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# Identifying Experts in Information Systems for System Evaluations

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## Abstract

*This research-in-progress paper reports preliminary findings of a study that is designed to identify characteristics of an expert in the discipline of Information Systems (IS). The paper delivers a formative research model to depict characteristics of an expert with three additive constructs, using concepts derived from psychology, knowledge management and social-behaviour research. The paper then explores the formation and application 'expertise' using four investigative questions in the context of System Evaluations. Data have been gathered from 220 respondents representing three medium sized companies in India, using the SAP Enterprise Resource Planning system. The paper summarizes planned data analyses in construct validation, model testing and model application. A validated construct of expertise of IS will have a wide range of implications for research and practice.*

**Keywords**: **Expert, Novice, Intermediate, System evaluation, Knowledge, Experience**

## INTRODUCTION

Social science research demonstrates that expertise (as a positive indication of degree of proficiency) is not a reflection of ones innate abilities and capacities, but rather a combination of acquired complex *skills*, *experience* and *knowledge capabilities* (Ericsson and Smith, 1991; Hunt, 2006; Norman, 2006; Yates and Tschirhart, 2006). Many social scientists have demonstrated the positive impact of extended deliberate practice and the impact of deliberate learning of skills on ones performance of a task (Eriksson et al., 1993). Similarly, heuristics have been established on the approximate number years in deliberate practice to attain a high level of expertise (Simon and Chase, 1973). Since early comparisons of the performance of experts and novices in social psychology (Chase and Simon, 1973; de Groot, 1978), research on 'degree of proficiency' has played an important role in management and social science disciplines.

Despite strong research from social psychology on expertise gained through 'years of experience' and 'deliberate practice', research has been lacking on several pertinent areas. Our review of literature suggests a strong need for research on three important aspects: (1) what salient 'knowledge types' are required to attain expert performance, and (2) how the generic 'socio-behavioural factors' contribute to ones expert performance. Moreover, many prior expertise studies have been completed in static disciplines (e.g. sports and mathematics), where practice and experience take precedence over the knowledge held by the individual. However, (3) in dynamic social science disciplines like Information Systems (IS), where changes are frequent, years of experience and deliberate practice may not have a substantial impact on ones performance. In dynamic disciplines, salient knowledge held by individuals tautologically should have a far greater influence on the expert performance.

Following these three foundational weaknesses, this research attempts to define the salient characteristics of expertise in the discipline of Information Systems. In doing so, we derive insights from the Generalized Expertise Measurement (GEM) of Germain (2009), Knowledge types of Davenport (1998), years of

experience research by Simon and Chase (Simon and Chase, 1973) and conceptual work of Ericsson and Smith (1991). The newly derived expertise guidelines of this research will then be applied in the domain of Information System (IS) '*evaluations',* where the application of expert performance is evidenced.
A formative research model is developed using four key constructs that purportedly measure expertise of an individual in Information Systems. The constructs include: (1) knowledge, (2) experience, (3) training, and (4) generic socio-behavioural characters. Since each of the constructs makes a unique contribution to expertise, the research model conceives the phases as dimensions 'forming' expertise. The expertise model is thus conceived and operationalised as a hierarchical, multidimensional, formative index (arrows pointing in). The derivation of the model would facilitate the identification of three levels of expertise (degrees of proficiency): novice, intermediates and experts; where an 'expert' holds the highest degree of proficiency, followed by intermediate and novice.

Once the expert characteristics are established, the model is the applied in the context of Information System evaluation using the IS-Impact Measurement model of Gable Sedera and Chan (2008), where we seek to demonstrate statistically significant differences in evaluation opinions between three levels of expertise. Data were gathered from 220 respondents in three medium size organizations in India using the same Enterprise System application in July – September 2009.

