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Effect of Different HRM Policies on Potential of employee Productivity

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Abstract

The purpose of this paper is to analyze the effect of HRM policies on Potential of employee Productivity (PEP) in a healthcare organization as essential requirement for success. The In the first phase, in this adaptive and descriptive research, the data collection started in the wake of reviewing related literature when a series of semi-structured interviews were conducted with hospital managers to determine their perceptions about the HRM policies in an Iranian hospital. Then, casual loop diagrams, and stock and flow diagrams were identified. Model equations were determined by integral equation related to system dynamics (SD). Model validity was checked by structural test, consistency test, extreme condition test, and parameters analysis. Parameters analysis was done with historical fitness between simulated data and actual data for total employee variable behavior by coefficient of determination, mean square error (MSE), bias component of MSE, variation component of MSE, and covariance component of MSE. Vensim software was used for simulation, sensitivity and policy analysis. The PEP decrease in the simulation with a non-linear pattern. Different policies in human resource management could affect the PEP by change in hiring rate, quit rate, and change in structure of decision making. According to the results, stop of current adopted policy based on hiring contract employees from 2010 and hiring them as long term hiring had a better effect on PEP. Productivity is affected by several factors. The case study verifies and visualizes that different policy of human resources, may result in important change in PEP. It is important that researchers critically consider the nature of the concept of PEP, how it could be maximize, and how it relates to other concepts, such as organizational performance.

Keywords: human resources management, productivity, hospital, system dynamics, Iran.

Introduction

Human resources (HR) are a core competency in many organizations and many strategic HR management efforts are designed to enhance organizational productivity[1]. This paper reports on the findings of research that provides insights into how HRM policies affect the PEP. It is an attempt to response a need to describe the relationship between them and effect of managerial policies on PEP that has been less studied. In this paper, we therefore pose the question: how do HRM policies affect the Potential of employee Productivity (PEP)? In answering this question, the paper uses system dynamics methodology to determine structure of managers' decision making in an Iranian hospital.

Iranian Social Security Organization (ISSO) is a social insurer organization. It is a non-governmental institution and provides 18 services, in the form of short-term and long-term obligations in insurance and medical section. The ISSO provides medical services as second provider in Iranian health sector. Medical care and medicines are provided directly to covered patients through medical facilities belonging to the ISSO. Medical services are provided through 73 hospitals and 270 medical clinics owned by the ISSO. Sixty hospitals out of 73 are certified by ISO 9001 certification. These hospitals have a process-based approach. In the case of hospitals in general, there are numerous contributions regarding performance assessment as measurement tools which facilitate the identification of indicators[2].

System dynamics is a powerful tool that gives a systematic approach to conceptualizing the problem, building a dynamic model and running simulations to identify the critical parameters which need closer control to enhance the efficiency and effectiveness of the organization[3]. In this paper, system dynamics approach has been used to study HRM policies in order to analyze its effect on productivity.

Human Resource Management: HRM deals with the design of formal systems in an organization to ensure the effective and efficient use of human talent to accomplish organizational goals. In an organization, the management of human resources means that they must be recruited, compensated, trained, and developed[1]. Human resources are defined as the efforts, knowledge, capabilities and committed behavior of people in the organization[4-5]. Also, management of human resource has been defined as the mobilization, motivation, development and deployment of human beings in and through work. HRM is a strategic player to achieve the objective of continuous quality

improvement, organizational existence[4] and sustained competitive advantage[6].

Studies have demonstrated that specific HR practices, which include skills, knowledge and abilities, can enhance human capital, especially in the management of knowledge workers in the health service sector[7]. It has also been demonstrated that health service firms use a range of strategic HRM practices to manage their knowledge workers and that these practices (including personnel control oriented HR practices such as staffing and training practices) lead to increased organizational performance. The human resources need to be treated with great care and human resource issues require special attention of decision makers at the strategic level[4]. Development of strategic leadership and management capabilities within modern organizations has been very important "in meeting the challenge of working effectively to promote not only economic, but also sustainable development". From an HRM perspective, a number of things have to happen. Strategic HRM can help to support sustainability through the identification of capabilities specific to sustainability and by seeking to align recruitment and selection practices to these capabilities. In brief, it is accepted that human resources are the biggest asset in any organization. Management policies should be lead to more efficient organizations by managing the short-term and long-term performance[8]. For example, evidence on reducing patient mortality[9] and "strategic fit" to compare organizational data on staff turnover, patient complaints on lack of skill, staff grievance, discipline, stress and staff injury are cited[10].

In the context of health service, human resources include all the necessary human ability, skills, competencies and knowledge required to deliver clinical care[4]. A large proportion (around 50%) of employees in healthcare organizations are professionally qualified staff. A combination of rapid expansion, high staff turnover and an increasingly ageing workforce has contributed to significant projected staff shortfalls of registered professionals and other skilled staff in many countries[11]. Health services sector employs many highly educated and skilled knowledge workers, frequently educated to doctoral level, who represent extensive human resources. How the return on these resources might best be achieved is an issue of ongoing concern to the sector[12]. Although several studies find a positive relation between certain HRM policies and organizational performance, literature and most empirical evidence alike do not explain or provide sounding evidence about managerial roles in optimizing PEP in their organization. However, there is a gap explaining how HRM policies contribute to the creation and improvement of productivity.

