SHOULD A COMPANY INVEST IN TRAINING
Costs/Benefits of PMP Certification on a Construction Project

Malgorzata Plaza, Komal Naz and Anthony Sangra
TRSM, Ryerson University, 350 Victoria Street, M5B 2K3, Toronto, Ontario, Canada

Keywords: Training, Project Management, Construction, Progress Curve.

Abstract: Training is an attractive solution in times where economy experiences a decline in the supply of skilled workers, which is the current trend in the Canadian construction industry. Regardless of its form, employee's training is expensive, so its benefits should be carefully assessed to assure a proper return from the investment. Research offers several methods, which can be used to measure the outcomes of training. Neither of those methods includes the non-linear changes of performance due to the "learning on the job" effect, which can be depicted by an employee's progress curve. This paper explores various training assessment approaches and offers analytical decision model. The model can be used to evaluate the impact of employee's progress curve on the time after which the benefits of training balance its costs. The model is illustrated with a real case of a construction project, in which cost effectiveness of hiring a senior PM is compared to training of a senior and a junior PMs, who are with the company for a number of years. The results of the study demonstrate that training of a senior PM is the most beneficial option.

1 INTRODUCTION

According to Statistics Canada, the construction industries employed about 1.2 million people in 2008, which accounts for 7.2% of all jobs in Canada and 30.6% of those in the goods-producing sector. The workers consisted of managerial, clerical and administrative personnel in various occupations. Any decline in the construction sector would have a huge effect on the economy, so the industry has to be carefully managed to ensure the well-being of Canadians as a whole (Clikeman 1999).

The construction firms experience continuous decline in the supply of qualified workers, which is one of the reasons why labour productivity has fallen in the industry ("Construction"). Training seems to be a proper solution; since it delivers the various skills to the candidates seeking employment and therefore carries a promise to increase the overall productivity of a Canadian workforce.

Training is expensive and takes time. Accountants can easily estimate its various costs but cannot with the same degree of confidence assess the value and future benefits of various training programs. It remains up to HR department to supply that information. HR, which aspires to become a strategic part of the organization, must fully understand the labour requirements and be able to evaluate various training strategies (Rowden 2001).

Research emphasizes the importance of training and offers a variety of assessment methods to measure its outcomes. However, the available methods do not include the impact of an employee's progress curve on his/her performance. As a result, the management cannot compare the two most common options, which are: (1) allowing an employee to "learn on the job", or (2) sending an employee to an external partner for a formal training (Plaza, Ngwenyama et al. 2010). There is also very limited discussion on the pros and cons of training a company's staff versus hiring a new employee.

This paper explores the available training assessment approaches and methods and closes the gap in the extant literature by offering an analytical decision model as its research contribution. The model can be used to assess the impact of a progress curve on the time, after which the benefits of training balance its costs. The model is illustrated with a real case study of a Construction Project. The Cost/Benefit analysis is conducted for a Project Manager (PM), who earns a Project Manager Professional (PMP) certification through a professional training.

Plaza M., Naz K. and Sangra A..
SHOULD A COMPANY INVEST IN TRAINING - Costs/Benefits of PMP Certification on a Construction Project.
DOI: 10.5220/0003718803710379
In *Proceedings of the 1st International Conference on Operations Research and Enterprise Systems* (ICORES-2012), pages 371-379
ISBN: 978-989-8425-97-3

The paper is organized as follows: the next section discusses the role of training and various approaches used to evaluate its benefits, including the Return on Training Investment methods. The analytical model is presented in Section 3.2 and its application to a Construction Project is discussed in Section 3.3. The future directions are outlined in the concluding Section.

2 LITERATURE REVIEW

2.1 The Significance of Training

People are the most critical resources for any organization and must be managed effectively. Training is a big part of resource management, since companies invest approximately $750 billion around the globe on training alone, which roughly makes 2% of payroll (Stewart 2007).

A study conducted jointly by the American Society for Training and Development (ASTD) and Saba Software in 2000 ranked organizations according to how much they spent on training. The researchers found that the firms in the top half had a shareholder return of 86% higher than firms in the bottom half and 45% higher than the market average. Furthermore, firms in the top quarter had a 24% higher profit margin and their price to book ratio was also 26% higher (Stewart 2007).