The paper proceeds in the following manner. First, it provides a summary of literature that summarizes contributions of prior studies and highlight possible improvements sought in this study. Next, the paper introduces the formative research model and related constructs. The subsequent section will address the driving hypothesis of the study and its four investigative questions. Next, the paper illustrates the survey instrument employed and the context that it was conducted at. The paper concludes with a summary of expected outcomes and implications for research and practice.

## LITERATURE REVIEW

Degree of proficiency is generally associated with skills, expertise and knowledge (Eriksson and Charness, 1994), which extends over a continuum, from *novice → intermediate → expert*, where an 'expert' holds the highest degree of proficiency. Expertise, in general, is defined as superior performance in terms of success, swiftness, and/or accuracy. Experts have prolonged or intense experience through practice and education in a particular field and they are able to deal with new situations in their domain. (e. g. (Ericsson and Charness, 1994; Glaser and Chi, 1988; Leplat, 1986; Schvaneveld et al., 1985). Moreover, an expert has recognized knowledge and expertise, can comment authoritatively on an issue, and often is asked to give an opinion with regard to the specific facts (Bainbridge, 1989; Olsen and Rasmussen, 1989). In contrast, a novice has only factual and free-context rules acquired from training and is typically at the early stage of their career (Dreyfus, 1992; Ward et al., 2006). In between two extremes of experts and novices are the intermediates.

The following review of literature commences with an introduction to the salient constructs constituting to the research model. It first introduces 'Years of experience' and 'Deliberate practice' as two of the most commonly used constructs in determining 'expertise'. The review then introduces 'Knowledge' as an important construct for Information System expertise. Thirdly, the review provides a summary of findings on the methods of identifying experts in a subjective self evaluation.

**Years of Experience**
'Years of experience' is one of the most common researched constructs in association with the level of expertise. Social Science research on expert performance and expertise (Chi et al., 1988; Ericsson and Smith, 1991) has shown that important characteristics of experts' superior performance are acquired through experience arguing that exceptional performance is an outcome of the environmental

circumstances, such as the duration and structure of activities[1]. Eriksson et al. (1993) hypothesized that the individuals' performances are a monotonic[2] function of the deliberate practice. They argued that the accumulated amount of deliberate practice and the level of performance an individual achieves at a given age is a function of the starting age for practice and the weekly amount of practice.

The view that merely engaging in a sufficient amount of practice, regardless of the structure of that practice, leads to maximal performance has a long and contested history and is demonstrated in a series of classic studies of Morse code operators. Bryan and Harter (1897) and Bryan and Harter (1899) identified plateaus in skill acquisition, when for long periods subjects seemed unable to attain further improvements. However, they observed, with extended efforts, operators could restructure their skill to overcome plateaus. Keller (1958) later showed that these plateaus in Morse code reception were not an inevitable characteristic of skill acquisition, but could be avoided by different and better training methods.

Though it is tautological that 'years of experience' is related to and at times influences the degree of proficiency, such a proficiency-classification that is purely based on the years of experience, for contemporary IS may lead to inconsistent interpretations. Such a simple classification based solely on the number of years would be unreasonable, especially given that a contemporary IS includes many user cohorts ranging from senior managers to data-entry operators - each cohort with a diverse set of skills and capabilities. In parallel disciplines, it has been established that it takes ten-years to become an expert from the time at which practice was initiated (Simon and Chase, 1973). Simon and Chase's (1973) "10-year rule" is supported by data from a wide range of domains: music (Sosniak, 1985), mathematics (Gustin, 1985), tennis (Monsaas, 1985), and swimming (Kalinowski, 1985). Given that Simon and Chase's 10-year rule has been generalized in a range of disciplines, it is intriguing to evaluate whether the same findings are generalized in Information System discipline as well.

