Information Technology Skill Management: A Systems Dynamics Approach

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Abstract

Managing information technology (IT) human resources and skills presents a challenging task for executives. With IT skill shortages projected to reach unprecedented levels, making the right choices for IT human resource management is increasingly considered imperative for shaping a firm's competitive advantage. The complexity associated with the fluctuating demand for IT skills, coupled with dynamic and innovative approaches to short-term and long-term staffing, as well as the inevitable delays in skill acquisition, makes this a challenging task. This research attempts to examine the impact of potential staffing strategies under various conditions, and provide guidance for staffing decisions, using a systems dynamics approach. The model and accompanying simulation can serve as a practical decision support system for IT human resource decision makers.

1. Introduction

Managing information technology (IT) human resources presents a challenging task for executives. In the current IT market, which is rebounding from the downsizing of 2000 and 2002 [20], firms are faced with considerable pressures to attract and manage IT professionals. Hiring managers expect that almost 600,000 positions will go unfilled due to a lack of qualified workers [16]. More recently between 2005 and 2006, the U.S. IT labor market increased by 54,000 jobs [28]. The issue of IT human resources was rated second amongst the top concerns reported by IT executives in 2006 [19]. Projections from Forester Research suggest that the U.S. shortfall will reach more than 6 million jobs by 2015. Increasingly, strategic choices about IT human resource management (IT HRM) practices are considered imperative for shaping competitive advantage. Prior research in IT HRM has identified strategies to select suitable practices for different situations [2], [14]. However, the complexity and the dynamic nature of the IT HRM domain makes it difficult to assess the implications of IT HRM decisions, and whether more appropriate decisions could have been made given prevailing organizational, environmental, and contextual factors. The inability to effectively assess the consequences of IT HRM decisions in an a-priori manner leaves managers to speculate if the decisions made were indeed the appropriate ones. A model that captures the complexities, dynamics, and a range of IT HRM decisions could contribute to the knowledge base for effective IT HRM. In this study, we develop a computational model of the mechanics underlying the staffing aspect of IT HRM, representing this as dynamic interactions among the many factors that shape this domain. The model offers a holistic synthetic environment within which to examine questions of importance to IT HRM under a number of different organizational and environmental conditions. Once calibrated for a specific firm, the model can be used to provide practical decision support to identify suitable skill sources and examine implications of utilizing these options. The ability to a-priori assess staffing decisions, as opposed to relying on lagged post-hoc analysis, affords managers the ability to make more informed staffing decisions. The rest of this paper is organized as follows. The next section reviews key theoretical bases and prior work in the IT HRM domain. Section 3 discusses the systems dynamics modeling approach, and provides justification for its selection over alternative modeling methodologies. We then develop and present an integrative IT skill management model using multiple theory bases within the systems dynamics framework. The model provides a basis for simulating IT HRM staffing decisions and incorporates diverse internal and external environmental factors. After appropriate calibration, a series of simulations are run, to examine how firms can choose the most appropriate sourcing options under diverse environments. A discussion of the findings and their implications for HR managers rounds out the paper.

2. Theoretical Background: IT Human Resource Management

IT HRM, encompassing human and organizational skills, expertise, competencies, knowledge, commitments, values, and norms [7], [8] plays a crucial role in the effectiveness of IT infrastructure [6], [32]. Economists consider human resources as a collective asset of human capital, the productive capacity embedded in a single individual that results from natural capability, education, training, and experience [5]. Consequently, investments in skills and training of workforce participants build individual human capital, leading to the increased overall HR value [18]. Building on the theoretical foundation of Barney's proposal [4] (i.e. a resource can offer sustainable competitive advantage only if it is inimitable), several studies adopt the resource-based view to examine the critical nature of IT human resources, suggesting that it is a crucial component of firms' resource when it is rare, inimitable, and non-substitutable e.g. [3], [11], [22].

IT HRM has gained increasing strategic emphasis as a process of transforming IT human resources to a valuable resource, facilitating the firm's competitive advantage. Further, effective IT HRM through right investment in human capital is vital for being able to meet market demands with well-qualified HR at all times [15]. Skill acquisition strategies and skill management are important parts of IT HRM practice, where the aim is to provide the firm with the right mix of skill to meet existing and future needs [24], [30].

Previous research suggests that coherent and distinctive patterns of IT HRM practices exist to form an identifiable IT HRM strategy. Some approaches include the short-term orientation strategy [14], short-term producer strategy [2], control strategy [31], project-based strategy [21], or market type strategy [10]. These IT HRM strategies share a common philosophy that reflects a short-term, task-oriented attitude. The emphasis is on completing the requirements on time with reliance on the external labor market rather than internal labor pool, or establishing efficiency rather than in-depth commitments. Typical practices include higher starting salary with relatively lower training, development, and overall support [21].