When providing up to date training the companies keep workers engaged, motivated and productive. More and more organizations recognize the need for skills improvement, which is added to the experience gained during the work engagements. The management appreciates how training is linked to work, so it comes as no surprise that statistics provided by almost all national organizations show continual increases in monies invested in its various forms (Murray and Efendioglu 2007).

Canada follows the global trend. According to a Conference Board, leading-edge Canadian companies regard training as an investment, not as a cost, so businesses spend about $859 per employee each year on formal training (Stewart 2007). Nearly half the respondents in the Conference Board survey reported that their training budgets are increasing as they are recognizing employees as the source of their competitive advantage (Stewart 2007).

Investment in training is significant and must be managed accordingly. The companies need tools and methods to properly evaluate their training strategies. The traditional HR processes and policies are adjusted, so that training alternatives can be evaluated before the commitment is made. The management of the respective departments must develop the clear objectives for training programs, explain how they address organization's requirements for resources, and list the expected benefits (Dipietro 2006). In the next section we discuss the methods, which are frequently used to evaluate training.

2.2 The Evaluation of Training

Measuring the return on training investment is complex. The previous section already established that the cumulative effect of training on a bottom line must be calculated. There are many different models, which can be used to assess the impact of development programs on employee's behaviour on the job, and on the company's performance. Some organizations consider the costs of not training employees as it often leads to a loss of valuable resources. The company must then consider a cost associated with finding and training the replacement, a possible loss of any trade secrets, the loss of clients associated with the employee, etc. (Stewart 2007).

The three most popular training evaluation methods, which are discussed in this Section, are: Kirkpatrick's model, 360 degree feedback Method and Balanced Scorecard.

2.2.1 Kirkpatrick's Model

The model classifies training outcomes into four levels: reaction, learning, behaviour change, and results. Each level is evaluated by the following methods (Rowden 2001):

Level 1. The reactions of participants are evaluated first. Since "Happy trainees" are more likely to focus on the key concepts of a program and correctly apply the information on the job, the level of satisfaction must be measured right after the training is completed (Stewart 2007).

Specific feedback is important, so the participants must be given a chance to provide insights into the content and techniques that were helpful to them. Although positive reactions do not guarantee the success of training, the evaluation at this level allows screening any changes experienced by participants during the program.

Level 2. The knowledge of participants is evaluated second. The method assesses the content and outcomes of learning. Many organizations give exams before and after training to evaluate the improvement in employee's knowledge.

Level 3. Behaviour change, which is evaluated third, refers to the effective application of the material and principles learned in the training sessions on the job. The method evaluates the extent, to which the attitudes have changed and the new skills were gained.

Level 4. Finally, the financial results are measured. The method evaluates the costs versus benefits of training. Return from training can be seen in several areas, such as: increased productivity, decreased waste, improved quality or increased sales. (Stone 2005) believes that ROI is a most appropriate tool, particularly when the investment is made by a company with limited funds.

Kirkpatrick model is not overly expensive to use, provides immediate feedback and examines the impact of training on a personal level. If reliable, clear scoring metrics are established, the model gives accurate assessment of the knowledge gained and skills, which still need to be learned. The results are shared with both instructors and students, so the obstacles to performance improvements are identified and accountability is established.

The main drawback of this model is its complexity. Many organizations pick and choose the levels they want to apply, often leaving out a few levels and thus missing vital information. It has recently become apparent that managers are effective in evaluating Levels 1 and 2, but are still challenged by the assessment on Levels 3 and 4. The model must be applied comprehensively in order to draw the most benefits and get the real picture of the effectiveness of training.

2.2.2 360 Degree Feedback Method

The method offers as accurate view of performance as possible, since the input comes from all angles: supervisors, peers, team members, customers, and so forth. Evaluation revolves around self-assessment. It was demonstrated that such feedback improves behaviour and increases performance, which in turn has a positive impact on Return on Investment (ROI) (Rowden 2005). The method has the following advantages (Stewart 2007):

1) It is very comprehensive since responses are gathered from multiple perspectives.
2) The quality of information is better and it provides data for developmental purposes.
3) The emphasis is placed on internal and external customers and teams, so it compliments TQM initiatives.
4) It reduces bias and prejudice since feedback comes from several and not just one individual.
5) It provides more consistent information on behaviours and actions.
6) Feedback from peers and others increases employee self-development.