Dynamic nature of the employee–organization relationship makes the human resource management a challenging task. Human resource policies and practices result from a dynamic process, which evolves through negotiations, decision-making and review process. Managers have an essential role to play in the effective management of human resources. They decide to hire, quit or retire the employees. In addition their decisions affect turnover of people in and from the organization. Their decisions affect everyone in the organization[4].

Productivity: Productivity is a topic of growing interest among both managers and researchers and has a high priority in many sectors. There is an extensive literature on productivity and the complexities associated with its assessment. Productivity is widely regarded as a key success factor of organizations[13] and it is generally defined as a measure of the amount of output generated per unit of input. But the definition of productivity as being concerned with the relationship between input and output does not cover issues that many people have in mind when they talk about public sector productivity. It is explained that although the concept of productivity has been utilized for many years, it is often simplified, misinterpreted and misapplied[14-15]. In the healthcare sector, productivity is one of major challenges and its improvement is one attractive solution. Productivity is a relative concept: it cannot be said to increase or decrease unless a comparison is made, either of variations from a "standard" at a certain point in time or of changes over time. Although, the link between management policies and productivity is studied in most studies but the assessment have been related to the effects of an individual practice in isolation[16].

Relationship between productivity and organizational performance has been cited in many studies. Investment in HRM policies can raise and sustain a high level of firm performance and can represent a significant source of competitive advantage[16-17]. Additionally, a two-way causational relationship between the HR policies and performance had been discussed[16]. Empirical evidence about the positive impact of clusters of management policies on productivity is illustrated[8].

Productivity and performance are functions of many factors and it can be measured in a number of ways. Public sector productivity is most often measured as labor productivity[8,13-14]. On the other words, human resources are center of productivity in services management especially in health care sector. Since the mid-1980s, hospital performance measurement has increased both at the academic, policy-making, and managerial levels. Several service productivity models can be found in the literature[13]. Data envelopment analysis (DEA) or stochastic frontier analysis (SFA) are two common methods that are used to measure hospital productivity[17]. Measuring productivity as a vital issue not only is a very complex task as few mutually exclusive components such as labor productivity, but also the literature shows many ways of measuring productivity that most common one is employing indicators[2]. Without a well trained and well prepared labor force, businesses lose the ability to compete both nationally and internationally, resulting in decreased economic success[18].

The service research literature emphasizes effectiveness instead of productivity and it is used to calculation of PEP[19]. It is mentioned that the effectiveness and productivity are not

opposites but they should be understood as mutually complementary[14] and some complexities of inputs and outputs methods of productivity measurement and effect of a set of HRM policies on labor productivity is investigated[16] but quality of employee or PEP less studied. A strong and positive relationship between HRM intensity and productivity is verified. Some empirical evidences demonstrate indirect (or non-linear) causal relationship between the HRM practices and organizational financial performance[16].

Although importance of human resources of hospitals is confirmed, it is accepted that the management of these resources is not adequately developed[20]. HRM policies suffer from lack of analysis of management policies and the causality relationships between employees and processes. In addition, there are some kind of time lag between implementation of HRM policies and organizational outcomes[8,16]. Simulation based on system dynamics (SD) methodology can be used for analysis of PEP.

Simulation: When viewing organizations as systems, we must consider the human resource inputs, processes, and outputs that can lead to sustained competitive advantage. The organization's human resource system is therefore the dynamic processes that enable the firm to acquire, develop, and deploy its resources to achieve superior performance and ultimately a competitive advantage[18].

Simulation represents a different class of IT, one that facilitates learning as well as doing through virtual practice[21]. Computational modeling is useful for knowing and learning about organizational knowing and learning[22]. System dynamics (SD) is used for modeling and simulating dynamically complex issues and analyzing their resulting non-linear behaviors over time in order to develop and test effectiveness and robustness of structural policies[23]. SD is defined as a perspective and a set of conceptual tools that enables us to understand the structure and dynamics of complex systems. It is also a rigorous modeling method that enables us to build formal computer simulations of complex systems and use them to design more effective policies and organizations. System dynamics is built upon system thinking, i.e. the ability to see the world as a complex system, in which we understand that ''you can't just do one thing'' without thinking that ''everything is connected to everything else''[23-24].

Over the last decade, several top companies, governmental organizations, and consulting firms have used system dynamics to address critical issues and decisions. Examples and applications include diffusion of technologies, business cycles, the use and reliability of forecasts, service quality management, etc[24]. Productivity research should serve the objectives of organizations broadly and coherently. Long-span research projects are the only option to explore real productivity impacts because it is possible that benefits from investments come with delay and short-term impacts on productivity may even be negative[15].