**Knowledge contributes to expertise**

Managing a contemporary Information System is a knowledge intensive task that necessarily draws upon the experience of a wide range of people with diverse skills and knowledge capabilities (Gable and Klaus, 2000; Soh et al., 2000). In order to develop a better understanding of degree of proficiency, we sought explanations from the Knowledge Management literature, where managing knowledge has been identified as a critical success factor for contemporary information system success (Bingi et al., 1999; Davenport, 1996, 1998a, b; Gable et al., 1998; Sumner, 1999). Herein, we apply the three knowledge types of Davenport (1998b) for a contemporary Information System: (1) software-specific knowledge, (2) business process knowledge and (3) organization-specific knowledge.

Software specific knowledge refers to the knowledge, skills and expertise that those employees' possess in relation to the operation of the system they use. Other aspects of system related knowledge (such as, platform knowledge, infrastructure knowledge, architecture knowledge and network knowledge) can be included in specific circumstances where, the focus of the IS evaluation is predominantly of a technical nature.

Business process knowledge refers to the in-depth understanding that an employee possesses on, not just the functional area that s/he is involved in, but the entire business process that their functional area belongs to. Organizations of the 'knowledge-era' focus on increasing effectiveness through establishing strong foundations in knowledge, which includes not only software knowledge but employees' knowledge of business processes and work practices. Akin to Xu and Ramesh (2003), we argue that most (if not all) business processes are situational in nature, where the software is adapted to meet needs of specific business circumstances. In light of the aforementioned, it is argued that the two knowledge types of an IS employee are largely responsible for the degree of proficiency.

[1] Research demonstrates that some minimal biological attributes may also lead to the acquisition of expertise. This is considered beyond the scope of the study.

[2] Changing in one direction only; thus either strictly rising or strictly falling, but not reversing direction.

Moreover, in general (and regardless of the study context), 'training' has been identified as a critical aspect that contributes to employees' knowledge. Such formal training programs ensure wider distribution of highly context-specific knowledge that can be particularly useful throughout the phases of an IS lifecycle (Pan and Chen, 2005). In the interest of understanding the contribution of formal training on software and business knowledge, this study includes 'formal training' as an antecedent of overall knowledge.

Having established the salient characteristics and the criteria for identifying the degree of proficiency and the level of experience, figure 1 graphically depicts the relationship between the key variables. The solid line in figure 1 depicts the degree of proficiency gained through the years of experience and the innate ability; where the dotted line suggests the likely higher levels of degree of proficiency based on training and attainment knowledge requirements (in addition to the innate abilities and the years of experience).

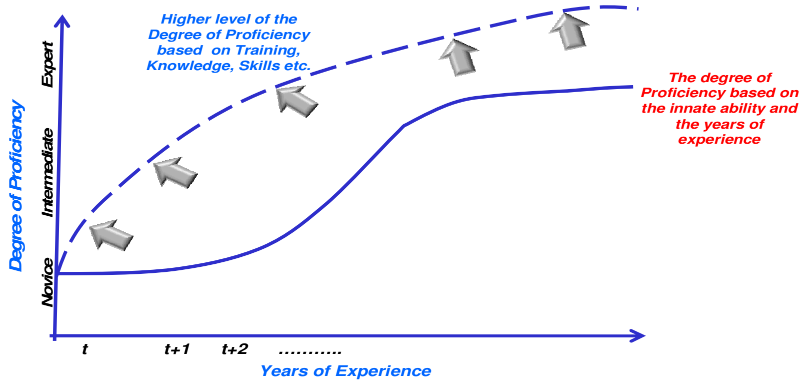


Figure 1: Relationship between the key variables

**Identifying experts**

This research follows the self-reporting approach[3] as per Vygotsky (1962) in order to identify the levels of expertise. In the self-reporting approach, survey respondents are asked to respond to a series of survey questions rating their own knowledge, expertise and / or skills. Though there are some limitations where respondents may overstate or understand their level of expertise, research suggests that self evaluations provide a reasonable depiction of the reality.

