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The use of discrete computer simulation modeling to estimate the direct and diffusion effects of leadership development intervention on the return on investment

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THE USE OF DISCRETE COMPUTER SIMULATION MODELING TO ESTIMATE THE
DIRECT AND DIFFUSION EFFECTS OF LEADERSHIP DEVELOPMENT
INTERVENTION ON THE RETURN ON INVESTMENT

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

In

The School of Human Resource Education and Workforce Development

By

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May, 2012

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ABSTRACT

Organizational leaders seek monetary returns on their investments (ROI). Thus, making decisions to invest in human capital, such as in leadership development interventions, are often difficult due to the lack of research demonstrating monetary returns on development investment (RODI). Further, little research has been conducted on the diffusion effects of leadership development intervention, or returns on leadership diffusion (ROLD). This research expands on previous research conducted by Avolio, Avey & Quinsenberry (2010), which was the first attempt to estimate RODI using utility analysis. This study is unique in that it uses computer simulation modeling along with current research data to generate random distributions of each utility analysis variable to estimate RODI. Comparisons of RODI methods are conducted. Further, the study incorporates a logistical growth model based on exponential growth theory and Diffusion of Innovation theory to estimate the returns from leadership diffusion.

CHAPTER 1: INTRODUCTION

Background of the Problem and Conceptual Underpinnings of the Study

Understanding methods used to evaluate leadership outcomes and their impact on follower and organizational performance in terms of return on investment (ROI) is challenging (Avolio, Avey, & Quisenberry, 2010; Avolio, Reichard, Hannah, Walumbwa, & Chan, 2009; Cascio & Boudreau, 2011). Challenges include evaluating and gathering data for leadership development outcomes while ensuring adequate quantity of high-quality data, dependency on how well the program is introduced, and the adequate use of indicators to measure performance in action plans (Lemay & Ellis, 2007).

Challenges can also come from improperly designed programs, causing difficulty in attributing results to program inputs, inadequate response rates, and inappropriate timing of data collection. Further, funding can affect several aspects of evaluating leadership development programs including the scope, timing and data collection methods (Lemay & Ellis, 2007). Research suggests, however, that amidst all these challenges, the development and implementation of leadership development programs remain an important and recognized reality (Doo, 2005).

CEOs and other leading executives are becoming more convinced that leadership development is a worthy investment; therefore, investing dollars in the development of their human capital appears to be an important goal (ASTD, 2009, 2010). A 2009 study conducted by The American Society for Training and Development (ASTD), reported that organizations across the United States spent \$125.88 billion on developmental programs (ASTD, 2010). Although this seems promising for the future of leadership development, Csoka (1997) reported that 90% of senior managers stated leadership as a critical component of their company's growth but only 8%

described their company as having excellent leadership. This bears the question of whether money spent on leadership development is well spent or a poor investment?

This gap in leadership development is not a surprise. Only 10.4% of training content has been focused on leadership development of management and supervisory roles, and only 4.4% has focused on executive development (ASTD, 2010). Therefore, considering the potential influence and diffusion effect of developed leaders, it would seem that organizational leaders would invest more than 15% to improve the leadership ability of top management to increase organizational productivity. This suggests the present and future need for innovative ways to enhance the practice of leadership development within organizations as well as the importance of continuing to close the leadership development gap.

One problem with closing the leadership development gap, however, is the difficulty in translating the value of leadership development into common business jargon and financial analysis. For example, financial terminology such as return on investment (ROI) is common for those charged with leading organizations to higher levels of productivity and making important financial decisions. Unfortunately, due to a lack of research demonstrating the ROI of leadership development interventions, many organizational leaders have limited ability to link their financial knowledge to the impact of leadership development.

Those who are already investing in their human capital are often uncertain of the ROI of their leadership development intervention. As a matter of fact, effectiveness of leadership development interventions is rarely evaluated appropriately with regard to performance outcomes (Avolio et al., 2010; Avolio, Sosik, Jung, & Berson, 2003). In a recent study conducted by the ASTD, only 17.9% of organizations actually measured ROI (ASTD 2010). Other researchers report only 24% of evaluators use ROI as a method of evaluation, with as many as

66% stating they rarely or never use ROI as a means to evaluation program success (ASTD, 2009; Saslow, 2006). This lack of ROI focus has likely inhibited organizational leader potential by not adequately investing in the development of their human capital; and, it is likely due to the fact that they do not understand how leadership development can provide sufficient value and return on their investment (ASTD, 2009; Avolio et al., 2010; Avolio et al., 2009; Saslow, 2006).

Evidence of this confusion was stated by Hernez-Broome and Hughes (2004) whereas they stated, “Historically, most organizations have not closed the loop through systematic evaluation and this made assumptions about its efficacy based on anecdotes, reaction, or hunches” (p. 8). Thus, the lack of understanding ROI can lead to inadequate focus on the monetary value in leadership development, including the temptation to make assumptions based on subjective evaluation criteria. Therefore, increasing pressure is being placed on both organizational leaders and leadership practitioners to demonstrate a ROI of leadership intervention (Hernez-Broome & Hughes, 2004; Kincaid & Gordick, 2003; Strang & Soule, 1998). Providing a clear, financially based method of valuating leadership development using ROI methodology could be a real-world solution to increase corporate interests in leadership development intervention, and it could also advance corporate recognition of its true financial value.