HRM policies could be simulated by promotion chain. The two-level promotion chain for new and experienced employees are known as a very useful structure in modeling the effect of training and assimilation delays on the productivity of a workforce as the growth rate varies[19,23].

This paper examines the role of HRM policies maintaining PEP, and investigates what the organization should do to ensure to maximize of its PEP. The issue to be analyzed in this article: How can HRM policies are involved in the successful improvement in productivity?

Several problems faced by hospitals are employee turnover, reduction in customer satisfaction levels, and lack of productivity. When experienced workers leave the team, they take with them the knowledge that was acquired in their activities. They are replaced with new workers that reduce overall performance. This occurs since these new workers will usually be slower in their activities and will require more help from the experienced colleagues until they leverage their knowledge. Managers need to review their human resource policies if they hope to create and retain a viable workforce[18]. It is strongly suggested that there is the need for further research in order to assess the impact of management policies upon the productivity[16]. This study investigates how potential of healthcare sector productivity will be improved. This paper examines the role of HRM policies maintaining PEP, and investigates what the organization should do to ensure to maximize of its PEP. The issue to be analyzed in this article: How can HRM policies are involved in the successful improvement in productivity? To address this, we take a systems approach to examining how PEP is influenced by quality of human resource inputs due to HRM policies. Because of the complexity of the problem described above, it is suggested here to use simulation based on system dynamics approach to model effect of HRM policies on PEP.

Material and Methods

The research methodology is in accordance with the principles of system dynamics. This includes: problem identification, system conceptualization, model formulation, simulation and validation, and policy analysis and improvement[25]. The problem identification stage involves the identification of variables which have influence on the knowledge level. In the first phase, in this adaptive and descriptive research, the data collection started in the wake of reviewing related literature when a series of semi-structured interviews were conducted between hospital managers to determine their perceptions about the HRM policies in the Fatemeh Al-Zahra hospital. The hospital is affiliated to Iranian Social Security Organization (ISSO). In addition, the managers in the medical deputy of ISSO were also interviewed. Then, casual loop diagrams, and stock and flow diagrams were identified. The two-level promotion chain for new and experienced employee was designed. Model equations were determined by integral equation related to system dynamics.

According to Sterman, calculation of productivity was done by: Average Potential of Employee Productivity (PEP) = Potential Output/Total Employees

In reality, on-the-job (OTJ) training often requires the help and mentoring of experienced employees. Inexperienced workers reduce the time experienced people can devote to their own jobs by asking questions and by causing experienced people to work at a slower rate. Each new employee consumes an amount of experienced worker time equal to the fraction of experienced time required for training.

Potential Output = Experienced Productivity*(New Employee Productivity Fraction* New Employee+ Effective Experienced Employees)
Effective Experienced Employees= MAX (0, Experienced Employees- Time Spent Training New Employees)
New Employees Quit Rate = New Employees * New Employee Quit Fraction
Experienced Quit Rate = Experienced Employees * Experienced Quit Fraction

Average PEP measured in Units/(Week*Person) is the effective number of units that each employee could reach it. Model validity was checked by structural test, consistency test, extreme condition test, and parameters analysis. Parameters were analyzed with historical fitness between simulated data and actual data for total employee variable behavior by coefficient of determination, mean square error (MSE), bias component of MSE, variation component of MSE, and covariance component of MSE. Vensim software was used for simulation. Simulation was done for ten years from 2005 until 2015.

Results and Discussion

Casual Loop Diagrams: In this section, casual loop diagrams are described based on the research finding that are shown in figure 1. Human resources should be hired in the hospital based on the gap between desired employee and actual employee. The hospital should request employee based on shortage from deputy of ISSO. The process has a time lag or delay. New employee numbers Increase with hiring new employees. Increasing new employee numbers would increase the total number of employees. Increase the total number of employees would reduce the gap between desired employee and actual employee. Hiring loop in figure 1 illustrates this negative feedback loop. New employees as shown on experiencing loop, with a delay time lead to increase in experience employees that lead to an increase in the total number of employees. Increase in total of employees would reduce the gap between desired employee and actual employee. Increase in new and experience employees would rise the quit and turnover of employees. These feedback loops are shown as quit loop and turnover loop.

Because of the delay in hiring new employee and as a response to hospital pressures to ISSO for employee shortage, a new policy was approved by ISSO. In the new policy, each hospital has allowed to hire new contract employees based on the average overtime of current employees. New contract employees are temporary employees that are hired for few months. Their loops are shown in figure 1 as hiring contract employees.