In contrast, other approaches including the long-term orientation strategy [14], long-term producer strategy [2], commitment strategy [31], options-based strategy [21], or internal type strategy [10], represents a different philosophy, with a longer term orientation and relational focus with broadly defined work requirements, internally sourced/ developed skills, greater investment on human capitals, and more committed workers [14]. The compensation structure in this approach is characterized by lower starting salaries with higher training, development, and other supports [21].

Between the two opposite approaches, a wide variety of alternative strategies exist (e.g., balanced professional strategy and high-performance professional strategy [2]), corresponding to the changes of environmental factors (e.g., urgency or available resource). Categorizing IT HRM strategies for a few discrete situations is unlikely to capture the dynamic reality of the entire spectrum. Further, in a rapidly changing environment, it may be desirable to employ multiple IT HRM strategies simultaneously. Our primary aim is to develop a computational model that captures this spectrum of environmental and organizational conditions using a systems dynamics approach, with a view to providing a host of staffing alternatives to meet the skills requirements for an organization's IT needs. Based on prior research [24], [30], the current study focuses on skill acquisition as a key practice of IT HRM.

3. Modeling Methodology: Systems Dynamics

Selecting the appropriate IT HRM strategy for staffing in a dynamic business environment requires a careful contextual analysis. Determining contextual appropriateness can be challenging in diverse and dynamic environments. Given that the staffing decision is a recurring one, a dynamic model that can relate performance from one time period to another is needed. The complex relationship between organizational, environmental, and contextual factors will likely involve non-linearity and discontinuities in the model, thereby ruling out dynamic programming solutions. Simulation represents a viable option under the circumstances. Systems dynamics, a form of simulation that permits modeling of behavior among related constructs as well as across successive time periods appears particularly relevant in this context. It has been already proved useful for testing macro-sociological theories [17], including environmental policy, corporate strategy, health care, operations management, change management [9], and strategic management [25]. Though the systems dynamics approach has not been extensively used in the IS field, a strong case for starting to apply it to IS research has been made [27], particularly in cases involving novel representations of real-world situations. Some notable examples of its use in IS include its application to business planning for network services [12], offshore outsourcing [13], and software project management [1], among others. A primary advantage of systems dynamics is that it facilitates the representation of quantifiable and hard-to-measure variables [12]. As with any modeling approach, concerns exist about the potential use of simplifying assumptions, possible inaccuracies in modeling vis-à-vis the real-world, and a lack of comprehensiveness in the final model. These concerns can be alleviated through validation of the model structure by multiple external experts, careful calibration of model equations, and extensive application to multiple and varied scenarios.

This research assembles and utilizes a model of IT HRM that focuses on the skill acquisition strategy, environmental changes, firm's resources, and skill gaps to shed greater light on the effect of staffing policy decisions. The model is developed using prior academic and professional literature in the domain, and has been assessed for validity using multiple experts in the IT HRM and the systems dynamics domains. Assembling the model requires the initial identification of stocks and converters that form the basis for the formal model. Next, these stocks and converters need to be related to each other, both within and across time periods. The resulting set of interlinked feedback loops reflects the processes of the simulated IT HRM staffing domain. Much of the art of system dynamics modeling is discovering and representing the feedback processes since most complex behaviors usually arise from the interactions among the components of the system, and not from the complexity of the components themselves [29]. Calibrating and validating the model forms the next step. Application to a variety of organizational and environmental conditions rounds out its development. When applying the model, our emphasis is on analyzing behavior patterns, trends, and how quickly a variable achieves stability, rather than on absolute values generated through the simulation. Recalibration of the model equations will permit focus on the actual numbers.

4. IT Skills Management Model

A major deficiency in much of the research to date on IT HRM has been its inability to integrate knowledge of the micro-components of the IT HRM process such as skill acquisition practices, sourcing decision and strategy, firm's resource, and skill gap to derive implications about the larger system where the micro-components are embedded. The model, depicted in Figure 1, captures the micro-components, presenting them using an integrative perspective.