Return on investment (ROI) has been used as an evaluation method to estimate the financial impact of program interventions, and is a derivation of utility analysis that has been extensively researched for over 70 years (Brogden, 1946; 1949; Brogden & Taylor, 1950; Cascio, 1982; 1991; Cascio & Boudreau, 2011; Cronbach & Gleser, 1965; Hunter, Schmidt, & Judiesch, 1990; Schmidt & Hunter, 1983; Schmidt, Hunter, McKenzie, & Muldrow, 1979). Utility analysis provides a quantitative means to measure the monetary benefits of an

intervention based on productivity improvements of an organization's employees. Thus, utility analysis is valuable for organizational leaders to assess the financial impact of an intervention (Bernstein, 1966; Cascio & Boudreau, 2011). Until recently, little research has been conducted estimating the financial return on investment (ROI) of leadership development intervention and the value to organizational productivity and an organization's bottom line (Avolio et al., 2010; Avolio et al., 2009; Cascio & Boudreau, 2011; Collins & Holton, 2004).

This leaves two questions for further consideration. First, if organizational leaders better understood the ROI of leadership development interventions, would this place a greater value on leadership development thereby increasing investment in the development of some of their most influential and effective employees? Second, could spending more money training top leaders reduce overall training expenditures by leveraging the investment placed in these developed top leaders who then diffuse their training to lower leadership levels?

Several studies have been conducted to help provide answers to these questions and determine the effects and value of development interventions. In a review of leadership literature from 1998 to 2008, over 32 meta-analyses were identified evaluating leadership theories including effectiveness and impact on leadership outcomes. However, although these meta-analyses provide positive evidence of leadership styles and impact on leadership interventions, they lacked a comprehensive (multi-theory) approach to evaluating the impact of leadership development. Each meta-analyses examined only one theory of leadership and had limited independent and dependent variables or outcomes (Avolio et al., 2009).

From a more comprehensive approach, Burke and Day (1986) conducted the first meta-analysis, which studied the impact of managerial intervention training from multiple leadership theories and development interventions. Their research reviewed 70 studies spanning from 1952

to 1980 and reported moderately positive effects. Expanding on Burke and Day's (1986) study, Collins and Holton (2004) conducted a meta-analysis of 83 studies spanning 1982 to 2001. Their study comprehensively reviewed more modern forms of leadership development intervention and replicated earlier findings of positive effects from managerial training found in Burke and Day's (1986) meta-analysis. However, Collins and Holton (2004) expressed concern that more clarity was needed to validate the impact of training on organizational performance outcomes. They stated that little research existed determining which theories among the many researched produced the most positive effects (Avolio et al., 2009; Collins & Holton, 2004).

In an effort to address some of these concerns as well as provide an even more comprehensive meta-analysis, Avolio and colleagues (2009) further expanded research on the impact of leadership development outcomes. Their meta-analysis covered both periods of the previous two meta-analyses. They identified over 500 leadership development intervention studies spanning post World War I to 2008, leading to a quantitative review comparing traditional leadership theories with newer theories, including analysis of intervention effects. These studies were consolidated into 200 usable experimental and quasi-experimental studies to determine average effect sizes. Then, using effect size results in a separate section of their study, they made the first attempt in leadership research to use effect sizes and other data to estimate ROI.

The Avolio et al. (2009) study provided a valuable foundation toward further understanding ROI of human capital intervention and its theoretical underpinnings. Further, building on this first known ROI estimation (Avolio, et al., 2009), Avolio and colleagues (2010) expanded this research to provide the first dedicated study to estimate the ROI from leadership development intervention. They termed this ROI approach the *return on development*

intervention (RODI), which estimated a dollar value associated with making leadership development investments in human capital. In particular, Avolio and colleagues (2010) focused on the leadership development of upper- and mid-level leaders, their effects on upper- and mid-level followers, and estimated RODI using a popular and well-researched utility analysis formula (Casico & Boudreau, 2011) based on original work by Schmidt, Hunter, and Pearlman (1982). This equation, which is called the RODI equation in the current study, is illustrated using the following variables (Avolio et al., 2010; p. 635):

$$RODI = (N)(T)(d)(SDy) - C$$

Where:

N = the number of participants in development intervention.

T = the expected time duration of change in leadership behaviors (converted to fraction in years such that a year and 6 months would be 1.5).

d = the effect size of intervention, also considered as the average difference in outcomes between trained participants and untrained counterparts.

SDy = the value of one standard deviation of performance or 40% of an individual's salary

C = the total cost of training the expected number of participants.

Using the RODI equation, the Avolio et al. (2010) RODI study demonstrated substantial returns from investing in the development of upper- and mid-level leaders. Their research was important because it provided a clear financial RODI through use of a popular utility method used to study value in the world of finance (Avolio et al., 2010). However, although this research provided a strong theoretical basis for determining the RODI of leadership development

intervention in particular, it had a limited scope due to the assumptions, limitations and estimation ability, including the ability to measure returns on leadership diffusion (ROLD).