The main drawback of the method is its administrative complexity. The method combines more information than a typical performance appraisal, so companies use Web technology to compile and aggregate the information. The other drawbacks are as follows (Stewart 2007):

1) Employees might feel overwhelmed and in shock from the information they receive.
2) There may be conflicting opinions, though they may all be accurate.
3) Employees may collude the system by giving invalid evaluations of one another. As a result, the feedback provided might be intimidating and may cause resentment. The evaluation may be seen as a popularity contest.

2.3 Measuring the Return from Training

There is an increasing trend to assess training as a long term strategy, rather than the short-term financial returns from investments. Unfortunately, four out of five organization do not even measure the ROI on their training dollars (Stewart 2007). The two ROTI methods presented below are suitable for analysis of strategic implications of training.

The first method was developed by Service Strategies. It is a spreadsheet guide that allows a user to insert organizational metrics related to strategic goals and training costs. The system calculates the bottom line financial results, which must be accomplished to justify the investment. The method encourages the use of metrics derived from Customer Relation Management (CRM) and an organizational budgeting system. The model consists of a 5 step process described below (Stewart 2007):

1. Supply basic investment and cost information (average class cost and other variables)
2. Calculate/estimate the value of estimated increased productivity
3. Calculate/estimate the value of increased customer retention (if applicable)
4. Calculate the value of reduced recruitment and retraining costs
5. Calculate the ROI and months required to payback the training investment

The second method, which was developed by FutureEd, uses the following approach to calculate the ROTI (Barker 2001):

1. Focus on a single unit, e.g., sales, product defects, employee turnover.
2. Determine a value for each unit, e.g., cost per item.
3. Calculate the change in performance attributable to training.
4. Obtain an annual amount.
5. Determine the annual value of improvement: the annual performance change multiplied by the unit value. ROTI then equals the net annual value of improvement less the program cost.

The second method is more suitable for a manufacturing industry while the first is adequate for a service firm, such as a construction company. The critical drawback of both methods is that the non-linear changes in performance due to learning on the job, which is a typical process on any project (Vandevoorde and Vanhoucke 2006) are not included. The next section discussed the learning curve theory, which is used to model and track the non-linear performance changes.

2.4 Learning Curve Theory

The learning curves have been used for decades to model the productivity improvements due to learning (Yelle 1979; Mazzola and McCardle 1997; Blancett 2002) and are most commonly associated with production rates and costs (Teplitz 1991). Learning curve is also used in relation to project management, where it is called a progress curve. For example, (Jackson 1998) applies a progress curve to financial analysis of technology implementations and (Ngwenyama, Guergachi et al. 2007) uses the S-curve to track the performance of a company after the Enterprise Resource Planning (ERP) project implementation.

An S-curve shaped progress curve were used to track the progress of projects by Cioffi (Cioffi 2005; Cioffi 2006). (Vandevoorde and Vanhoucke 2006) evaluated the application of various methods used to track the project schedule on three Construction Projects and came to the conclusion that S-curve based method would provide the best results.

Neither of the above mentioned methods allows tracking the impact of training on the project performance. (Plaza 2008) closes that gap and offers a model, which calculates the costs/benefits of training on ERP projects. Unfortunately, the model can only be applied to the teams and does not allow calculating the benefits of training the individual members.

The decision model, which is the contribution of this paper, addresses the above mentioned limitations. The model integrates a ROTI method with a progress curve, so it includes the non-liner changes of performance due to learning effects. Therefore, it can be used to assess the impact of a progress curve on the time, after which the benefits of training balance its costs.

3 TRAINING COSTS/BENEFITS MODEL

3.1 Research Method

In this paper we present a ROTI model developed from application of learning curve theory to project management. The main objective of the model is to support evaluation of various training strategies offered to a project manager, in order to improve the profit generated by a Cost Centre under his responsibility. The model can be applied to any of the evaluation methods discussed in Section 2.

We follow a design science research methodology, which is comprised of the four key stages (Hevner, March et al. 2004). First, the constructs or the vocabulary for the problem are selected. The model, which is an analytical representation of a problem domain, is created from the constructs next. The instantiation of a model is its implementation, for example a prototype system, which would automate and streamline the calculations. It is developed in the third stage. A method, which offers a guideline of how the model should be applied to a problem domain, is proposed in the fourth stage.

The problem domain revolves around costs/benefits of training. The constructs, which we selected for the model, include accumulative cost function and a performance function. The cost function depicts training costs, expenses and salaries of a PM incurred before, during and after the training. The PM's performance changes due to learning are depicted by a progress curve.

