AN EVALUATION OF FACTORS AFFECTING PROFESSIONAL OBSOLESCENCE OF INFORMATION TECHNOLOGY PROFESSIONALS

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Abstract

Design and development of effective information technology (IT) based systems depends upon a staff of competent information technology professionals (ITPs). Due to the rapid pace of technological innovation, diverging application of IT, and changing role responsibilities of ITPs, it is becoming increasingly difficult for ITPs to maintain up-to-date professional competency. Recent research suggests that, because of outmoded knowledge and skill deficiencies among their IT staff, some firms purposely forgo implementation of emergent technologies.

Although not previously examined in IT research, professional obsolescence threats have been acknowledged and evaluated in referent research. Psychologists studying the engineering discipline have suggested individual characteristics, nature of work, and organizational climate as being important determinants of obsolescence.

The purpose of this research is to evaluate the relationships between manageable work context factors and degree of professional competency, or conversely obsolescence of ITPs. Structural equation modeling is employed in evaluating the plausibility of the direct-effects model of professional competency.

This field study used questionnaires to obtain 161 usable self-report responses from Systems analysts. Validity of self-reports were verified using cross-reference ratings from respondents' supervisors. The results of this study suggest that individual personality differences and factors of the work environment do effect professional competency levels. Overall, the research model accounted for 44% of the variance in information technologist professional competency.

1. INTRODUCTION

Contemporary organizations and workers have experienced rapid environmental change as evidenced by global economic markets, changing organizational structures, and altered work roles with evolving skill requirements [14]. Advances in technology [13], restructuring of organizational relationships [10] and procedural changes [8] alter the work roles, methods and skill requirements of information technology professionals (ITPs). For example, structured development, object orientation, and CASE represent radical changes in system development methodologies, procedures and tools [35].

Under conditions of rapid technological and organizational innovation, maintaining the intellectual capacity of a firm's professional resources becomes critical [28]. Maintaining current knowledge of rapidly emerging technologies is especially important to ITPs who play a technological gate-keeping role for organizations because knowledge regarding novel technologies is prerequisite to envisioning their usefulness, adoption and use [36]. Success in today's dynamic environment requires ITPs to remain technologically current, learn new knowledge domains, and acquire new as well as updated proficiencies. ITPs must actively renew professional knowledge and skills.
because their existing intellectual capital becomes obsolete every few years [24].

1.1 Threat of Professional Obsolescence

Professional obsolescence represents a deficiency that occurs to the extent a mismatch develops between vocational requirements and abilities possessed by the professional. According to Fossum, et al. [9], obsolescence occurs when the job incumbent previously possessed talents commensurate with requirements of the profession; however, change in the knowledge domain or change in the individual, has resulted in a mismatch.

Obsolescence is not limited to inadequate domain knowledge possession, rather obsolescence also relates to applied problem-solving abilities [18]. Professional competency is broad concept, whereas job competency relates only to ones’ ability to perform requirements of their current job or position [7]. Traditional COBOL programmers may skillfully perform current job requirements and concurrently become professionally obsolete [35]. In this study obsolescence is considered the converse of competency, and ITP competency is defined:

Information technologist professional competency (ITPC) exemplifies the degree to which one possesses expert knowledge and skills, and exhibits behaviors that are effective in performing the design, development, and consulting duties relevant to the contemporary IT profession.

Referent discipline research suggest professional obsolescence is influenced by rate of knowledge change, work context, individual differences and updating behaviors enacted [16].

1.2 Obsolescence Research in an IT Context

Disciplines engaging emergent technologies experience rapid knowledge domain changes and restrictive knowledge half-life periods. Therefore, professional obsolescence should be of concern to technologically intensive occupations such as IT. Neither theoretical nor empirical IT research has directly examined the obsolescence concept. Investigating an associated topic, ITP educational needs assessment, Nelson [25] discovered ITPs as a group rate themselves as deficient in every category evaluated, thus demonstrating obsolescence is a potentially severe problem. Applying a practitioner perspective, IT executives rank human resource development among high priority issues and express concern regarding outmoded skills and low productivity of traditionally skilled programmer/analysts [26]. Research indicates knowledge and skill levels influence the performance of ITPs [35]. To date, however, theoretical and empirical IT research have not directly addressed the etiology, constitution or consequences of professional obsolescence. Such research is relevant to both practitioners and scholars because competency is considered prerequisite to effective performance [21].