Limitations to Previous RODI Methodology

One limitation of the RODI methodology was that although average effect sizes were statistically calculated using a meta-analysis of a plethora of studies, the Avolio et al. (2010) RODI study did not use a random distribution of effect sizes. This limited the statistical validity of the study. For example, only three points of measure were used to estimate RODI for each leader level. The same three high, average, and low effect sizes were used for upper- and mid-level leaders, and the same three high, average, and low effect sizes were used for upper- and mid-level followers.

The second limitation of the Avolio et al. (2010) RODI study was the duration of the leadership development intervention effect, called intervention effect duration in this study. Avolio et al., (2010) suggested “it is plausible that leadership performance may decrease after the close of the intervention (training) as the participant begins to struggle to apply new skills and knowledge learned in the intervention” (p. 639). Thus, the intervention effect duration they used to estimate RODI was assumed as a constant of two months (.167 years) (Avolio, et. al., 2009; Avolio, et. al., 2010). However, Avolio and colleagues (2010) admitted that their two-month assumption was a conservative intervention effect duration estimate stating, “a highly salient event could affect someone for years as opposed to months” (p. 639). Considering this statement, it is suggested that leadership development effects could last much longer – even years.

The third limitation in the Avolio et al. (2010) RODI study was in regard to assumptions made for the length of leadership development intervention (training). The Avolio et al. (2010) study was limited to only 1.5- and 3-day leadership development interventions, with a high,

average and low effect size assigned to 1.5 days of training intervention and double that effect size for 3 days. This posed two main problems. First, Avolio et al. (2010) assumed that upper- and mid-level leaders have the same length of intervention, which is highly unlikely as executive leaders often have a much more intensive leadership development intervention than mid- and low-level leaders (ASTD, 2010). Second, although 1.5 and 3-day intervention lengths were reasonable for their study, to better estimate RODI it is necessary to generate some type of distribution to provide a more accurate assessment. The current study uses a more empirical method to determine the intervention length as well as a means to generate random distributions using more representative data to adequately and statistically support a range of leadership development intervention length.

The fourth limitation refers to the source and method of salary data, which Avolio and colleagues (2009; 2010) used to estimate RODI. They used interviews to gather salary data and make salary assumptions for upper- and mid-level leaders, and mid-level followers. Specifically, they assigned a \$100K salary for upper-level leaders, \$75K for mid-level leaders, and \$50K for mid-level followers. However, because salary assumptions provide a significant multiplier in the RODI equation, salary data is an important variable and must be as accurate as possible considering that it multiplied across several variables.

Inaccurate salary data could also affect other variables in the RODI equation such as cost of training (C), since a C includes salary as a factor. This leads to a fifth limitation, which is an assumption used in the Avolio et al. (2010) study that training costs were the same for all leaders levels. Thus, a more representative data sample of salary and costs data could very likely provide a more accurate estimation of C ; and thus, a more accurate estimate of RODI.

A sixth limitation of the Avolio et al. (2010) RODI methodology is that the estimation of the diffusion effect of leadership, or cascading leadership effect, on RODI was limited and not representative. However, the researchers are praised for their pioneering efforts and did recognize that leadership development is multi-level, involves more than one person, and can be diffused to others (Avolio et al., 2010; Berson & Avolio, 2004).

In the Avolio, et al., 2010 study, RODI was calculated for upper-level leaders and those directly below them (upper-level followers) as well as RODI for mid-level leaders and those directly below them (mid-level followers). However, there were two main problems. Although their efforts were pioneering and a great advancement in the diffusion of leadership, they studied only one level of diffusion: from upper-level to mid or from mid-level to lower. They assumed that all upper-level followers would participate in this diffusion effect on the same level within one year. This could have grossly overestimated RODI and the return on leadership diffusion (ROLD). Further, there were no costs associated with diffusion since all of the effect sizes used were positive. This could also overestimate RODI and ROLD and assumes no cost associated with diffusion of leadership. The current study suggests the contrary.

A final limitation is the assumption of doubling the effect size for double the training. The Avolio et al. (2010) study assumed that 1.5 days of intervention (training) was equal to the effect size. Further, it was assumed double the length of intervention was double the effect size; thus, three days of intervention equaled two times the effect size. Avolio and colleagues (2010) did, however, state that this assumption could have a different effect than just linear in that it could also be a “curvilinear negative, curvilinear positive, triadic, quadratic or an exponential calculation” (p. 636). Yet, this assumption poses several methodological problems.

First, the behavioral objectives associated with developing a leader are assumed to be covered in 1.5 days, or 3-days, which is reasonably impossible. Second, this RODI analysis assumed that the effect size itself should vary in direct proportion with the intervention effect duration. However, the current study suggests that effect sizes should not be varied; they should be randomly assigned via generated distributions. Effect sizes from the meta-analysis demonstrated the measure of the change in performance from control groups compared to experimental groups. Therefore, in a more technical sense, the difference that is actually being measured is the percentage of behavioral objectives met from the intervention relevant to individual performance. Therefore, this means that the effect size would not necessarily vary by length of the intervention but rather, the percentage of behavioral objectives met within the intervention would vary by length of the intervention and in turn, could affect effect size.