The model is derived using a 5-step process after (Stewart 2007). It integrates the cost and performance functions. We use a linear function to represents an accumulative daily costs and expenses. Earned Value (EV) delivered during the progression of a project represents PM's performance and S-shaped progress curve is used to depict the changes

of EV as a function of time after (Cioffi 2006; Vandevoorde and Vanhoucke 2006; Plaza 2008). A project is a Cost Centre, so the changes of EV are substituted with a profit generated by a Cost Centre in a period of time similarly like in (Ngwenyama, Guergachi et al. 2007). The constructs and model are further discussed in Section 3.2.

The instantiation of a model is a prototype decision system developed in Excel. The system includes several graphs, which depict an impact of PM experience, learning ability, salary scale and training costs on the time after which investment in training is returned. The system was developed using a similar approach as discussed in (Plaza and Turetken 2009).

We selected a real life construction project as a most suitable Case Study to illustrate the application of our model. The problem domain includes analysis of timing and benefits of PMP designations subsidized for PMs by a construction company. In our case, the PM is responsible to generate a fixed amount of profit during a year. The company expects that amount to be increased after PM successfully completes the training and receives a PMP designation. The Case Study and a method, in which the model can be applied to a real life situation is discussed in Section 3.3.

3.2 Basic Concepts and Formal Description of the Model

Let's assume that i is PM's salary grade and is equal to 1 (before training) or equal to 2 (after training and promotion to the next level). If $C_i(t)$ represents a cost of a PM incurred over time, r_i is PM's daily rate, T_T represents the number of days of training and r_T is the total cost of training, than a cost function can be depicted by Eq. (1), assuming that the individual is not producing profit while in formal training.

$$\begin{cases} C_1 = r_1 t \\ C_2 = r_1 T_T + r_T + r_2 t \end{cases} \quad (1)$$

The total cost of training includes course fees and expenses if training is provided out of a place of employment. We are also assuming that training is taken on company's time and therefore wages paid to PM during training are included.

Let's also assume that $P_i(t)$ is a performance function (Figure 1), which takes a form of an S-curve (Eq. (2)) and represents the changes in profit delivered by a PM over time.

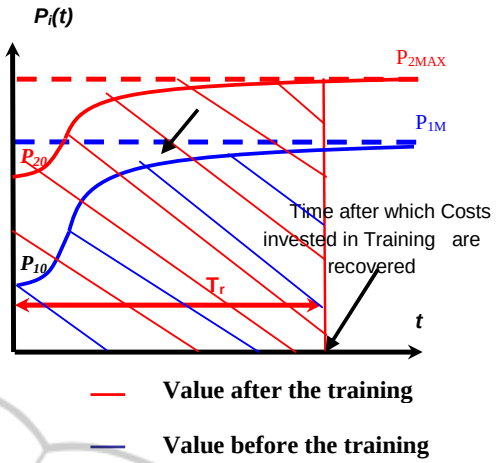

Figure 1: The Performance Functions of a PM before and after training.

$$P_i = P_{iMAX} \int_0^t \frac{dt}{1 + (m_i - 1)e^{-kt}} \quad (2)$$

where:

k is a Progress Curve Coefficient

P_{iMAX} is the asymptote to the Progress Curve or a maximum profit generated by a PM

P_{i0} is the minimum profit, and

$m_i = \frac{P_{iMAX}}{P_0}$ is a Profit Increase Coefficient.

Note, that a Progress Curve Coefficient represents the gradual performance changes due to experience accumulated on the job. However, the maximum profit and a Profit Increase Coefficient represent the shift of performance expected from training. Therefore, the investment in training will be recovered when the difference in profits before and after training will balance the difference in costs incurred, which can be expressed as:

$$P_2(T_r) - P_1(T_r) = C_2(T_r) - C_1(T_r) \quad (3)$$

where T_r is the number of days, after which an investment in training is recovered. When Eqs. (1) and (2) are substituted into Eq. (3) it can be transformed into:

$$\begin{aligned} & P_{2MAX} \int_0^{T_r} \frac{dt}{1 + (m_2 - 1)e^{-kt}} + \\ & - P_{1MAX} \int_0^{T_r} \frac{dt}{1 + (m_1 - 1)e^{-kt}} = \\ & = r_1 T_T + r_T + (r_2 - r_1) T_r \end{aligned} \quad (4)$$

which after integration can be rearranged as:

$$P_{2MAX} \ln \frac{m_2 - 1 + e^{kT_r}}{m_2} + \\ - P_{1MAX} \ln \frac{m_1 - 1 + e^{kT_r}}{m_1} + \\ + k(r_2 - r_1)T_r = r_1 T_T + r_T \quad (5)$$

Equation (5) cannot be solved explicitly for the critical points, so we use a Goal Seek function in Excel to numerically derive a time of investment recovery, T_r.