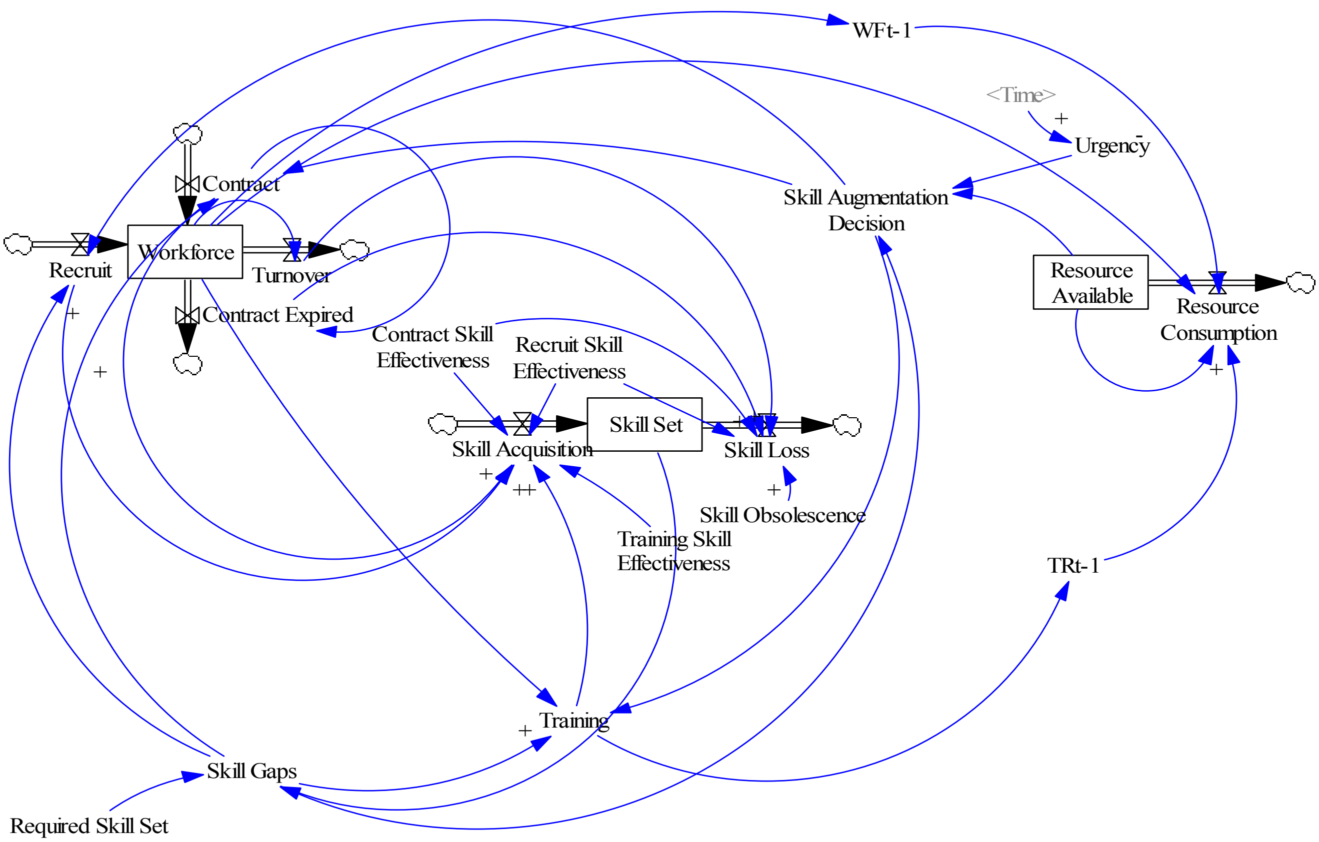

Figure 1. IT skills management model

IT staffing decisions are typically driven by the skills needed and those possessed by the available workforce. We treat the workforce and skill set as two related but separate stocks, since one can be affected without changing the other. The workforce can be augmented through long term strategies like recruitment and short terms strategies like the acquisition of contract workers, consulting arrangements, or outsourcing. It is depleted through turnover, manifest as resignations, retirements, and layoffs. Completion of temporary contracts will also reduce the available workforce. Several simplifications are evident. We do not model details such as the antecedents of turnover or the relationship between separation from employer and turnover, as examined in [18]. These details provide a micro-level analysis of the recruitment and turnover processes, and while especially important for retention studies, would add complexity without shedding additional light on the interactions being examined in this research.

The available skill set is based on the characteristics of the current workforce, but can also be augmented through training activities. Likewise, skills not used can be lost, and advancing technology may render the existing skill set less useful through obsolescence. In this model, the skills acquired are the accumulation of skills acquired through the three available skill sources of training, recruitment, and contracting. The determination of the amount of acquired skills is based on the number of personnel recruited, contracted, or staff trained. However, it is necessary to acknowledge that none of these modes of skill acquisition are 100% effective. New recruits and contract workers may not have the precise skills needed and not all training is completely effective. To compensate for this, we introduce three effectiveness terms, which can be used to moderate the effect of the skill acquisition decisions. These terms can be manipulated to capture the relative efficacy of each skill acquisition decision. In addition to skill obsolescence, the overall skill set may erode due to turnover and contract worker departure.