For example, if an intervention covers one-fifth ($1/5$) of appropriate behavioral objectives, then in theory, the effect size should be one-fifth its value. However, doubling an intervention time would not necessarily mean the effect size would double. The result could actually be opposite. Although this example is an oversimplification, meeting 100% of the behavioral objectives would, in essence, result in the full effect size. Thus, to double the effect size would require a 200% Further, it would depend on the behavioral objectives included and whether they are simply new leader development objectives, a repetition of previous development objectives, or the objectives could have little to do with leadership development. The current study suggests an alternative to account for variations, the addition of a new variable, P , is the percentage of behavioral objectives within a leadership development intervention that are relevant to a person's performance. This equation is illustrated using the following variables:

$$RODI = (N)(T)(d)(SDy)(P) - C$$

Where:

P is the percentage of behavioral objectives within a leadership development intervention that are relevant to a person's performance.

Amidst these limitations, Avolio and colleagues' (2010) approach is understandable given the limited ability to calculate RODI without the use of other statistical means, such as computer simulation modeling. To further relax these assumptions, stochastically model the data, and expand previous research (Avolio et al., 2010), this study will provide a discrete-event computer simulation model in an attempt to reduce previous study limitations and provide a better means to estimate or predict RODI. Using this type of computer simulation modeling may also provide the ability to break new ground by estimating the RODI of the diffusion of leadership from one level to the next using logistic differential theory, which the author of this study calls the return on leadership diffusion (ROLD).

Limited Study of Leadership Diffusion Effects on RODI

Although little research has been conducted on the returns on leadership development intervention from the cascading or diffusion effect of leadership, the idea is not a new concept. Over the course of several decades, one of the most well-researched, and well-documented, theories demonstrating the process of diffusion in social systems is through the study of how opinion leaders and change agents impact the diffusion of innovations throughout a society (Rogers, 2003). Everett Rogers, a leader in diffusion and innovation research, officially termed the theory "Diffusion of Innovations" and defined diffusion as a planned or spontaneous process whereas "an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5). He further described diffusion as a two-way process of exchanging information that can involve continuous cycles of communicating messages leading

to a type of social change where “new ideas are invented, diffused, and adopted or rejected, [which] lead to certain consequences” (Rogers, 2003, p. 6).

This diffusion effect is well supported in leadership literature and research. For example, follower or subordinate behaviors were found to be similar to, and dependent upon, those behaviors exhibited by those at higher organizational levels across various industries (Bass, Waldman, Avolio, & Bebb, 1987; Bowers & Seashore, 1966; Misumi, 1985; Ouchi & Maguire, 1975; Stogdill, 1955). Mayer, Kuenzi, Greenbaum, Bardes, and Salvador (2009) reported “a positive relationship between top management and supervisory ethical leadership” (pg. 9) and stated that their results were “consistent with extant theory and research that top management leadership cascades down to employees” (Bass et al., 1987, p. 11; Bass, 1990).

Furthermore, social systems and social or diffusion networks are key to diffusion and play a key role in leadership diffusion (Hannah, Avolio, Luthans, & Harms, 2008; Rogers, 2003). Upper-level leaders and management teams have been shown to diffuse leadership among direct and indirect followers through social network pathways and shape subsequent follower behavior (Hannah et al., 2008; J. Jansen, D. Vera, & M. Crossan, 2009). This social aspect of the Diffusion of Innovations theory involves an adoption process where adopters, encouraged by change agents or opinion leaders, are categorized into one of five categories based on their rate of adoption: (1) innovator, (2) early adopter, (3) majority adopter, (4) late adopter, and (5) laggard (Rogers, 2003).

This adoption process has many parallels to that of the diffusion of leadership and the social and human factors involved. Internationally, when plotting the frequency of adopters within the adoption process, this generates a normal, bell-shaped curve. However, plotting the cumulative frequency, an S-shaped curve is generated (Rogers, 2003). Thus, the adoption

process demonstrates that the rate of adoption begins relatively slowly and then speeds up until most all have adopted. Once most all have adopted the innovation, the rate begins to slow and level off as it gets closer to carrying capacity. Interestingly, distributions generated from adopters of innovations within organizations also demonstrate a similar S-shaped curve (Rogers, 2003).

S-shaped curves are based on an exponential growth relationship, which is considered one of the fundamental modes observed in the behavior of a system (Rogers, 2003; Sterman, 2000). Exponential growth has compounding properties such as found in population growths and compound interest. Therefore, a minimum but consistent investment in an exponential environment can reap significantly high returns on investment over time and can be demonstrated using numerous exponential formulas, depending on the nature of the system studied. It is suggested in the current study that leadership has this exponential relationship as has been demonstrated in the Diffusion of Innovations theory.