The simple system, which is comprised of several graphs supporting training strategy selection, was developed in Excel as an instantiation of the model. The application of a model is illustrated using a real construction company, which needs to analyze an investment in a PMP certification. PMP training and a Case Company are introduced in the next section.

3.3 Case Study

3.3.1 PMP Training and Certification

Due to the investments in new infrastructure and buildings, the construction industry has seen enormous rise in employment, which doubled between 2000 and 2008 ("Construction"). It became extremely difficult to find the suitable resources. The companies have the most difficulties to hire experienced and qualified managers for their projects. Training and promotion of internal qualified staff is a preferred choice under the circumstances.

The PMP program was developed by a Project Management Institute to train and certify Project Managers. The students gain knowledge in the following areas, which are fundamental for a successful project planning and execution (Madore and Ó Conchúir 2011):

- **Risk Management Processes –** In this area students learn how to identify and avoid or mitigate risks and how to take advantage of opportunities.
- **Human Resource Management Processes –** Students learn how to **e**mpower resources, delegate tasks and find the right people for the job.
- **Procurement Management Processes –** Students learn about buy/make decisions, how to write a request for quotations, how to structure and execute bidding processes, etc.
- **Quality Management Processes –** This area involves planning and evaluating quality through inspection, benchmarking national standards, establishing the right metrics and using the right tools such as histograms, and cause and effect diagrams.
- **Time Management Processes –** Students learn how to ensure that the project is on time.
- **Cost Management Processes –** This area revolves around estimating and managing costs including indirect costs. Identification of cost synergies and how to stay on/under budget are critical here.

The cost of PMP training is significant and includes: course fees ($5,200) and examination fee ($400). The training is often subsidized by a company and it is completed on a company's time. Although there are several qualified provider available in almost every part of the world, in the case of a construction company the training would most likely be provided out of the place of employment. Additional costs might therefore include a two weeks of salary (the duration of a typical PMP course is 10 days) and travel/ living expenses.

3.3.2 Background of a Project/company

A Canadian Construction Company, which is based in Alberta, delivers projects, such as: Hospitals, airports, universities and shopping malls. Due to the confidentiality agreement we will not disclose the name of the company and refer to it as "CCC". The company is a large mechanical contractor and is a privately held firm. The service offering includes any commercial mechanical work, except for the sprinkler systems.

PMP is one of the key professional designations, which CCC expects their PMs to get. The company supports the suitable candidate by covering the costs of PMP training, examination and allowing him/her to work toward the designation on a company time. Currently, the support is provided without the adequate analysis of when training should be offered and when CCC should expect the return of that investment.

The Cost Centre, for which a PM would be responsible, is a construction of a new morgue in a hospital. The project is a Bid Spec job, where a budgeted price of 3 million dollars was accepted by the client. The project is expected to be completed during 14 months. CCC reviews PM's at the end of every year in order to assess their value. Each PM is expected to bring in a flat line of yearly profit, which in our case is $1 million. With any additional profit a bonus program is implemented in order to

compensate successful PM's at the end of the year.

The costs of training and hourly rates for a senior PM, who would be a proper candidate to manage the project, are summarized in Table 1. For comparison purposes, we added rates for a junior PM, who could also be considered in that situation.

Table 1.

	Before Training		After Training	
	Senior PM	Junior PM	Senior PM	Junior PM
m_i	3	10	2	5
r_i	$ 60	$55	$ 66	$60
P_{iMAX}	9%	8%	13%	9%
r_T	5200 + 400			
T_T	10 days			

In Table 1 the profit (P_{iMAX}) was calculated by prorating the amount of an expected flat yearly profit to the PM's daily rate. Note, that although a junior PM is less expensive, he also delivers a lower profit and has a lower starting performance ($m=10$) than a senior PM ($m=2$). The PMP course is 2 weeks (10 days) and although the travel and living expenses are not included, the 2-week salary is included in the training costs.