1.2 Research Question

This theory guided study evaluates the relevance of professional obsolescence within IT context. Using an established model of technical obsolescence, this study empirically examines the relationship of potential antecedent factors and professional obsolescence. Selective facets of individual differences, nature of work, and organizational climate are examined in relation to the obsolescence of systems analysts. The research question guiding this study are summarized below:

Are there significant relationships between professional obsolescence of ITPs and the proposed antecedent factors (individual differences, organizational climate, and nature of work, )?

2. LITERATURE REVIEW AND MODEL DEVELOPMENT

The intention of this study is to integrate an existing direct effects model of obsolescence to empirically evaluate theoretically postulated relationships between antecedent factors and professional competency of ITPs. Existing evidence relevant to professional obsolescence is abstracted from a limited and mostly atheoretical body of obsolescence literature. Although this study does not specifically address creativity/innovation, it does fit (Person/Characteristics) into Couger’s (1996) framework for IS research on creativity/innovation by examining the impact of work environments on the competency of ITPs.

2.1 Model of Professional Obsolescence
For many years, the engineering profession has openly acknowledged the threat of professional obsolescence [15]. Since IT contexts display technological change patterns and environmental dynamics comparable to engineering, referent discipline research findings and models serve as a useful starting point for research purposes. Kaufman's [16,17] direct effects model of obsolescence (Figure 1) serves as a foundation for this study.

This direct effects model proposes individual characteristics, nature of work, and organizational climate as important determinants of obsolescence. Individual characteristics reflect the notion that systematic individual dispositions, needs, and aptitudes are useful predictors of individual behaviors and outcomes. Nature of work reflects how intellectually and psychologically challenging or routine professionals perceive their work assignments to be. Organizational climate represents individuals' perceptions of organizational context; updating climate is mostly determined by social influences, management practices and organizationally sponsored rewards that either stifle or stimulate keeping professionally up-to-date.

Refining the scope of several constructs, proposed antecedent factors influencing obsolescence are classified as individual personality differences (IPD), nature of work (NOW), and organizational updating climate (OUC). Figure 2 illustrates the adapted direct effects research model.

2.2 Individual Personality Differences (IPD)

Individual differences, such as personality, aptitude, and demographic factors, may influence individuals' willingness to keep current. This study focuses on personality factors rather than demographics and aptitude. Personality may be defined as "the organization of psychophysical systems in each individual that determines the interaction of that individual with the environment" [33]. Understanding personality factors and personal predispositions helps explain why two individuals behave differently when placed in similar context [12].

2.3 Achievement Need

Keeping professionally up-to-date is a complex threat faced by ITPs interacting with rapidly changing technologies, especially since obsolescence is an invisible threat that is easily ignored in place of more immediate concerns. Achievement need refers to a relatively stable personality trait comprising motive to achieve some standard of accomplishment or competency [23]. Persons with high achievement needs aspire to accomplish challenging tasks, maintain high standards, exert extra effort to attain excellence, respond positively in competitive situations, work toward future goals, and are willing to accept moderate risks [33].

2.4 Self-Efficacy

A critical link in determining motivational force...
involves an individual's judgement about his or her capabilities for successful performance given a certain investment of time and effort. Self-efficacy represents relatively stable judgments or beliefs about one's performance capabilities in a particular domain [32].

Hence, high self-efficacy persons are likely to psychologically accept challenging assignments that require learning and focus efforts on updating activities, whereas low self-efficacy persons are likely to feel threatened and avoid professional challenges. Therefore, high self-efficacy supports career self-concept.

2.5 Nature of Work (NOW)

Characterized by job assignments and task requirements, nature of work reflects how intellectually and psychologically challenging professionals perceive their work assignments to be. Routine, narrowly focused work assignments do not exercise the full repertoire of existing professional skills and do not encourage the development of new skills, whereas challenging jobs exercise existing skills, stretch the limits of existing proficiencies and encourage continuing professional development [20].

Salient job characteristics associated with challenging jobs include skill complexity and variety, autonomous decision making, task identity and significance, and feedback regarding difficult but achievable goals [1]. In addition, Couger [2] found that challenging work was positively and significantly correlated with organizational environment for creativity and innovation. To the extent job characteristics, such as task variety and identity, enhance psychological meaningfulness of work and expectancies, the worker will be motivated to exert greater effort.