Using mathematical equations in conjunction with computer simulation modeling facilitates this diffusion process. It provides a means to simulate S-shaped growth using random inputs, thus allowing the ability to simulate a potentially exponential relationship with regard to leadership diffusion. Because organizations have a finite number of employees, it can be argued that an organizational system has a type of carrying capacity, which is a characteristic of S-shaped curves and Diffusion of Innovations. This means that the size of an organization's population (the current carrying capacity) is limited, and as the number of leaders participating in the diffusion process increases the diffusion rate slows and could eventually come to a halt – at least until a new intervention is introduced into the system and the diffusion process begins again (Rogers, 2003; Sterman 2000).

There are several different mathematical equations that could be used to calculate this exponential effect (Rogers, 2003), which can be incorporated into a discrete-event computer simulation model to estimate the RODI and return in leadership diffusion (ROLD). Pierre Francois Verhulst (1838; 1977) expanded the original Malthusian model, or simple growth model, through the development of the logistic growth model, where population growth depends on both the population size and its upper limit. As the population starts to grow, it goes through an exponential growth phase. However, once growth reaches about half of the carrying capacity, it begins to slow down and eventually level off. This creates a sigmoid (S) curve, whereas Verhulst's formula consists of the following:

$$N_{t+1} = rN_t \left(\frac{K - N_t}{K} \right)$$

Where:

N_{t+1} = population size at the next time period (e.g. the next hour, day, year, etc.),

r = Malthusian factor (the multiple that determines the growth rate),

t = time period (i.e. minutes, hours, weeks, months, years, etc.),

K = carrying capacity (the total number of the population to be affected), and

N_t = population size at time t .

Using the effect size distributions to determine the growth rate, this formula is proposed as the most appropriate to estimate the RODI. The model's simplicity and popularity, especially in population biology, has been useful for scientists and has become a foundation for research in many fields (Alimo-Metcalf, 1998; Brauer & Castillo-Chavez, 2000; Edelstein-Keshet & Ermentrout, 1998; Kingsland, 1982). The logistic growth model, in conjunction with computer simulation modeling, would allow the ability to determine an approximate number of lower-level individuals impacted from the diffusion of leadership from a higher level of leadership.

Furthermore, the computer simulation model would allow the variables of this logistic formula to be populated with distributions that are randomly entered as many as 10,000 times or more (Allen, 2011).

Addressing Computational Problems With Simulation

Computer simulation modeling dates back over 40 years and has become increasingly popular for understanding collective behavior in the social sciences, including economics and business (Forrester, 1999; Kelton, Sadwoski, & Swets, 2010; Kirman & Zimmerman, 2001; Robinson, 2005; Srbljinovic & Skunca, 2003; Sterman, 2000). It has been applied to various issues in top-management and has become useful in project planning and implementation, including systems analysis and design within social systems (Forrester, 1999; Kelton et al., 2010; Robinson, 2005).

Computer simulation modeling and modeling software has become more user-friendly, flexible and programmable, allowing it to be more usable to researchers and organizations in strategic and operational decision making (Kelton, et. al., 2010). Even more impressive, computer simulation modeling has been greatly expanded in its ability to be used as an experimental approach to understand and mimic system behavior through the use of various types of computer simulation modeling. Examples include discrete-event, agent-based, continuous and dynamic systems modeling (Forrester, 1999; Kelton, Sadowski, & Swets, 2010; Sterman, 2000).

One of the most popular modeling techniques is discrete-event simulation, which is used when systems have identifiable queues or activities, discrete points of change, and a random or stochastic nature (Robinson, 2005). Discrete-event simulation can also be used when distinct individuals are involved, probability distribution sampling is needed, and there are actual

occurring events (Brailsford & Hilton, 2001). With discrete-event simulation, models are generally less complex to design as opposed to agent-based or continuous models; and, they are used when the nature of data being modeled is discrete, which means that the data are fixed or well-defined (Morecraft & Robinson, 2004).

Discrete-event computer simulation modeling offers many advantages and could greatly expand previous RODI research methodology (Avolio et al., 2010). For example, the characteristics needed to successfully calculate RODI are demonstrated in the previous study. However, computer simulation modeling could increase the predictive capability of RODI by relaxing the assumptions of the discrete RODI variables used, thereby increasing generalizability of the variables and the entire study through randomization and simulation.

Computer simulation modeling could also provide the ability to generate random distributions of discrete RODI variables (e.g. effect size distribution, intervention effect, or any other necessary variables) for each RODI calculation independently. This distribution of RODI values would provide the ability to more accurately predict RODI, providing known minimum, average, maximum, standard deviation values, and all values in between, for the RODI calculation and estimation. Computer simulation could greatly reduce limitations caused by use of only arithmetical means to calculate RODI. For example, within its modeling capability, it can calculate multiple equations using random variables that lead to near endless replications (runs) of the RODI equations. Reducing limitations in the previous RODI study (Avolio et al., 2010) by using this computer simulation method could greatly enhance future RODI analysis of leadership development intervention.

To address the first limitation of the Avolio et al. (2010) study of only three effect sizes (*d*) per leader level (high, average and low), discrete-event computer simulation modeling would

allow a random selection of effect size from a generated distribution of effect size values for each RODI calculation simulated. The computer simulation would not only provide a means to compute a random distribution of the effect size means and standard deviations, but also randomly input these independent values into each RODI calculation over a specified number of independent replications (runs), such as 10,000 times. Therefore, this computer simulation method would provide a true randomization of the effect size distributions using the average effect sizes and standard deviations that were skillfully calculated based on over 50 years of leadership development intervention data (Avolio et al., 2009).