The required skill set and the available skill set determine the skill gap. The former is based on the number and nature of IT projects that are under development currently or in the foreseeable future. The required skill set is currently modeled as an increasing step function to reflect the acquisition of new technologies involving additional skills, as depicted in Figure 2. Varying the required skill set provides an opportunity to examine different skill acquisition decisions within the same simulation. Clearly, this can be configured differently for other organizational IT requirements, if needed.

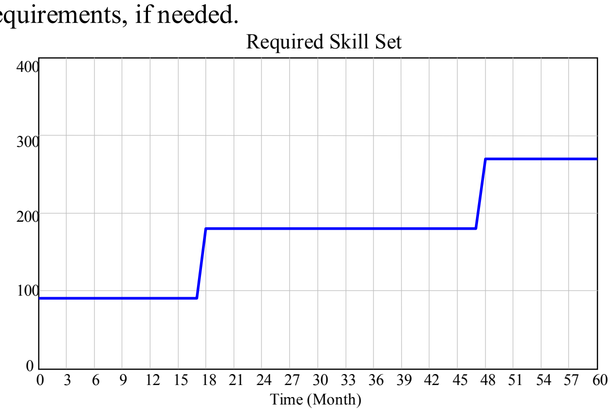

Figure 2. Required skill set

In its current formulation, only positive skill gaps are recognized. An oversupply of skills does not lead to retrenchment, though that can easily be accommodated. The magnitude of the skill gap will drive the need for additional skill acquisition, either through training, recruitment, or contract worker addition. The choice of skill acquisition is less a function of skill gap magnitude, than organizational and environmental factors. Based on prior literature, we identify resource availability and problem urgency as factors that shape the decision on how best to acquire the skills in short supply. Low levels of urgency and resource availability suggest acquisition through inexpensive means, favoring training as the preferred alternative. Cases involving high levels of problem urgency will suggest rapid acquisition, favoring contracting. Recruitment becomes the preferred option when the urgency is not critical, and sufficient resources are available. After considerable analysis of different situations involving urgency and resource availability, it was determined that a rule-based approach to recommending a skill acquisition decision would be too simplistic, and would not cover the likely spectrum of scenarios effectively. Instead it was determined that a multi-dimensional approach be adopted. A grid search of the two-dimensional space generated through problem urgency and resource availability was performed, and after several rounds of experimentation, a partitioning of the space was evolved, as depicted in Figure 3. The x-axis reflects the level of urgency, and the resource availability appears on the y-axis. These constructs have been normalized for simplicity, though recalibration would enable the use of alternative metrics. Another advantage of using normalized numbers is that these constructs can now be formulated as contiguous variables rather than a few discrete categories.

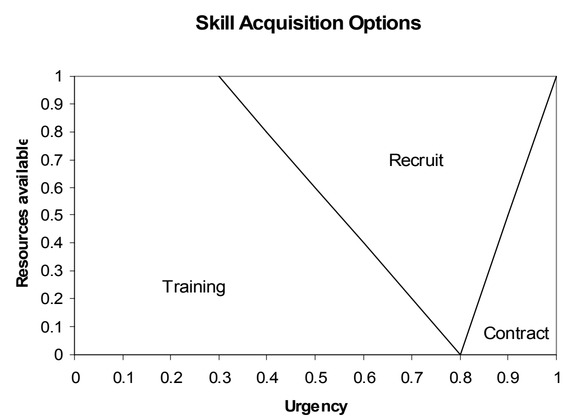

Figure 3. Skill acquisition decision space

In its present formulation, the space is divided into three areas based on relationships between resource availability and urgency. Other relationships are viable, and can be easily accommodated. Application to a different organization will involve recalibration to reflect the organization's propensity to select different skill acquisition options based on how it intends to trade off using costs, risks, and existing policies, to name a few. Partitioning the problem space in this manner also permits flexible decision making. It is possible to see changing decision patterns as one of the constructs is varied. For example, selecting a scenario with moderate resource availability and urgency would favor training. As the urgency increases, this may push the decision towards recruitment. At more elevated levels of urgency, a contracting strategy may be preferred. In a similar manner, if the urgency was held constant, adjustment in the levels of resource availability will entail different skill acquisition strategies. Although the cost of using external consultants and contracts is expected to be high [26], traditional recruitment is assumed to cost more in the long run, and also limit the organization's flexibility.

Urgency is currently modeled as a continuously increasing function, representing the need to complete projects as their deadlines approach. In its present form, it is a linear function, though that can be easily revised to reflect other scenarios. Resources available are currently treated as a constant that is depleted through consumption based on skill acquisition decisions. If needed, suitable infusions of resources can be made assuming a critical level is reached.