Hiring new employees lead to increase in new employees stock in the case hospital. The productivity of new employees is typically a fraction of that for fully experienced employees. In addition, increase in total new employees stock leads to increase in on-the-job training. Inexperienced employees reduce the time experienced people can devote to their own jobs by asking questions and by causing experienced people to work at a slower rate. Each new employee consumes an amount of experienced worker time equal to the fraction of experienced time required for training. Additionally, Increase in new employees leads to increase in decay of effective experienced employees and then it decreases the potential output. Finally, the PEP will be decreased by decrease in potential output and increase in total employee. The model casual relations are shown in figure 2. In this causal diagram, there are five positive feedbacks and five negative feedbacks that have casual relationship with PEP. This causal diagram shows a fundamental structure to understand dynamics of HRM and PEP in the hospital.

Stock and Flow Diagrams: Stock and flow diagrams (SFD) as a computable dynamic structure are constructed from causal loop diagrams. In the SFD of the model, new employees, experienced employees, contracted (temporary) employees are defined as a stock or level variable that take on its value as a consequence of accumulation and de-accumulation and are not determined as a direct mathematical function of some other variable.

The new employee's variable is the accumulation/de-accumulation of hiring and quit or experiencing. The variable hiring is accumulating by dividing employee gap by adjustment time to hire. The new employee's quit variable is determined by new employees multiplied by new employee quit fraction. Additionally, the variable is de-accumulated by dividing new employee by employee experiencing time. In contrast, the experienced employee is accumulated by dividing new employee by employee's experiencing time and it is de-accumulated by dividing experienced employee by employee turnover time or experienced employee multiplied by experienced employee quit fraction. PEP is calculated as above illustrated. The full coupling of these sub-structures can be seen graphically in figure 2.

The temporary employee was defined as a separated level variable. It is accumulated by dividing desired temporary employee by time to temporary employee hire.