The cost of promoting from within a company is preferable and more secure to that of hiring a new PM. The company has a variety of management and accounting systems that are tailored for their outfit. A new PM would have to gain an intimate knowledge of the company's protocols and systems, so the initial learning process is long.

Although it is the least desirable option for a company, hiring a new senior PM is also included in the analysis. Based on the industry rates; we estimated that hiring a new PM would cost the company an additional 3-month salary. We assumed that his rates will be the same as for the Senior PM after the training however his initial performance will be similar to a junior PM.

3.4 Analysis

In our case study we evaluated the following three options, which were considered by CCC:

- Option 1 – CCC will train a senior PM, who will be promoted and will receive a 10% raise upon receiving a PMP certification. A certified PM will be expected to deliver at least 4% more profit than before training.
- Option 2 – CCC will train a junior PM, who has a lower hourly rate but is expected to bring in a lower profit after training. He will also receive a 10% raise upon successful PMP examination.
- Option 3 – CCC will hire a new senior PM. The time required to recover the costs associated with hiring a new senior PM are compared to the costs/ benefits associated with assigning a senior PM, who did not complete PMP training, to the project.
- Option 4 – is the same as Option 1, but calculates the time after the investment is return assuming that a senior PM does not deliver the expected profit, which after the training is only 2% higher than before.

The goal of the evaluation was to answer the following three questions, which had to be addressed before the company committed its resources to train an internal candidate:

(1) How do learning abilities of a candidate impact the recovery time (ROTI)?

(2) What is a profitability, which PM must demonstrate before he is granted the opportunity? How should it improve after the training?

(3) Would it be more beneficial to hire a new PM, who already has the certification and will have the potential to deliver the improved profit, or to train the promising internal resource?

The results of evaluation are summarized in Figure 2, where the times, after which the investment is recovered are depicted as functions of a Progress Curve Coefficient, *k*.

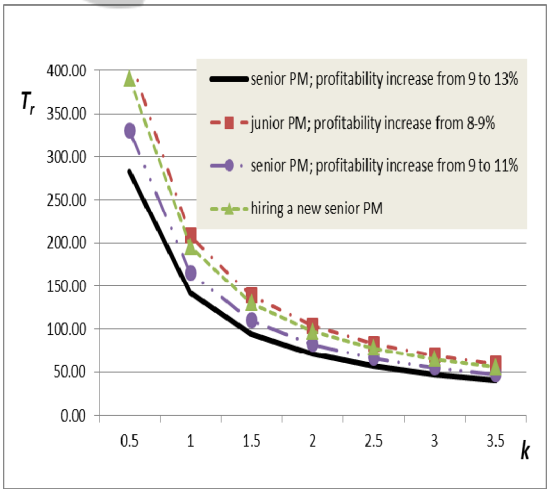

Figure 2: Times required to recover an investment in training as a function of PM's learning abilities.

The following critical trends can be derived from the analysis of the options available in the Case Study:

1. The recovery time is very short (around 50 days) if a PM demonstrates a high Progress Curve Coefficient (above 1.5) due to either sufficient experience or other significant training.

2. The most beneficial option would be to train a senior PM, even if he fails to deliver the required profit after the training (option 1 and 4 gives shorter times of recovery than option 2).
3. Hiring a new senior PM is more beneficial than training a junior PM but less beneficial than training a senior PM even if he does not complete the program or does not deliver the expected profits (option 1 and 4 gives shorter times of recovery than option 3).

The analysis presented in this section clearly points to option 1 as the most beneficial choice. Assuming the average learning abilities ($k=2$), the investment in training will be recovered after 60 – 70 days for a PM who can deliver a profit ranging from 11-13% of his salary upon a successful completion of a PMP program.

4 CONCLUSIONS

As demonstrated in the Case Study discussed in this paper, training proves to be the best option, which not only improves a performance of a PM but also outweighs hiring a new PM. Many companies are looking at hiring as the less desirable choice. Their decision, however, could not be justified with the accurate ROTI analysis due to the lack of analytical decision models.

Our decision model was developed in an attempt to address the very issue. We are planning to extend the model discussed in this paper into the decision support system for human resource management and develop a policy, which will offer guidelines and recommendations for providing training to employees.