5. Experimental Results

The simulation was conducted using Vensim® PLE, a fully functional system dynamics software package from Ventana Systems, Inc. It was run over a period of 60 months, representing a medium term planning horizon. While it is tempting to simulate over longer terms, the uncertainty of environmental conditions over an extended period precludes making meaningful assessments and predictions.

The key decision in the simulation is the staffing decision, and is represented by the Skill Augmentation Decision construct in the model. As currently formulated, this can take one of four values, representing training, recruitment, contracting, or no additional staffing during this period. Urgency and resource availability will dictate which option will be used. For the conditions simulated, with increasing urgency and no additional resource infusion, over the course of the simulation, the actual decisions made are depicted in Figure 4.

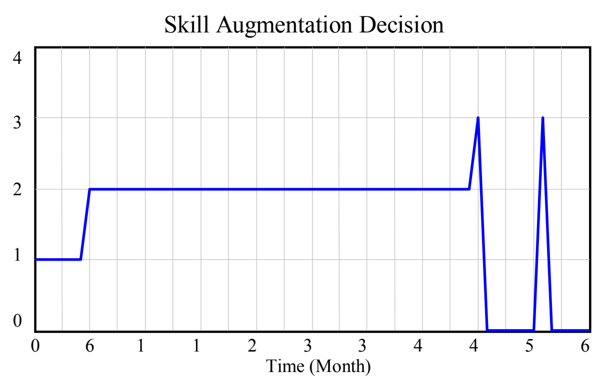

Figure 4. Skill augmentation decision

The values of 0, 1, 2, and 3, represent the different staffing options of non-activity, training, recruitment, and contracting respectively. From the figure it is clear that a variety of options were utilized over the period of the simulation. Initially, with low values of problem urgency and moderate resource availability, the preferred option was training of the existing workforce. With the passage of time, the workforce is reduced through turnover and expiry of some contracts. This has the effect of depleting the skill set, and therefore increasing the skill gap. More importantly, training also depletes resources available. Likewise, urgency increases as project deadlines loom nearer. The twin changes in the urgency and resource availability force the staffing decision towards recruitment for the middle portion of the simulation. Recruitment also depletes the resources available, and urgency continues to rise. In addition, the skills required periodically rise over the simulation, as illustrated in Figure 2, increasing the skill gaps, which forces additional staffing. Further reduction in the resource availability and continued increase in the problem urgency lead to a change in the staffing decision in month 48 – favoring the use of contract workers over recruitment. Due to the ability to bring on contract workers with specific skills, the skill gap is closed, and no additional staffing is needed. However, the expiration of contracts necessitates further staffing, which is once again met through contracting. The simulation illustrates very clearly that different conditions will lead to different staffing decisions, with periods of no additional staffing due to adequate skill coverage among the temporary and permanent workforce.

The skill acquisition decision is largely shaped by resource availability and urgency. However, the driver for this decision is the skill gap. An understanding of the behavior of this gap over the course of the simulation is crucial to examining staffing decisions. As illustrated in the equations in the appendix, the gap is a function of the skills required, and any changes to the existing skill set. Staffing decisions add to the skill set, while turnover, contract completion, and skill obsolescence reduce the skill set. The observed levels of skill gaps over the course of the simulation appear in Figure 5. This behavior has to be interpreted in light of the staffing decisions made in Figure 4, and the skill requirements illustrated in Figure 2.