This study operationalizes nature of work as a second order construct encompassing facets associated with work assignments. Specific job characteristics examined in this study include skill variety, comprehensive assignments, decision autonomy, and project challenge. Skill variety suggests work assignments are neither routine nor primarily administrative, thus allowing the ITP to practice a variety of professional skills. Decision autonomy indicates the ITP uses professional discretion in deciding how to conduct assigned work tasks. Degree of decision autonomy also measures participation in determining task assignments and priorities. Comprehensive work assignments entail task significance and identifiability through vertical loading of work tasks. Challenging projects involve skill complexity and novelty, thus increasing the intellectual demands associated with work assignments, and indicating that learning is required before the project can be successfully completed.

2.6 Organizational Updating Climate (OUC)

Organizational updating climate represents individuals’ socially influenced interpretations of technologies, management policies, supervisor practices, peer relationships and other salient work environment features that influence updating tendencies [6]. Kozlowski and Hults [19] defined, evaluated,
confirmed reliability and supported validity for global and specific facets of organizational updating climate.

In this study, five facets of organizational updating climate were adapted from Kozlowski and Hults [19]: innovation/updating climate, updating support, supervisor support, management/reward policy, and information exchange.

Innovation/updating climate is the extent to which innovation, creativity, and up-to-date competencies are representative features of the organization. Updating support is the extent to which the organization provides support for advanced degrees, training, technical literature, and professional activities. Supervisor support is the extent to which supervisors provide performance feedback, career counseling, opportunities for updating, rewards for updating, and participant goal setting.

Management/reward policy is the extent to which organization policies contribute to an achievement orientation. Information exchange is the extent to which information is freely shared among peers, supervisors, department, and higher management.

3. METHODOLOGY

3.1 Sample

The purpose of this study is to evaluate naturally occurring phenomena within an applied context. Field research, employing quantitative analysis of self-report questionnaire data is the primary method of this research. However, qualitative interviews and data gathered from managers were used to supplement the primary quantitative analysis and evaluate potential common-method bias.

Systems analysts, an important category of ITPs, are the targeted population of study because 1) they compose a large and important ITP occupational category, 2) the analyst category is expected to provide the greatest number of IT job opportunities during the 1990s [22], and 3) analysts face extensive obsolescence threats due to their boundary spanning project integrator role. Overall, analysts furnish an ideal subject pool for obsolescence research because of systems analysts (ITPs) exposure to forces of environmental change, the crucial role they play in facilitating technological change and expanding importance of their professional role.

Respondents were drawn from multiple organizations in order to facilitate generalizability and to prevent restricted response ranges of organizational climate variables. Within each organization, selection of subjects was random to reduce systematic bias.

3.2 Administration

The measurement instrument was pre-tested using an expert panel of academic and practitioner domain experts. This pre-test is intended to verify content validity and check for ambiguous measurement items. The pre-test involves a small sample size and therefore cannot be used to preview statistical significance of postulated relationships.

The survey sample measurement instrument was distributed via intra-organizational mail at each participating organization. Pre-addressed, postage-paid return envelopes facilitated confidentiality and hastened return of completed questionnaires directly to the researcher. A cover letter soliciting cooperation and assuring confidentiality of responses accompanied each survey instrument. This letter, co-authored by the researcher and an executive of the sponsoring organization, is intended to enhance response rate while also informing subjects of their rights and disclosing the voluntary nature of participation.

Respondents were conspicuously identifiable; however, as previously stated confidentiality of responses was assured. Identifiability facilitates researcher contact with non-respondents, reduces response bias of self-report measures, facilitates comparison of self-reports with alternative performance measures, and enables potential future extension of the study to include longitudinal analysis. Presuming organizational cooperation, a second phase of surveys will be distributed to the supervisor of each respondent. The supervisor will be asked to rate professional competency, updating behaviors, and performance of each ITP within their group. Correlational analysis comparing self-report and supervisory ratings provides an indication of the reliability and validity of ITP self-report responses. To maintain confidentiality, the supervisor will not have access to individual ITP responses at any time before, during or after this survey; likewise the ITPs will have no access to supervisor responses. Comparative analyses will be provided in aggregate form only.

3.3 Measurement

For each three exogenous variables and the endogenous variable, ITPC, an existing instrument was adapted in order to maintain consistency with prior
research. Nevertheless, changes are being made to existing instrument items for three primary reasons: (1) wording was slightly modified to better fit an ITP (systems analyst) work context, (2) items were modified to reduce ambiguity, and (3) pragmatic instrument administration considerations mandated a reduction in the number of items representing each construct. However, in order to minimize measurement error associated with mono-item measures of constructs, each latent variable was represented by multiple facets, and each facet by multiple items.