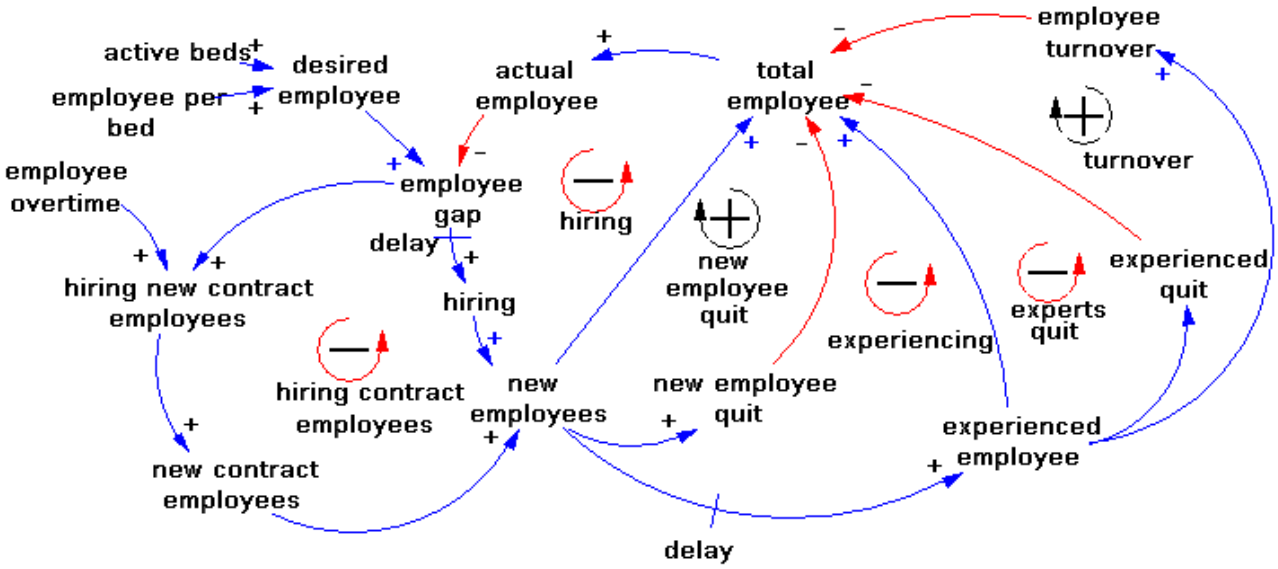


Figure-1
Employees hiring and quit casual loop diagrams in the case hospital

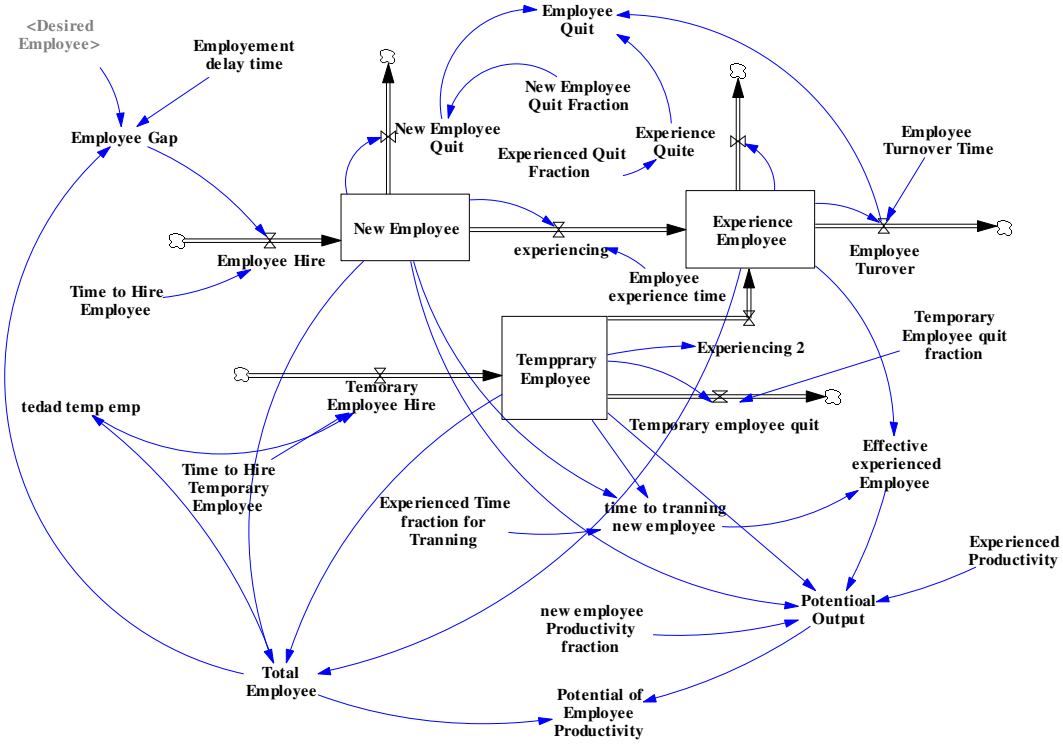


Figure-2
HRM and PEP stock and flow diagrams in the case hospital

Base Case Behavior: According to the research findings, total employees increased from 250 persons in 2005 to 383 in 2009, but the stock decreased to 334 in 2011 and afterward will increase into 404 persons in 2015. The result of simulation and the model behavior is shown in part A of figure 3. The number of experienced employees that was 170 prior to simulation reached to 224 in time 10 then it decreased to 183 in the 10^{th} year of simulation. The number of new employee that was 170 prior to simulation reached to 114 in time 07. Then, it decreased to fifty people in time 11 and rose to 80 in the end. The number of doctors was 56 in the beginning of simulation and with some oscillation reached to 57 in the end.

Temporary employment policy was implemented in 3^{th} year of simulation. Before that time, temporary employee stock had been zero. Hiring temporary employees led to an increase in the stock from time 03. The policy also led to a decrease in employee experiencing rate and experienced employee stock. Employee's experiencing rate rose from 30 persons per year to 45 in time 07 and then fell to 26 persons per year in the final phase of simulation. On the other hand, the decrease in new employee resulted from the policy.

Potential output in the case hospital was raised from 182 units/weeks in time 05 to 256 units/weeks in the 7^{th} year of simulation. Then it, with a relative reduction, reached to 229 in the end of simulation. Effective experienced employee from 162 persons reached to 224 persons in time 2011 and then it decreased to 188 in the end. Time spent to training new employee from 8 persons reached to 12 in the 7^{th} year of simulation and with a relative decrease until the 8^{th} year of simulation increased to 16 in the 10^{th} year.

Potential of employee productivity was 0.728 units/ (weeks*persons) in the start of simulation. It decreased to 0.659 in the 4^{th} year and then reached to 0.704 in the time 2012. Finally, it reached to 0.624 at the end of simulation.

Historical fitness between simulated data and actual data for total employee variable behavior showed that coefficient of determination (R^2) was calculated 0.98632, mean square error (MSE) 0.01517, bias component of MSE 0.05732, variation component of MSE 0.0122, and covariance component of MSE 0.82067. it`s behavior is shown in part M of figure 3.

Sensitivity Analyses: Multivariate Sensitivity Analyses (MSA) was used as a tool for checking validity of the model. In a MSA, probability distributions are defined for uncertain variables, and parameter values are sampled from these distributions and many (e.g. thousands of) sets of parameter values are simulated instead of just one.

Minimum and maximum of variables in the sensitivity analysis are shown in the table 1. Result of the model's variable is shown in figure 4. These simulations are somewhat simplistic because: (i) parameter values sampled from the probability distributions do not change during a run, and (ii) it is assumed here that the different distributions are independent.

Policy analysis: In this section, the sequence of changes made to create different policies is reproduced. Policy analysis is commonly used as a tool in system dynamics. In the policy analysis, results of the system behaviors in different situation were analyzed before implementation. Encouraged by this finding, three policies were analyzed relative to a base run situation, with focus on the current HRM policy in the ISSO's hospitals and its dynamic effect on the total knowledge level. These policies include: Policy one: continuation of current adopted policy based on hiring contract employees; Policy two: stop of current adopted policy based on hiring contract employees from 2010; Policy three: stop of current adopted policy based on hiring contract employees from 2010 and hiring them as long term hiring.