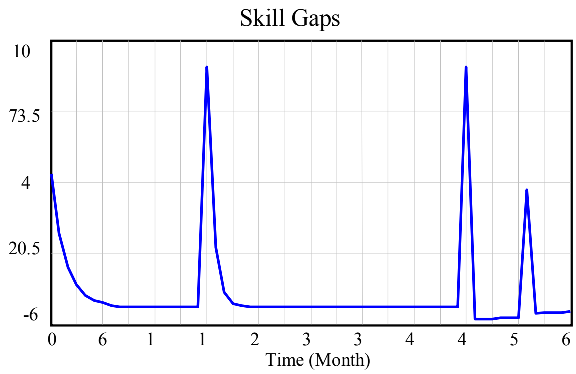

Figure 5. Skill gaps

The simulation starts out with a positive skill gap, otherwise there will be no need for additional staffing. The skill gap initially begins to fall with the use of training as the preferred mechanism for addressing this gap. Since training is not considered the most effective mechanism for alleviating the gap, based on a training skill effectiveness of 0.3, the rate of reduction of the skill gap is slow. However, over the course of 7 months, the gap is driven down to zero. At months 18 and 48, the skill gap rises sharply, as there is a significant step up in the level of the required skills (Figure 2). Without periodic increases in the required skill set, there is little need for additional skill acquisition after the initial skill gap is closed to zero. At this point, the resource availability and urgency dictate that recruitment should be the preferred skill acquisition mode. Since recruitment is viewed as a more effective opportunity to add workforce with specific skill sets, modeled using a recruitment skill effectiveness of 0.5, the rate of closing of the skill gap is quicker than in the training case, and the skill gap once again is driven towards zero. After the second surge in the required skill set, the prevailing conditions favor the use of contract workers to fill the skill gap. This approach is modeled as the most effective option to address specific skills needed, using a contract skill effectiveness of 0.7. As a result, the skill gap is very quickly closed, and the actual skill set exceeds the required skill set. This condition gives rise to the period when there is no additional staffing decision made (in Figure 4). The skill set is eroded due to turnover, contract completion, and skill obsolescence. Note that these are slower processes, and the erosion is a gradual process. At month 55, the skill gap spikes, and forces an additional staffing decision. Once again, conditions favor the use of contracting, as illustrated in Figure 4. This leads to a quick closing of the skill gap, and no subsequent staffing is needed during the course of the simulation. From Figure 5, it becomes clear that not all staffing decisions have the same impact on addressing the skill gap. Training has a gradual impact; the effect of recruitment is more pronounced, and the use of contract workers produces the most immediate result.

The use of three different staffing decisions over the course of the simulation indicates that the organizations and environmental conditions changed sufficiently to warrant different approaches to staffing decision making. Urgency and resource availability were the primary components in shaping the staffing decision. Urgency was modeled as an increasing function of time (in the appendix). Resources availability, on the other hand, was viewed as a depletion of an existing resource base, due to expenditures on training, recruitment, and contracting. This effect is seen in Figure 6.

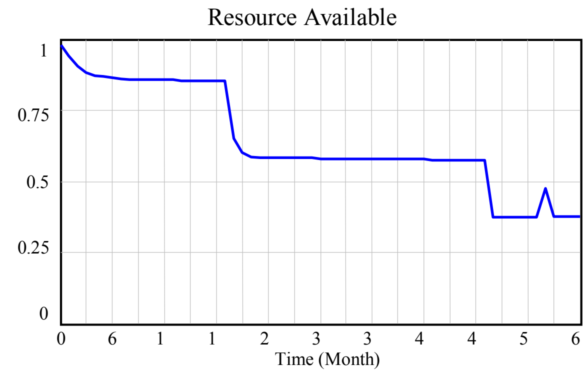

Figure 6. Resources available

Since there were no additional replenishments, the curve is expected to decrease continually. The initial decrease is gradual, as training is the least costly staffing alternative. As the skill gap is driven towards zero, there is no additional staffing need, and the resources available level off. At month 18, when the required skill set increases considerably due to additional projects, the decision shifts to recruitment, and the depletion of resources available is clearly steeper. Once again, as the skill gap reaches zero, there is no additional staffing, and the resources available level off. At month 48, there is a second increase in the required skill set, triggering the contracting decision. In this case, the resource depletion is obvious. As the skill gap is closed, the resource available levels off. An unusual event is observed at month 55, where the resource availability actually increases. In this case, the expiration of a contract triggers the release of several contract workers, adding to the resources available. However, it also leads to an increase in the skill gap, due to a loss in the skills from the released contract workers. As a result, there is another contracting decision, and the resources fall back to the pre-release levels.

6. Further Model Evaluation

While the model provides reasonable results and considerable insight into the effect of various staffing decisions over time, it represents a narrow slice of possible scenarios that an organization may face when determining the appropriate staffing options. A more comprehensive exploration of the various conditions is needed to ascertain the robustness and fidelity of the model. The advantages offered by the simulation approach is that it "offers greater fidelity in modeling processes, making possible both more complex models and models of more complex systems" [1].

However, unless a systematic exploration of different conditions in decision rules is attempted, generalizations from experimentation with the model are of limited value. Accordingly, the model was evaluated for a number of different conditions and scenarios. The results were consistent with expectations, though some of the scenarios proved less insightful than others. Specific conditions studied included the use of more stable and more volatile environments.

Stable environments produced fewer discontinuities in the observed results. The simplest way to control this was to hold the urgency constant, and examine the effects at different levels of urgency. The immediate impact of keeping the urgency constant was that the staffing decision did not change over the course of the simulation in most cases. This is understandable in that the constant urgency and the decreasing resources available would most likely ensure that the staffing decision remained the same, as suggested by Figure 3. For low levels of urgency, this led to training as the preferred skill acquisition option. Skill gaps closed more slowly than before, and resource s available also decreased in a gradual manner. Higher levels of urgency led to decisions that used recruitment or contracting as the preferred skill augmentation decision. As expected, both skill gaps and resource availability dropped in more dramatic fashion. Though the insights provided by these scenarios did not add much to the findings from the previous cases of experimentation, it did serve to confirm that the model performed correctly in these circumstances.