Following Vygotsky (1962), Eriksson and Charness (1994) suggest the statistical term *outlier* as a useful heuristic for identifying an expert. They suggest that, usually, if a person is performing at least one or two standard deviations above the mean level in the population, that individual is said to be performing at the expert level. Similarly, when one performs below one or two standard deviations below the population mean, they fall into the category of 'Novice'. The remaining respondents are classified as the 'Intermediates'. Elo (1986) too makes similar observations in relation to Chess ratings, where an expert is determined using two to three standard deviations above the mean.

[3] As opposed to the classical test theory approach as per works of Novick, M. R., 1966, The axioms and principal results of classical test theory Journal of Mathematical Psychology v. 3, p. 1-18 and Lord, F. M. N., M. R., 1968, Statistical theories of mental test scores: Reading MA, Addison-Welsley Publishing Company Classical test theory requires a set of fixed prepositions in a situation. It is difficult to employ such a technique in any of the social science disciplines where a definite answer to an issue is rare.

# RESEARCH MODEL DEVELOPMENT

As per the Petter et al. (2007) guidelines for identifying formative variables, measures of expertise; (i) need not co-vary, (ii) are not interchangeable, (iii) cause the core-construct as opposed to being caused by it, and (iv) may have different antecedents and consequences in potentially quite different nomological nets. Expertise herein is conceived of as a construct that encompasses the *three* constructs identified above (knowledge possessed by the respondent, years of experience, and socio-behavioural attributes of the respondent).

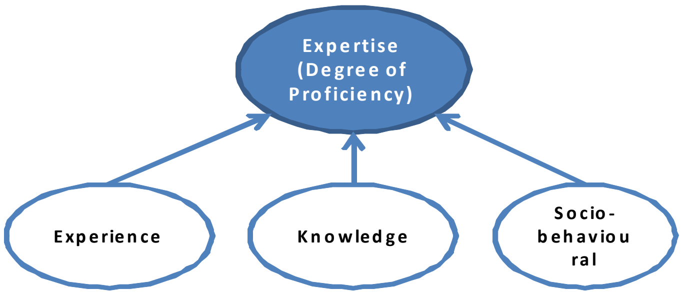


Figure 2: High-level research model

**Relevance of Experts in Information System Evaluations**

Having discussed the research model, we now turn to its application in the domain of Information Systems evaluations. In IS evaluations (commonly known as IS success with the most prominent model developed by DeLone and McLean 1992; 2003 and Gable Sedera Chan 2008), respondent's characteristics has been recognized as an important consideration. The respondents' perspective is the first question of the seven questions by Cameron and Whetten (1983). However, most system evaluation studies do not pay a close attention to the characteristics of the respondent. It is our belief that an expert is able to provide a better and more insightful evaluation of a system. Thus we argue herein that organizations will benefit by paying close attention to system evaluations of 'experts'. This study gathered data on expertise as well as information systems success. Once the experts are identified through the research model described above, respondents can then be separated into three mutually exclusive groups of: novice, intermediate and expert. After deriving these three groups the study will then explore IS Evaluation using the data collected from the IS success measures.

The IS-Impact measurement model of Gable Sedera and Chan (2008) employs 27 measures arranged under 4 dimensions to assess the level of success of a contemporary Information System (Gable et al., 2008:381), wherein IS-Impact is defined as 'the stream of net benefits from an information system, to date and anticipated, as perceived by all key user groups. To the extent that the three groups demonstrate statistically significant differences argue for the existence of the three degrees of proficiency: novice, intermediaries and expert. As per prior literature (Ross et al., 2003), it is advisable to gather data at the later phase of the ES Lifecycle.

# HYPOTHESES DEVELOPMENT

The main hypothesis of the study: <u>Experts evaluation of a system is different to those of an intermediary or a novice</u>, where we define an expert of Information System as someone with "substantial experience with high knowledge of the software, business processes, and organization, with a strong capability to adopt and adapt to organizational changes".