To address the second limitation in the Avolio et al. (2010) study, which was the use of a constant, 8-week intervention (training) effect duration (T), discrete-event computer simulation modeling would allow for a distribution of intervention effect duration values to be generated between zero (no intervention effect) and 1-year. These values then would be randomly selected and entered into the appropriate RODI equations.

The value of using the discrete-event computer simulation model would not only include the 2 months intervention effect duration as used in previous research (Avolio et al., 2010), but it would also include a stochastic distribution of interventions effect duration consisting of: (1) a leader who is trained and may quit immediately after the intervention (intervention effect = 0), (2) a leader who may struggle to apply the new skills developed (i.e. annual intervention effect = 8 weeks or .167), (3) a leader who may apply leadership year round (intervention effect = 1), and (4) all of those leaders whose intervention effects fall between 0 and 1-year of actual development intervention or training.

Generating a distribution of intervention effect duration appears to be the best method of estimating T since there is very little research on the lasting effects of leadership development except that learning does have a half life (Cascio & Boudreau, 2011).

To address the third limitation of Avolio et al.'s (2010) RODI study, regarding 1.5- and 3-day interventions only, the current study will investigate more representative data to review different intervention lengths per leader level commonly found across a variety of industries. The current study will consider different intervention lengths for different leader levels. Once more representative data is gathered, computer simulation will provide the opportunity to create distributions of the new data and randomly select values be used for the RODI equations.

Computer simulation modeling could also be used to provide a better salary estimate to address the fourth and fifth limitations of the Avolio et al (2010) study, which is the salary assumptions of upper- and mid-level leaders (called upper-level followers in the current study), and mid-level followers (called low-level leaders in the current study) based on interview data. More representative salary research used in combination with computer simulation modeling could increase the generalizability of salary data. It could also allow for a distribution of salary data to be generated and used as necessary for each leader level and RODI calculation. Therefore, computer simulation could relax salary assumptions of the previous study (Avolio et al., 2010) and provide a more accurate estimation of the economic value of an employee's change in performance (SD_y), which is determined by calculating 40% of the leader-level's average salary. This 40 Percent Rule is well documented in research literature and based on extensive meta-analyses (Cascio & Boudreau, 2011; Hunter & Schmidt, 1982).

This more accurate salary data could then be used to address the Cost (C) of intervention, which as suggested by both Cascio and Boudreau (2010) and Avolio et al. (2010). The data could also address direct training costs as well as time in participant salary and lost production time.

To address the sixth limitation of the Avolio et al. (2010) study, which was the limited ability to model the return on leader diffusion (ROLD) across multiple leader levels (Avolio et al., 2010), the current study will allow an added ROLD effect from leadership development intervention. Although Avolio and colleagues' (2010) RODI methodology was able to demonstrate the impact of the higher-level leaders diffusing to those at a level lower, they were only able to assume one level of diffusion. They also used the maximum number of leaders expected from the effects of diffusion rather than a partial number, which would require a modification of their RODI methodology. Computer simulation modeling allows the generation of multiple random distributions, and then the ability to input these variables independently into an RODI equation. In addition, including logistical growth model formulation allows modeling of leadership diffusion through multiple lower-levels of leadership, providing a partial diffusion effect that grows based on exponential growth theory.

To address the seventh limitation of the Avolio et al. (2010) study, the doubling of effect size for double training, the current study will include a fifth variable (P) to account for the percentage of behavioral objectives met within the intervention relevant to performance outcomes (Cascio & Boudreau, 2011; E. F. I. Holton, 2011). This adjustment, as proposed by Holton (2011), would allow the effect size to remain constant with a variation by the percentage of behavioral objectives addressed in the intervention. Computer simulation modeling would allow the generation of a normal distribution of P values to be randomly selected and multiplied

by other RODI variables. This would account for a random percentage of behavioral objectives met by the training intervention to vary from 0 to 100% relevancy to a person's performance.

For example, in an ASTD (2009) research study sponsored by Booz, Allen and Hamilton that studied executive development programs and practices, the average program length was reported as 45 hours (5.625 days). It is more reasonable to assume that the average length of executive development programs (5.625 days) would likely meet about 50% of the training objectives needed to effectively develop a leader. This 50% would be comparable to an average effect size of leadership interventions, which in the case of Avolio et al.'s (2010) study, the average effect size of an upper-level leader was $d = .51$. Therefore, regarding Avolio et al.'s (2010) study, it is highly unlikely that 100% of leadership development competences would be taught in 1.5 days. Computer simulation modeling would provide the ability to randomly select from a distribution of P values to be entered into the RODI equation.

Two other advantages of using discrete-event computer simulation modeling is the ability to provide sensitivity analysis to the data variables as well as reduce the need for competing human and physical resources. Once a computer simulation model is designed, the researcher can easily change or adjust variables enabling the creation of multiple scenarios leading to faster, more accurate, and more prudent decisions. Further, there are limited human resource needs using this RODI methodology as opposed to both substantial time and personnel needed to design, implement and analyze study after study.