In an attempt to understand how things might unfold in more volatile environments involving technological uncertainty, the turnover rate and the skill obsolescence factors were increased. The volatility in the IT job market has led to considerable switching between organizations by individual IT workers. As the market becomes active again, and more organizations start to utilize additional information technologies, voluntary turnover is expected to increase. In a different vein, the practices of outsourcing and offshoring have led to increased non-retention of IT workers – representing involuntary turnover. Accordingly, the turnover rate was varied from 0.1 to 3. Likewise, in an IT world that is replete with technological innovation, the rate of base technology replacement will entail acquisition of new skills as well as abandonment of existing skill sets. The increased skill obsolescence will necessitate additional replenishment of skills. Skill obsolescence was varied from 0.1 to 3. A new set of simulations was conducted to examine the impact of the increased environmental volatility. The results yield further insight into the potential impact of various skill acquisition options under different circumstances. Figure 7 illustrates how the decision options change under current and more volatile conditions. The baseline conditions are depicted in red with a marker of 2, while the more volatile conditions appear in blue using a 1 for the marker.

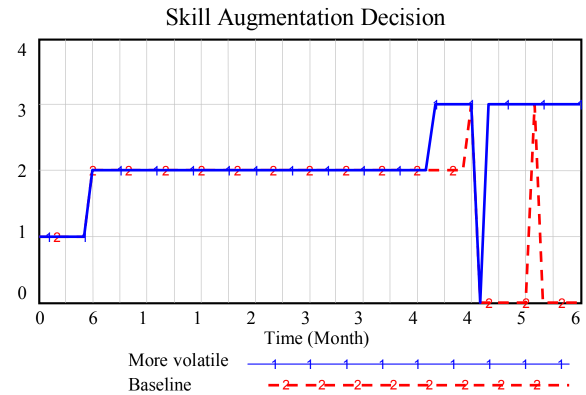

Figure 7. Skill augmentation decisions in a volatile environment

It is readily apparent that the overall trend is similar, but the transition and frequency of decision changes is quicker under more volatile conditions. In both cases, the initial option chosen is training, and that moves over to recruitment after six months. However, in the more volatile case, the switch to contracting occurs sooner. More importantly, the contracting is near continuous, unlike the original scenario, where a number of periods involved no additional staffing decisions.

Skill gaps in the more volatile environment were closed less quickly than in the baseline or less volatile environment. This is seen in Figure 8. As before, the baseline conditions are depicted in red, while the more volatile scenario is captured in blue. It is clear that the skill gaps close less quickly, due to the increased turnover, and the increased skill obsolescence. It is interesting to note that the difference between the baseline and the more volatile situation is much more pronounced for the contracting situation than the training or the recruitment options. This is actually an illusion as the skill gaps are at zero for the more volatile case, and are negative for the baseline case, with a slow return to the equilibrium condition.

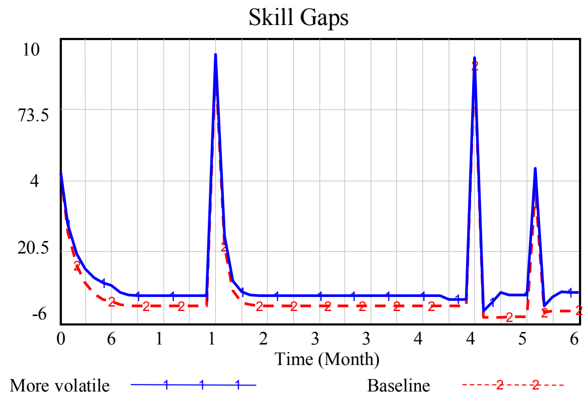

Figure 8. Skill gaps in a volatile environment

The impact on resources available is depicted in Figure 9. Once again, the baseline conditions are depicted in red, while the more volatile scenario is captured in blue. Though the trends are similar, the effect of increased turnover and greater skill obsolescence lead to more training, greater recruitment, and more contract activity. As a result the resources available decrease considerably faster than the baseline scenario.