Figure 5 shows the behavior of five variables: total employees, time spent on training new employee, effective experienced employee, potential output, and PEP. In the second and third policies, total employees are decreased in the long term. The decrease is resulted from decision making structure and delays in it. Effective experienced employee, potential output, and PEP will be gained the higher level. Time spent on training new employee will be reached to lower level in the third policy. Finally, the third policy could lead to increase in PEP per each person in the long term.

The study can be defined as an experimental case study. This paper discusses the application of SD to a case study of the HRM policies on PEP. This approach has been used to study the relationships linking HRM policies with PEP and to understand the complex behavior of system to managerial decisions. In particular, the proposed case study suggests that HRM policies may result in change in PEP and the use of contract employees was associated with lower potential of productivity.

Management practices are known as an ambiguous driver of productivity and higher performance. This is because of the methodological issue, qualitative and subjective measures of either management practices or firm performance. This makes the results not comparable across studies, across firms or even within firms over time. On the other hand, management practices are multi-dimensional constructs that generally do not demonstrate a straightforward relationship with productivity variables[8]. This study shows that the relationship between them is non-linear, dynamic and affected from qualities of policies. In addition, policy analysis is used to overcome these difficulties such as comparable result over time.

Recent research shows that the different polices in HRM lead to change in potential of productivity in the organization. A major issue for senior executives is ''how do I make sure that the productivity per person maximize in the case hospital?'' Using SDM may be the only way to solve one of the main difficulties

connected to HRM and productivity, namely the time lag dimension. Few researchers have exploited this idea[26]. Increase of productivity is becoming a main challenge in many countries as human resources become a main asset of organizations. Managers could gain interesting and useful insights by using SDM even though the technique is used only for portions of a whole system[26]. In fact, SDM was used for planning, including policy design, interactions with suppliers, with labor, with customers and competitors, financial performance and knowledge management[24, 26].

In estimating technical efficiency of hospital services a few studies have undertaken sensitivity analysis to improve the reliability of estimated results.

The number of articles that examined the sensitivity of their findings in the USA is surprisingly low. Only four out of 158 articles attempted to estimate the reliability and/or validity of the measures used. In reviewing non-parametric and parametric applications, little sensitivity analysis or statistical testing has been undertaken; even though these advanced methods are under development[17]. Monte-Carlo simulation that was used to sensitivity analysis is one of the strengths of this research.

It is explained that mangers perceived the given medical education system as satisfactory and so questioned why they should provide further professional development[20]. This study shows the effect of HRM policies and role of manager`s decision on productivity. In fact, productivity dip until new people learn their jobs and other outcomes such as customer satisfaction will be declined[1].

Although, the idea of SDM in planning is not new, there are few studies combining HRM and potential of productivity with a dynamic simulation approach. However, the system dynamics approach has already proven to be a very beneficial technique in other similar areas such as planning, inventory control, goal seeking behavior, oscillations and instability, and forecasts.

The promotion chains were used to modeling the human resource management policies. This structure is very useful in modeling the effect of training and assimilation delays on the productivity of a workforce as the growth rate varies[23]. In addition, Causational relationship between the HR policies and productivity are utilized. There are a two-way causational relationship between the HR policies and financial performance[16]. Although, there is little examination of causality or research design testing of models, and difficulties in use of methodologies to test the causation and contribution of performance are some difficulties encountered by HRM literature[10]. It could resolve the criticism of positivistic methods to link causality between HR and productivity.

The ideas about knowledge-based HRM lead us to think that the key goal of HRM is optimizing the continuous development of the entirety of an organization's knowledge of employees and their ability to create value. As such, the key process would be developing and managing individuals, competencies and communities. According to this research, successful HRM policies could be affected PEP by hiring, quit and change in policies. The most productive organizations are those where managers are of high quality and tend to adopt the best managerial practices[8, 27].

However, this paper focuses on displaying structure of the HRM policies in order to stimulate for seeking the best policy to deal with productive people in an appropriate and ethical way, especially in the hospital. The result of simulation suggests applying temporary policy would reduce the PEP in the hospitals.

The performance of people and organizations improves generally as a result of increasing potential of productivity and reduction in it could lead to fall productivity and success of the hospitals[22]. It concludes that HRM policy implementations should be analyzed earlier in the policy selection, supported by simulation techniques for scenario-testing and evaluation.

It is also proved that SD is a valuable supporting tool not only for analysis of productivity but also for making decisions and taking managerial actions aimed at improving the PEP. The model can be used as a flight simulator to anticipate any consequences of various policies by leveraging on a few parameters and as a supporting tool for continuous managerial learning resulting from ongoing process feedback.

There are also several limitations to our study. One obvious limitation is that the model is based only on one hospital data and therefore is not likely to be applicable in the other hospitals. A second limitation is the distinction made between a mental or cognitive model, which is based on hypothesized relations, and the real life model of real businesses, which is based more on verified and concrete measures. An important weakness of the study is the problem of access to confidential information. The information used for our SDM is based on information gathered using multiple methods. Some model assumptions, e.g. exact time delay and loops are based on a combination of simplicity and considerations within the case hospital.