Discrete-event computer simulation modeling can be an effective tool that assists organizational leaders in many ways when determining whether investing in leadership development intervention is a worthy investment. The Avolio, et al. (2010) study has provided a great foundation for estimating a monetary and percentage value of RODI and is an excellent

contribution to the advancement of leadership development research. Furthermore, it has provided a strong theoretical basis for adding to the scarce research and resolves problems surrounding the estimation of ROI regarding leadership development intervention.

Although this research is valuable in enriching our understanding of leadership development intervention and its value, it has limited scope due to the assumptions, limitations and ability to estimate RODI. For example, the Avolio et.al. (2010) study lacks the ability to measure any returns on leadership diffusion. Avolio and colleagues (2010) were unable to use random distributions of variables to calculate RODI. Only three effect size values for each leader level were used, including the average effect size. Their study also assumed a single (2 month) intervention effect duration for all leader levels and only two leadership development intervention (training) lengths (1.5 and 3-day), doubling the effect size for double the intervention length. Salary data and its statistical representation were limited, which affected training cost estimation. These assumptions likely skewed their estimation of the economic value of an employee's change in performance, which was a necessary variable used in the calculation of RODI (Cascio & Boudreau, 2011; Hunter & Schmidt, 1982). It was assumed that 1.5- and 3-day interventions contained behavioral objectives that were 100% relevant to participant performance. The main limitations of the Avolio et al. (2010) study were the inability to replicate more than one study at a time, provide sensitivity analyses of variables, and generate distributions of variables to create a statistically representative pool of data to estimate RODI from leadership development intervention

Combining meta-analytic data spanning over 200 experimental and quasi-experimental studies conducted over 55 years (Avolio et. al., 2009) and other current research data with RODI methodology and computer simulation, the current study proposes a groundbreaking computer

technology using real world research to solve real world problems. To address the limitations in the previous research (Avolio, 2010), this study proposes the use of a discrete-event computer simulation model, grounded in utility theory. This method provides the ability to relax assumptions of the effects of leadership development intervention using multiple, randomized variable distributions of meta-analytic data and other variable data. It also provides the ability to replicate the effects of leadership development intervention a nearly unlimited number of times thereby providing a replication of thousands of studies. The result will provide a practical, more statistically accurate estimation of the RODI and the ROLD, which were not possible in the previous study nor has been found in existing research.

The current study will expand on previous RODI research (Avolio et al., 2010) by providing a tool for organizational leaders to make more prudent financial decisions; it will also help stakeholders recognize the value of investing in the leadership development of their employees. The power of computer simulation modeling is the ability to simulate over 10,000 or more studies to create a distribution of the RODI enabling organizational leaders to predict the financial impact of investing – or not – in leadership development intervention. It will also help organizational leaders avoid overlooking the impact of the return on leadership diffusion (ROLD) throughout their own organizations and cross-organizations.

The current study will benefit the greater good of society by advancing current leadership research in ways that provide future economic benefits. It will advance research by demonstrating the economic benefits directly associated with the financial impact of investing in, and developing, human capital. The result will be a potentially exponential nature of the diffusion of this developed human capital. Further, it will demonstrate that leadership

development is multi-level, involving multiple people and is “typically diffused and cascaded to others” (Avolio et al., 2010, p. 636; Berson & Avolio, 2004).

Statement of the Problem

Previous research is sparse regarding the link between return on investment and human capital, in particular the effects of leadership development as providing a sufficient return on development investment (RODI). No studies have been found that use current meta-analytic research combined with discrete-event computer simulation modeling to estimate the RODI of leadership development intervention and the return on leadership diffusion (ROLD).

Purpose of the Study

The current study is intended to assist researchers and organizational leaders better understand and estimate the value of investing in leadership development intervention. Expanding on research conducted by Avolio et al. (2010), the use of discrete-event computer simulation modeling will allow an improved method of estimating RODI using standard utility analysis in conjunction with computer simulation modeling. Discrete-event computer simulation modeling will provide a means to estimate the return on leadership diffusion (ROLD), or the diffusion effect of leadership that is diffused from higher levels to lower levels of leadership. This type of simulation study has not been found in previous research.

Nature of the Study

The current study applies the process of discrete-event computer simulation modeling in combination with meta-analytic data from over 200 experimental and quasi-experimental studies (Avolio et al., 2009), spanning World War I to 2008. Using this meta-analytic data, RODI methodology and computer simulation modeling, the current study estimates the financial return of development investment (RODI), and return on leadership diffusion (ROLD), after investing

in the development of organizational leaders. Further, the study relaxes assumptions of the previous RODI study (Avolio et al., 2010) by creating random distributions of variables for data to be drawn as inputs to RODI equations, thereby enabling the ability to simulate a real world situation rather than a snapshot of the RODI (Avolio, et al., 2010).

Chapter 1 detailed the success of leadership development interventions among organizational leaders but also the problems surrounding corporate and executive level ability to determine RODI in organizations throughout the United States. It also addressed limitations of previous RODI methods and presented potential solutions to create a more accurate estimate of RODI.