The differences in views on system evaluations of the three classifications are tested employing dimensions and measures of the IS-Impact model.

Following the main hypothesis, four investigative research questions are derived: (1) what are the salient characteristics of an expert in Information Systems discipline for system evaluations?, (2) what are the salient knowledge types required for one as an expert for system evaluations?, (3) whether ones experience with the Information System make a positive contribution to his/her expertise?, and (4) what socio-behavioural characteristics are necessary to define expertise?.

In seeking answers for the first investigative question, we turn to recent research of (Germain, 2009), who developed a psychometric measure of perception of employee expertise termed 'Generalized Expertise Measure (GEM)'. This is one of the very few studies developed to understand expertise from a perceptual viewpoint. GEM defines an "expert" as someone with (i) specific education, training and knowledge, (ii) ability to assess importance in work-related situations, (iii) capacity to improve them-selves, (iv) intuition and (v) self-assurance and (vi) confidence in their knowledge. Herein we adapt guidelines of GEM to Information Systems. The first investigative question also seeks to explore whether expert evaluation of a system is significantly different to an evaluation by intermediaries and novices.

For the second investigative research question, we seek explanations from Knowledge Management literature. Specifically, we employ Davenport's (1998) knowledge matrix for contemporary IS that include: software specific knowledge, business process knowledge and organization specific knowledge. We argue that an expert for system evaluations must have above-average knowledge in all three types of knowledge. We further argue that, one with above-average knowledge of all three knowledge types would be in a better position to answer questions in relation to all four dimensions of IS-Impact model. Given the majority of an organization is operational and management staffs, we argue that both stakeholder groups must have substantial knowledge of all three types of knowledge. Following conclusions of Vogotsky (1962), respondents will make a 'self-assessments of their knowledge' in relation to the three knowledge types, where an expert in general scores 2 or more standard deviations higher than the sample mean for measuring items.

Investigative question three seeks to develop the relationship between years of experience with the Information System and expertise. Inspired by findings of Simon and Chase (1973), where an individual takes, on average 10 years to master in a subject domain, we investigate the purported relationship between experience and expertise. Herein, we disagree with some research in psychology discipline, who identified that individual's performances is a monotonic function of the deliberate practice, where the accumulated amount of deliberate practice and the level of performance an individual achieves at a given age is a function of the starting age for practice and the weekly amount of practice. In this research, we attempt to demonstrate that expertise is not an innate neither a function of deliberate practice – but it is highly influenced by such aspects like training and organizational knowledge sharing culture.

## INSTRUMENT AND CONTEXT

Seeking answers to the four investigative questions, we developed a survey instrument that included 18 questions pertaining to expertise. Section one of the survey instrument gathered demographic data (respondent's name, employment title, employment description, and the number of years with the organization). The remaining 16 questions in section two included questions to determine the level of expertise of a respondent using; 7 questions of knowledge, 4 questions of proactive self-learning, and 5 questions on willingness and adapting to change that extends Germain (2009). The questions of the survey instrument are illustrated in table 1. In addition to the 18 items of the four constructs, the survey instrument included 5 criterion measures (1 per construct and another for the overarching Expertise). Section three included the validated 27 questions of the IS-impacts measurement model of Gable et al. (2008) (for a full list of the items see Appendix of (Gable et al. 2008:405)).

The survey instrument was circulated to all 350 direct operational and management users of the three medium sized organizations using SAP Enterprise System in India between July – September 2009. The survey received 220 valid responses (with a response rate of 63%).

All questionnaire items were measured using seven-point Likert scales with the end values (1) "Strongly Disagree" and (7) "Strongly Agree", and the middle value (4) "Neutral". The draft survey instrument was pilot tested with a selected sample of staff of a single organization with 10 users (3 managers and 7 operational staff).