3.4 Exogenous Variables

<table>
<thead>
<tr>
<th>Construct/Scale</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>Valid N</th>
<th>Items/Scale</th>
<th>alpha</th>
</tr>
</thead>
<tbody>
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<td>Individual Personality Differences</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Achievement Need</td>
<td>4.65</td>
<td>0.60</td>
<td>3.33</td>
<td>6.00</td>
<td>161</td>
<td>6</td>
<td>.69</td>
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<tr>
<td>Self-efficacy</td>
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<td>0.51</td>
<td>3.22</td>
<td>6.00</td>
<td>161</td>
<td>9</td>
<td>.77</td>
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<tr>
<td>Organizational Updating Climate</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Reward policy</td>
<td>3.80</td>
<td>0.97</td>
<td>1.00</td>
<td>5.89</td>
<td>159</td>
<td>9</td>
<td>.91</td>
</tr>
<tr>
<td>Updating Support</td>
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<td>0.95</td>
<td>1.50</td>
<td>5.70</td>
<td>159</td>
<td>10</td>
<td>.85</td>
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<tr>
<td>Innovative Climate</td>
<td>4.01</td>
<td>1.10</td>
<td>1.00</td>
<td>6.00</td>
<td>161</td>
<td>6</td>
<td>.87</td>
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<td>Information Exchange</td>
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<td>0.95</td>
<td>1.00</td>
<td>6.00</td>
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<td>7</td>
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<td>Nature of Work</td>
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<td></td>
<td></td>
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<td>Professional Autonomy</td>
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<td>6.00</td>
<td>159</td>
<td>8</td>
<td>.80</td>
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<tr>
<td>Job Challenge</td>
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<td>0.87</td>
<td>1.67</td>
<td>6.00</td>
<td>160</td>
<td>6</td>
<td>.77</td>
</tr>
</tbody>
</table>

Nature of Work was measured with 10 Likert type items developed by Farr, et al. [5]. Kozlowski and Hults [19] refined these scales, and supported adequate reliability and validity of the measures. Additionally, a 7 item short-form of the job description index [11] provided an independent measure of job complexity. Organizational climate was measured by adapting Likert type items from Farr et al. [6], as refined and validated by Kozlowski and Hults [19]. Each facet of organizational climate employed five items for measurement. Individual personality differences were measured with adaptations of instruments previously developed for measurement of achievement need and self-efficacy. Achievement need was measured with a 5 item Likert type instrument developed and validated by Steers and Braunstein [31]. Self-efficacy was measured with 8 items from a generalized-self-efficacy scale developed and validated by Sherer, et al. [29].

3.5 Endogenous Variable

The endogenous variable, Information Technologist Professional Competency (ITPC) (or conversely, obsolescence) was measured with 4 generalized items adapted from Kaufman [16,17]. In addition, scaled items adapted from behavioral anchored rating scales [5] provided perceptual measures of seven specific professional facets including 1) professional knowledge, 2) interpersonal communication skills, 3) project management skills, 4) problem analysis skills, 5) conceptual design skills, 6) system evaluation skills, and 7) implementation skills. In a manner similar to updating measures, supervisory ratings supplemented ITPs self-report ratings of ITPC.

3.6 Analysis of Exogenous Measurement Model

Initial attempts to estimate the exogenous model revealed that the exogenous variable error covariance matrix was not positive definite which indicates matrix identification problems that are occasionally encountered in conducting covariance structure
modeling [34]. This problem was overcome by splitting the self-efficacy scale into two separate composite indicators, both of which demonstrated sufficient reliability. The formation of this third indicator for the IPD construct successfully resolved model identification concerns.

In addition, exploratory factor analysis suggested several item to scale respecifications. The supervisor support scale lacked uniqueness, as intended items loaded to related subfactors. Professional autonomy and job challenge proved to be the primary dimensions described by nature of work items, as job identity and skill variety measurement items were dissipated by other scales.

After exploratory factor analysis and respecification, six scales were retained. Reward policy, innovation climate, updating support, and information exchange represent the OUC construct, while professional autonomy and job challenge represent the NOW construct.

4. FINDINGS

Our study develops the main effects in Kaufman’s model with respect to information technology professionals. These three factors, Individual Personality Differences (IPD), Organizational Updating Climate (OUC) and Nature of Work (NOW) were evaluated with 174 ITP’s in 12 separate organizations.Incomplete surveys, and those from respondents in managerial levels were dropped from analysis, leaving 161 responses to be evaluated.

To measure Kaufman’s antecedents, an instrument was developed containing series of questions that were extracted from prior research and conversations with peers. This instrument was pretested with 26 ITP’s.