However, before we can move in that direction we must address the following two key limitations of our model:

1. The limits for Progress Curve Coefficient (from 0.5 to 3.5 in Figure 4) were established from the research on training provided to a project team prior to implementation of an Enterprise Resource Planning system (Plaza, Ngwenyama et al. 2010). The testing procedures and a set of data for assessing k must be established for a given industry sector before the model can be used to support development of a training policy.
2. The simple prototype system developed in Excel in order to test the model must be expanded into a decision support system, which will offer a selection of graphs and reports required during a comprehensive analysis. The system must be properly tested by a wide group of managers and HR personnel to demonstrate its real value and potential.

The results of this study are encouraging, so we are planning development of a decision support system as the natural next step.

ACKNOWLEDGEMENTS

Funding was generously provided by the Ryerson Summer Assistant Program.

REFERENCES

"Construction". "A Guide to the BC Economy and Labour Market." Retrieved July 17, 2011, from http://www.guidetobceconomy.org/major_industries/construction.htm.

Barker, K. (2001). "Return on Training Investment: An Environmental Scan and Literature Review." FutureEd. Retrieved July 15, 2011, from http://futured.com/audited/returned.htm.

Blancett, R. S. (2002). "Learning from productivity learning curves." *Research Technology Management* 45(3): 54-58.

Cioffi, D. (2006). "Completing projects according to plans: An earned value improvement index." *Journal of the operational research Society* 57(3): 290-295.

Cioffi, D. F. (2005). "A tool for managing projects: an analytic parameterization of the S-curve." *International Journal of Project Management* 23: 215-222.

Cioffi, D. F. (2006). "Designing project management: A scientific notation and improved formalism for earned value calculations." *International Journal for Project Management* 24(2): 136-144.

Clikeman, P. M. (1999). "Improving information quality." The Internal Auditor 56(3): 32-33.

Dipietro, R. (2006). "Return on Investment in Managerial Training." *Journal of Foodservice Business Research* 7(4): 79-96.

Hevner, A. R., S. T. March, et al. (2004). "Design Science in Information Systems Research." *MIS Quarterly* 28(1): 75-105.

Jackson, D. (1998). Technological change, the learning curve and profitability. and Northampton, Mass., Elgar; *distributed by American International Distribution Corporation*, Williston, Vt.

Madore, O. and D. Ó Conchúir (2011). Overview of the PMBOK guide : short cuts for PMP certification. *Heidelberg Germany*, Springer.

Mazzola, J. B. and K. F. McCardle (1997). "The stochastic learning curve: Optimal production in the presence of learnin." *Operations Research* 45(3): 440.

Murray, L. W. and A. M. Efendioglu (2007). "Valuing the investment in organizational training." *Industrial and Commercial Training* 39(7): 372-379.

Ngwenyama, O., A. Guergachi, et al. (2007). "Using the learning curve to maximize IT productivity: a decision

analysis model for timing software upgrades." *International Journal of Production Economics* 105(2): 524-536.

Plaza, M. (2008). "Team performance and IS Implementations: Application of progress curve to the Earned Value Method during IS project." *Information Systems Frontiers* 10(3): 347-359.

Plaza, M., O. K. Ngwenyama, et al. (2010). "A comparative analysis of learning curves: Implications for new technology implementation management." *European Journal of Operational Research* 2010(2): 518-528.

Plaza, M. and O. Turetken (2009). "A Model-based DSS for integrating the impact of learning in project control." *Decision Support Systems* 47(4): 488-499.

Rowden, R. W. (2001). "Exploring Methods to Evaluate the Return-on-Investment from Training." *Business Forum* 27(1): 31 - 36.

Rowden, R. W. (2005). "Exploring Methods to Evaluate the Return-on-Investment from Training." *Business Forum* 27(1): 31-36.

Stewart, E. B., M. Belcourt, G. Bohlander, S. Snell (2007). Essentials of Managing Human Resources. Toronto, Nelson.

Stone, P. W. (2005). "Return-on-investment models." Appl Nurs Res 18(3): 186-189.

Teplitz, C. J. (1991). The learning curve deskbook: A reference guide to theory, calculations, and applications. New York, Quorum Books.

Vandevoorde, S. and M. Vanhoucke (2006). "A comparison of different project duration forecasting methods using earned value metrics." *International Journal of Project Management* 24(4): 289-302.

Yelle, L. E. (1979). "The learning curve: historical review and comprehensive survey." *Decision Sciences* 10(2).