Conclusion

This paper examines the role of HRM policies maintaining PEP, and investigates what the organization should do to ensure to maximize of its PEP. Because of the complexity of the problem described above, it is suggested here to use simulation based on system dynamics approach to model effect of HRM policies on PEP.

The result of simulation suggests applying temporary policy would reduce the PEP in the hospitals. The performance of people and organizations improves generally as a result of increasing potential of productivity and reduction in it could lead to fall productivity and success of the hospitals[22]. It

concludes that HRM policy implementations should be analyzed earlier in the policy selection, supported by simulation techniques for scenario-testing and evaluation.

The SDM approach for potential of productivity provides an idea of the quantitative effect from time delays on the outcome from altering input variables. Because of the value of specialist versus generalist human capital[5], HRM policies could be separated in two processes such as employees and doctors. Finally, as the others explained simulations predict behaviors arising from particular case scenarios and assumptions, which require post validation because the best way to assess the responsiveness of a case model is to compare real world performance records[21, 28]. However, this approach poses limitations in the sense that the application of the proposed model is highly specific to the particular case hospital. Moreover, a SD model gives the current picture of a system, so it must be constantly updated to include the latest organizational changes.

Future work related to HRM and employee productivity with SD could address adapting this and other models to the context/characteristics of productivity, adapting this and other models to a set of possible substitute HRM and productivity, mapping possible dependencies between them, extending the model to explore possible issues and/or extending the current model with the behaviors, performing Exploratory Modeling and Analysis (deep uncertainty analysis) to this and other models, and analyzing the effect of training and assimilation delays on the productivity of a workforce.