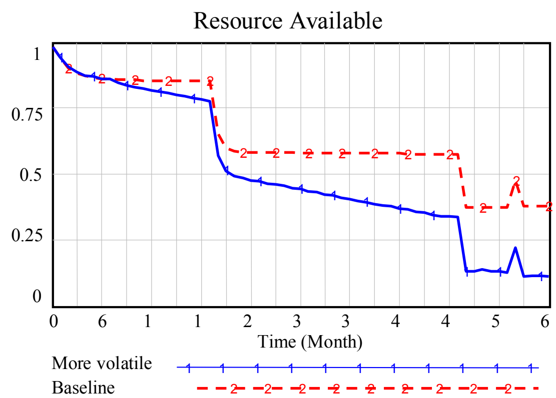

Figure 9. Resources available in a volatile environment

7. Implications and Discussion

The skill management model illustrates that skill augmentation decisions need to be shaped by environmental and organizational conditions, and they have definite implications for resource consumption in the context of IT staffing. A number of clear implications can be deduced through repeated simulation with the model. In a stable environment, the skill augmentation decision is relatively simple and does not vary much with time. Under these conditions, skill gaps and resource consumption tail off in a smooth manner, as additional resources are devoted to closing the skill gap. Cases involving limited resources favor the use of training as a skill augmentation option. As the urgency increases, other options like recruitment and contracting are more frequently selected as the preferred option. The relative effectiveness of these three options also prompts differences in the rate at which these options are applied.

In a more volatile environment, one that is characterized by greater turnover of personnel and increased skill obsolescence, similar trends are observable. However, the rate at which the skill gap is closed tends to be a little slower. In addition, the resource consumption increases over the stable scenario. Greater uncertainty in the system leads to more frequent changes in decision making, and at greater expense. While this confirms traditional thinking in the IT HRM domain, the ability to control and systematically vary modeling conditions permits HR managers to explore different options and examine the impact on a variety of variables of interest.

Though detailed in several respects, the model does present opportunity for further refinement and enhancement. For instance, whenever talented personnel leave a firm, hiring, assimilation, or vacancy cost is incurred [20]. These costs can be modeled in more detail than is currently the case. In the current model, turnover represents an exogenous variable, and is driven primarily by the IT job market and any observable skill shortage. In practice, however, many controllable antecedents of turnover have been identified. Modeling the behavior behind turnover could provide additional insight into this aspect of the simulation. Currently, resources available are presented as a continually declining resource that is consumed without replenishment. In practice, some other assumptions may apply. Likewise, the baseline scenario involves stepwise increases in the skill set needed. Upon completion of projects, it is likely that the skill set needed will fall back to level that prevailed before the start of the project.

Another limitation in the model is the range of skill augmentation options presented. The model currently uses only three options – training, recruitment, and contracting. Several other creative strategies for short-term and long-term skill augmentation are available. A related limitation is that assumption that only one skill augmentation option will be pursued at a time. While it is tempting to use this approach, larger organizations will probably employ multiple options at the same time. A simple strategy would be to probably model these as independent decisions. However, it should be acknowledged that these are related decisions, in that organizations will probably not recruit and contract in a significant way during the same time period.

8. Conclusion

This paper describes ongoing research to study the dynamics of skill management within the domain of IT HRM. It employs a modeling approach that is based on systems dynamics, permitting HR managers to explore the implications of alternative staffing options when seeking to manage skills needed for IT-related activities. The model permits evaluation of the multi-faceted, dynamically changing, and interactive factors that affect IT HRM strategy formulation. The model can be easily calibrated to reflect different organization contexts. Environmental conditions can be manipulated to permit systematic what-if analysis, thereby serving as an effective decision support system for IT human resource managers.

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Appendix: Model Formulation

Equations:
Workforce(t) = Workforce(t-1) + Recruit + Contract – Turnover – ContractExpired
SkillSet(t) = SkillSet(t-1) + SkillAugmentation – SkillLoss
ResourceAvailable(t) = ResourceAvailable(t-1) – ResourceConsumption
Skill Gaps = RequiredSkillSet – SkillSet
RequiredSkillSet: as per figure 2
SkillAugmentationDecision: as per figure 3
Skill Acquisition = Training*TrainingSkillEffectiveness + Contract*ContractSkillEffectiveness + Recruit*RecruitSkillEffectiveness
Skill Loss = Turnover*RecruitSkillEffectiveness + ContractExpired*ContractSkillEffectiveness + SkillObsolescence
Training = min{Skill Gaps*1.5, Workforce} (assuming the decision is to recruit)
Recruit = Skill Gaps*1.5 (assuming the decision is to recruit)
Contract = Skill Gaps*1.5 (assuming the decision is to contract)
Urgency = 0.30 + 0.013*Time
ContractExpired = Contract *0.5, with a 6 month delay

Constants:
Workforce(0) = 250
SkillSet(0) = 40
ResourceAvailable(0) = 0.98
Turnover = 0.1 (assuming Workforce is greater than 0.1, zero otherwise)
Skill Obsolescence = 0.1
Training Skill Effectiveness = 0.3
Recruit Skill Effectiveness = 0.5
Contract Skill Effectiveness = 0.7