOT > 0.5 , then accept the null hypotheses:

Hypothesis 2 Test Results

<u>Questions</u>	<u>Results</u>
Question on Belief (5.3):	
H ₀ : $\mu_{5.3} \leq 0.5$; Accept the Null Hypothesis	X
H ₁ : $\mu_{5.3} > 0.5$; Reject the Null Hypothesis	
Question on Values (6.3):	
H ₀ : $\mu_{6.3} \leq 0.5$; Accept the Null Hypothesis	X
H ₁ : $\mu_{6.3} > 0.5$; Reject the Null Hypothesis	
Question on Ideas (7.2):	
H ₀ : $\mu_{7.2} \leq 0.5$; Accept the Null Hypothesis	
H ₁ : $\mu_{7.2} > 0.5$; Reject the Null Hypothesis	X
Question 8.3 on Knowing How (Skills) :	
H ₀ : $\mu_{8.3} \leq 0.5$; Accept the Null Hypothesis	X
H ₁ : $\mu_{8.3} > 0.5$; Reject the Null Hypothesis	

Table 6

Statistical tests (See Table 7 below) indicate that, one of the above questions rejected the null hypothesis:

Hypothesis 2. The primary source of a person's explicit knowledge is NOT the tacit knowledge dimension.

Therefore, the test indicates that **the primary source for a person's explicit knowledge is the tacit knowledge dimension.**

Statistical Test Results for the Second Hypothesis

<u>Hypothesis Test</u>	<u>Q5.3 Beliefs</u>	<u>Q6.3 Values</u>	<u>Q7.2 Ideas</u>	<u>Q8.3 Knowing How</u>
Sum (Q)=	2	16	31	9
No. of Obs (n)+	37	37	37	37
Means [Y(BAR)]=	0.05	0.43	0.84	0.24
Std. Dev. (s)=	0.23	0.50	0.37	0.44
Test mean =	0.5	0.5	0.5	0.5
<u>T-Value</u>	-11.67	-0.81	5.42	-3.54
df	36			
One-tail test for Alpha of .05 for df:	1.69	1.69	1.69	1.69
Mean <= 0.5	Yes	Yes	No	Yes
Accept Ho if the mean is equal or less than 0.5				
Effect Size	1.95	0.14	0.90	0.59

Table 7

In Table 7, the ideas question that rejected the null hypothesis has an effect size that provides a high probability of rejecting a False H₀.

A Pearson correlation test was performed on all data elements for the recoded hypothesis linked question. The results did not indicate any significant correlation to or between the hypothesis-linked questions.

Limitations of Study and Future Research

One of the limitations of the study is that the survey respondents were all graduate students attending the Stevens Institute of Technology, Howe School of Technology Management. In this case, the ability to generalize the results of the study to a larger population is limited.

The survey respondents were self-reporting via recollection. Therefore, the potential exists for single source bias in the recollection process. In most studies, single source bias is a concern when rating constructs (Avolio, Yammarino, & Bass, 1991). Avolio, Yammarino, and Bass (1991) state that “single-source bias is a special case of common method bias. They state that “all other things being equal, single source bias is operationalised as the degree to which the relationship between two variables deviates from the true score correlation when using a single source, producing what Chapman and Chapman (1967, 1969) have labeled the illusory correlation.” They further state that “single source effects are not necessarily an either or issue, but are perhaps a function of a number of factors and may be a matter of degree.” In this study, there were no significant correlations to report and there cannot be a reliable alternative for a respondent’s source of knowledge. The potential of having a single source bias limitation should be considered.

Some of the limitations provide areas for future research. In this study, the population sample is graduate students. The population used in Future research should study a population that is more diverse. In addition, only one belief, value, and skill (knowing how) were tested. Future research should look at a range of beliefs, values, skills (knowing how) to see if there is a distribution among documents, self, and others as sources of knowledge. It may be possible that some beliefs, values, and skills are highly personal and self is the primary source of this knowledge. Some other sources of knowledge may be accepted as personal knowledge, when the knowledge is not considered highly personal (defining the individual). Another area to investigate is the potential of additional sources of knowledge or developing a source of knowledge structure.

Conclusion

The research into Polanyi's Tacit Knowledge dimension demonstrated that it exist. The un-expressible tacit knowledge dimension was empirically tested. This test used a selected sample of graduate students in the Stevens Institute of Technology's Howe School of Technology Management, who were in a Masters in Technology Management program. The data collection method was a survey. The first null hypothesis is:

Hypothesis 1. Polanyi's tacit knowledge dimension does not exist

The decision logic of the statistical test was structured so that if the means of all four hypothesis-linked questions was NOT > zero (0), then the null hypothesis would be accepted. The survey results showed that three (3) out of the four questions rejected the above null hypothesis. The one-tail tests were conducted using an alpha of 0.05. The statistical test results showed that two

of the questions rejecting the null hypothesis had an effect size greater than 0.8. The third question's results had an effect size greater than 0.5.

The second null hypothesis investigated whether or not Polanyi's tacit dimension was the primary source of a person's explicit knowledge. The null hypothesis is:

Hypothesis 2. The primary source of a person's explicit knowledge is NOT the tacit knowledge dimension

The decision logic of the statistical test was structured so that if the means of all four hypothesis-linked questions were NOT > 0.5 , then the null hypothesis would be accepted. The survey results showed that one (1) out of the four questions rejected the above null hypothesis. The one-tail tests were conducted using an alpha of 0.05. The statistical test results showed that the question rejecting the hypothesis had an effect size greater than 0.8.

The results of the research reported in this paper verified empirically that the tacit knowledge dimension of Polanyi's Personal Knowledge theory is more than just a theory. It exists in the real world for the population surveyed. Based on the research reported in this paper: Variables for future research into tacit knowledge can now be defined and operationalised; Scholars should be able to arrive at a consensus on the definition of tacit knowledge; viable examples can be created to facilitate the understanding of tacit knowing that will have the same meaning. The major contribution of this research is that the door has been opened to the development of management practice for managing tacit knowledge in the organization.

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