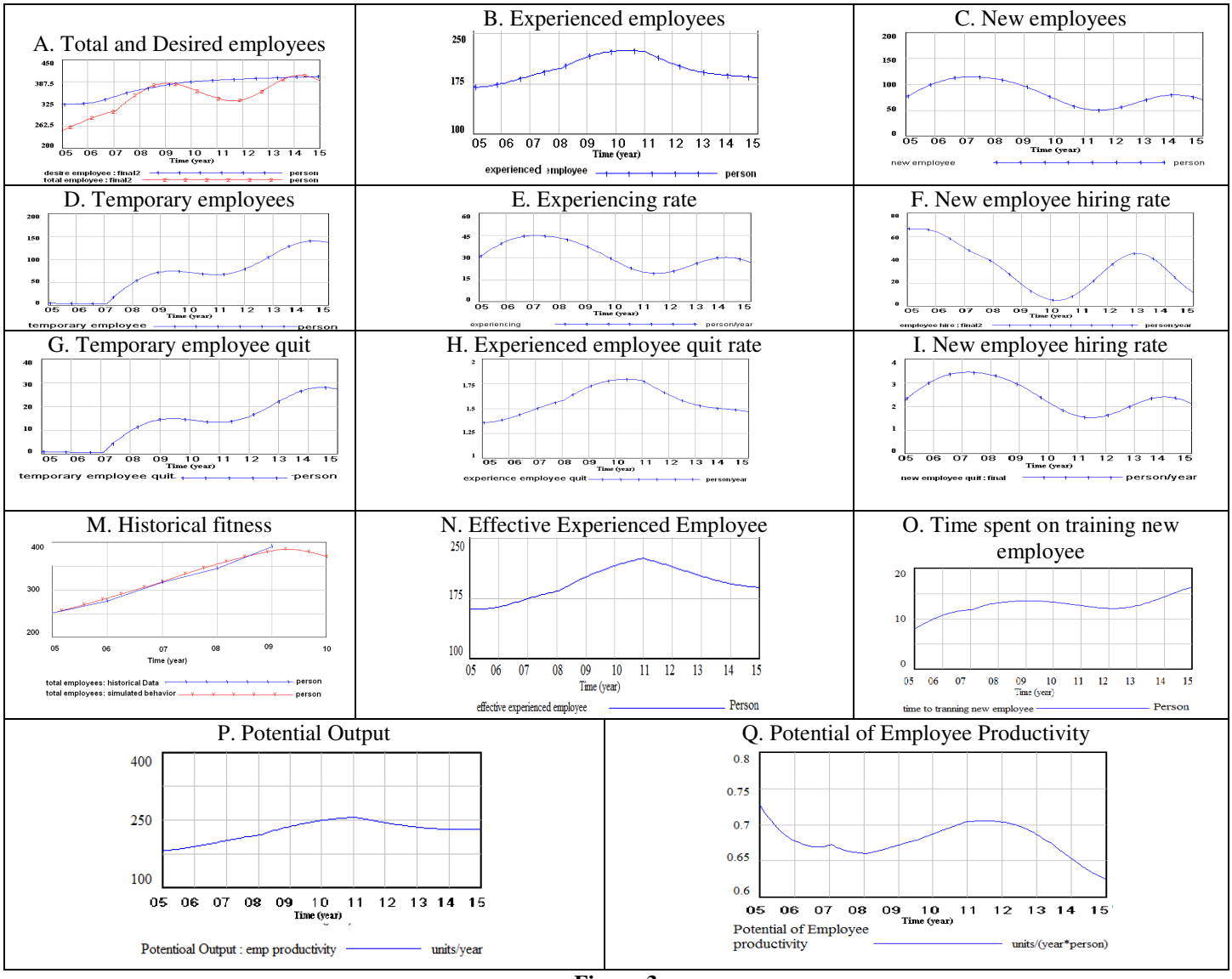


Figure-3
Behavior of the model variables in the case hospital

Table-1
Variables name and values for Multivariate Sensitivity Analyses in the case hospital

Variable name	Base run value	maximum	minimum
Delay in hiring employee (years)	1.48	2	1
Delay in hiring contract employees (years)	0.6	1	0.3
New contract employees quit rate (person/year)	0.2	0.5	0.1

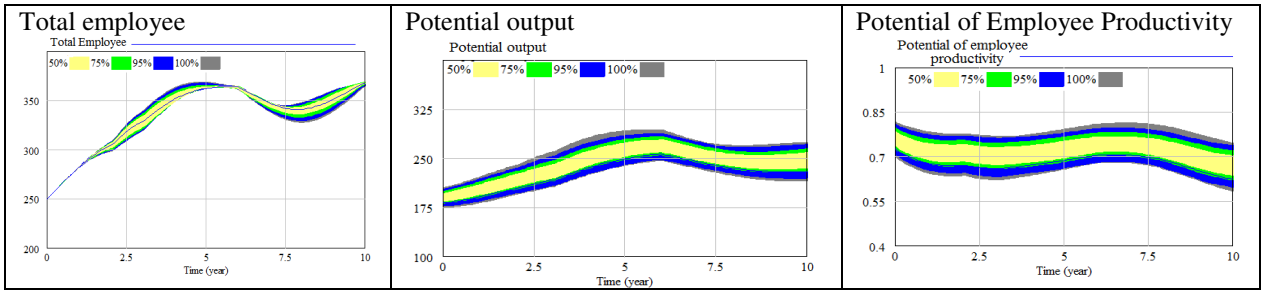
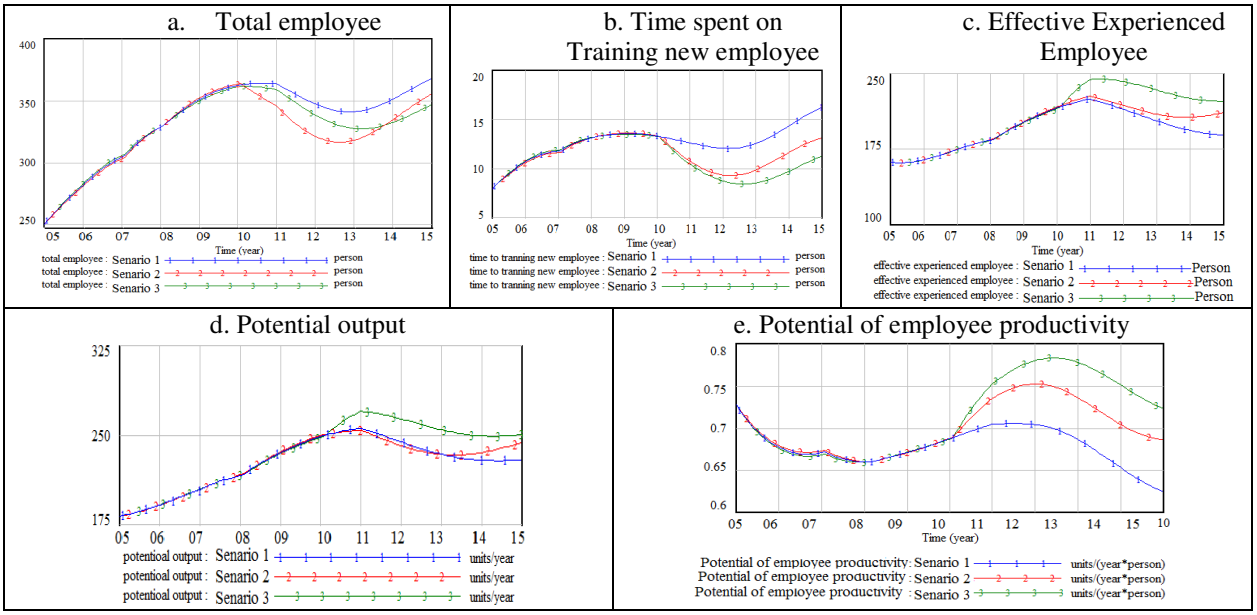


Figure-4
Some model variable behaviors in the Multivariate Sensitivity Analyses in the case hospital



Figures-5
The behavior of five variables of the model in policy analysis

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