Table 1. The Survey Instrument

| | |
|---|---|
| | **Proactive self-learning** |
| 1 | I refer to corporate database before processing some tasks |
| 2 | I try to document and store expertise and guidelines on new tasks and policies |
| 3 | I extensively search through customer and task-related databases to obtain knowledge necessary for the tasks |
| 4 | I can learn what is necessary for new tasks |
| | **Willing to adapt** |
| 5 | I can refer to best practices and apply them to my tasks |
| 6 | I can use the Internet to obtain knowledge for the tasks |
| 7 | I obtain useful information and suggestions from brainstorming meetings without spending too much time |
| 8 | I search information for tasks from various knowledge sources administered by the organization |
| 9 | I am ready to accept new knowledge and apply it to my tasks when necessary |
| | **Knowledge Competencies** |
| 10 | I fully understand the core knowledge necessary for my tasks |
| 11 | My knowledge of SAP is more than enough to perform my day-to-day tasks |
| 12 | I have colleagues and workmates helping me with SAP related problems and issues (inversely worded) |
| 13 | I rarely contact SAP helpdesk for software related problems |
| 14 | I rarely make mistakes when completing my tasks in SAP |
| 15 | I have an in-depth knowledge of the tasks that I must do on a day-to-day basis |
| 16 | I have a good knowledge of the organizational goals, procedures and guidelines |
| | **Years of Experience** |
| 17 | Years with the current department |
| 18 | Years in the business sector |

## EXPECTED FINDINGS AND IMPLICATIONS

As stated above, this paper is summarizes in-progress research. The researcher is yet to complete the data analyses and make observations. Thus, herein we state the expected outcomes with the respective analyses ranging from construct validation, model testing, and model application. This section concludes with a summary of implications for research and practice.

**Expertise model testing**

The formative expert model (as per figure 1) employs new constructs that necessitates a range of model validation tests. As per formative construct validation procedures described by (Diamantopoulos and Winklhofer, 2001), Variance Inflation Factors (VIF) will be first computed separately for each of the 18 expertise measures to assess the possible existence of multicollinearity between formative measures. The measures with VIF scores below the common threshold of 10[4] will be retained for further analysis (as recommended by (Kleinbaum et al., 1998)). A similar procedure will be followed for the IS-Impact measurement model. Once the absence of multicollinearity of items is established, a MIMIC model will be developed and tested following prescriptions of Jarvis et al (2003, p.214, Figure 5, Panel 3) to observe the Goodness of Fit indicators. Finally a PLS model will be developed using the 18 items together with their respective criterion measures to test the strength of the model and its stability. It is expected that aforementioned analyses will provide a stable model with appropriate indicators.

**Deriving the three level continuum of expertise**

Once the validated expertise items are identified, following prescriptions of Vygotsky (1962) and Eriksson and Charness (1994) all items per respondent will be aggregated to a new variable. This will allow researchers to establish the standard deviations for each respondent for each construct and the overall construct of expertise. Based on the aggregated score and their standard deviations, we can now determine whether a respondent is an expert, intermediate or a novice.

**Application of classification on IS-impact model dimensions**

In order to test the validity and application of the three level continuum of expertise, we will then observe the 'evaluation scores' for each respondent. To statistically determine whether a respondents hold diverse views on the success evaluation criteria, a series of independent sample t-tests will be carried out using the, aggregated scores of the four success dimensions and its variants. Observing statistically significant differences will provide further evidence of the validity (and existence) of the three levels of expertise.

**Implications**

This research has the potential to demonstrate a range of implications to research as well as to the practice. Identification of generalizable characteristics of experts of Information System will be a starting step with substantial impact on most sub-disciplines. Specifically for Information System success research, the characteristics of an expert of IS, will add much more confidence in system evaluations.

From management practice, identification of expert characteristics will allow organizations to emulate qualities of experts to novices and intermediates. Moreover, the simple identification of cohorts based on their expertise will allow organizations to allocate practices, training and resources according to the areas of need.

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[4] The largest VIF for the study measures being 6.1.

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