<table>
<thead>
<tr>
<th>Construct/Scale</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Valid N</th>
<th>Items/Scale</th>
<th>alpha</th>
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<td>Technical Knowledge</td>
<td>3.11</td>
<td>0.76</td>
<td>1.33</td>
<td>5.29</td>
<td>161</td>
<td>21</td>
<td>.89</td>
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<td>Organizational Knowledge</td>
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<td>1.07</td>
<td>1.31</td>
<td>6.23</td>
<td>161</td>
<td>13</td>
<td>.92</td>
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<tr>
<td>Competency Behaviors</td>
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<td>0.54</td>
<td>2.86</td>
<td>5.67</td>
<td>160</td>
<td>8</td>
<td>.74</td>
</tr>
<tr>
<td>Employability</td>
<td>3.73</td>
<td>0.78</td>
<td>1.63</td>
<td>6.00</td>
<td>158</td>
<td>21</td>
<td>.81</td>
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<tr>
<td>Professional Knowledge</td>
<td>4.32</td>
<td>0.74</td>
<td>2.00</td>
<td>6.00</td>
<td>161</td>
<td>1</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Six survey items were dropped at this point due to either ceiling effects or indications of equivocal statements. The remaining sixty-one items were evaluated to assess scale reliability and validity. Results of the pretest were compared with supervisor responses, and no common method bias was noted.

The items were first evaluated on an a priori basis. Using the common factor model, items with low scores on the predicted construct were dropped from further analysis.

IPD, OUC and NOW were analyzed separately. Because it was anticipated that OUC and NOW factors would be intercorrelated, they were analyzed with a PROMAX rotation. This resulted with the factors identified in Table I.

Next, the factors impacting information technologist professional competency (ITPC) were assessed. 63 items, derived from prior research and the development of behaviorally anchored scales were used to assess four dimensions of ITPC. Through the use of common factor analysis, 7 items were eliminated, resulting in the factors of ITPC in Table II.

A model with IPD, OUC and NOW as exogenous variables and ITPC as the endogenous variable was assessed using LISREL8 (Figure 3). Table III provides overall fit indices for this model.

The various indices indicate that this direct effects model is adequate. The only index in issue is the \( \chi^2 \), which is sensitive to sample size. Furthermore, the \( \chi^2/d.f. \) ratio is less than 2.00, countering the effects of a significant \( \chi^2 \). The model accounts for 0.44 of the variance in ITPC.

## 5. DISCUSSION

As organizations become increasingly dependent upon innovation application of enabling technologies, they also become more dependent upon professional proficiencies of ITPs who envision, develop and implement these technologies. Thus, understanding factors influencing ITPs professional competency relates to both career concerns of individuals and performance concerns of organizations. There are several managerial implications from this study that are worthy of discussion. First, this study demonstrates that organizational climate and the nature of work assignments directly influence the competency of ITPs. Interventions, such as raising the level of work challenge, should result in an increase in the competency of ITPs. For example, Snow and Couger [30] found that implementing a creativity improvement intervention in an organization resulted in an improvement in "the quality and quantity of ideas generated by the systems development group." A second implication of this study is that management should encourage updating activities in order to enhance intellectual capital within the firm. The degree of updating activity is significantly related to the level of ITP competency. Since ITP performance is related to ability [27], and since organizational success is dependent upon enhanced productivity of knowledge workers [4], management should be concerned with strengthening professional abilities. Thus, IT management should be aware of the degree to which ITPs participate in professional development activities.

A third implication of this study is that organizations should focus on the person. Selecting job candidates possessing high achievement drive and self-confidence may result in a professional staff that is motivated to remain proficient, exerts updating efforts in order to maintain high levels of professional competency, and are cognitively effective in learning environments.

A fourth implication is that work-self-concept IPD should be considered an important component of professional development programs and technology transition programs. This study suggests self-confidence stimulates the motivation to participate in updating activities while concurrently enhancing competency levels independent of motivation and updating, perhaps because reduced anxiety permits less distortion during ongoing learning processes. Due to the significant impact of work-self-concept, organizations planning major technological changes that require new knowledge and skill sets should consider initiating programs to first elevate the self-efficacy of persons targeted for retraining.

<table>
<thead>
<tr>
<th>( \chi^2 )</th>
<th>d.f.</th>
<th>GFI</th>
<th>NNFI</th>
<th>CFI</th>
<th>IFI</th>
<th>RMSEA</th>
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<td>116</td>
<td>72.9</td>
<td>.93</td>
<td>.94</td>
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Table III: Overall Fit Indices for Research Model
REFERENCES