The literature review in Chapter 2 provides an historical background with regard to leadership development and evaluation approaches including the most effective evaluation methods to estimate the financial impact of leadership development intervention. Several meta-analyses were discussed including their comprehensive ability to create an empirical measure of the effects of leadership development intervention. A review of computer simulation modeling was discussed as well as the diffusion, or cascading effect, and how the Diffusion of Innovations theory parallels aspects of leadership diffusion in many ways. Chapter 2 provides the conceptual basis for expanding on the previous RODI study conducted by Avolio et al. (2010) by using discrete-event computer simulation modeling to more accurately estimate the RODI of leadership development intervention of organizational leaders.

Chapter 3 provides the methodology employed in conducting computer simulation methodology, Chapter 4 provides results of the study, and Chapter 5 provides a conclusion to the study and future recommendations, which are expected to provide a basis for further investigation into how leadership development outcomes play a critical role in return on

development investment (RODI). Knowledge gained may encourage leadership development training and help further understanding of the diffusion effects from developing upper-level leaders.

Objectives

The objectives of this study include answering the following research questions related to discrete-event computer simulation modeling of return on development investment (RODI) and return on leadership diffusion (ROLD) for high-, middle-, and low-level leaders, compared to using an arithmetic calculation with constant, non-random variables as proposed in Avolio, et al (2010) study:

1. Can the Avolio et al. (2010) RODI analysis be replicated using discrete-event computer simulation modeling by programming variables: number of participants (N), effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) into the RODI equation?
2. Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax assumptions of variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) than estimated in the Avolio et al. (2010) RODI analysis?
3. Which method of discrete-event computer simulation modeling will allow relaxed variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) to better estimate the return on development investment (RODI): (a) Developing only upper-level leaders and diffusing to mid- and lower-level leaders? (b) Developing upper- and mid-level leaders and diffusing only to lower-level leaders? or, (c) Developing all three levels; upper-, mid- and lower-level leaders?

4. Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax a fifth variable, percentage of behavioral objectives met (P), as suggested by Holton (2011) and Cascio and Boudreau (2011), in addition to relaxing variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) and incorporating the effects of leadership diffusion?

Summary

Estimating return on investment (ROI) for leadership development of leaders within organizations is nearly absent from previous research, even though organizations continue to see some value in the development and training of their human assets (ASTD, 2010; 2009). Over 60 years of research on leadership development interventions and outcomes provided a great foundation for estimating the value of leadership development intervention and its ROI.

Several researchers have been building a foundation for future research in studying the effects of leadership development interventions as well as using this research to estimate RODI (Avolio et al., 2009; Avolio et al., 2010; Burke & Day, 1986; Collins & Holton, 2004). In particular, Burke & Day (1986) provide a meta-analysis of leadership development outcomes that spanned 1952 to 1980. Collins and Holton (2004) expanded their research by reviewing leadership development outcomes beginning where they left off (1980) to 2000, looking specifically at more modern forms of leadership development intervention. Avolio and colleagues (2009) further expanded this research in their recent meta-analysis, which covered both periods of the previous two studies spanning studies conducted from early World War I to 2008. This meta-analysis included over 500 studies and was reduced to 200 experimental and quasi-experimental studies, which was necessary to derive the quantitative data in order to make it possible to calculate the return on leadership development investment (RODI).

Avolio and colleagues (2010) used the this foundational meta-analytic research to provide the first independent study to estimate the RODI, which estimated a dollar value associated with making leadership development investments in human capital. While their research is valuable to the advancement of linking leadership development intervention to a clear financial ROI, there were limitations to their study. Therefore, the current study attempts to expand on Avolio, and colleagues (2010) research by providing a discrete-event computer simulation model that reduces the previous study limitations and provides a means to better predict RODI. Further, this study breaks new ground by estimating the return on investment of the cascading effect of leadership, which the author calls the return on leadership diffusion (ROLD).

CHAPTER 2: REVIEW OF THE LITERATURE

Organizational leadership does not occur by default. Although some leaders may have certain innate predispositions to lead more effectively than others, leaders are made, not born. Thus, it is imperative that organizations establish organized efforts to develop leadership capacity through leadership training and development programs to maximize human capital. Fortunately, the implementation and popularity of leadership development programs have increased over the years. This is evident in that United States corporations have invested considerable amounts of time and money into employee training and leadership development programs to enhance workplace efficiency and increase productivity and profitability. The American Society for Training and Development's (2010) *2010 State of the Industry Report* reported \$125.88 billion spent on employee learning and development across U. S. organizations in 2009. Although a decrease of 6.1% from the previous year, this is considered quite stable despite the poor economic conditions. This is especially relevant considering the decrease occurred mostly due to direct learning expenditures such as payroll, staff salaries, administrative costs, and other non-staff costs (ASTD, 2010).

Billions of dollars spent in human capital investments suggest leadership development training is a worthy investment. Research literature also recognizes the worthiness of leadership development. Previous research has demonstrated that there are significant benefits from increasing leadership outcomes such as values, expectations, motivation, attitude, attributes, innovation, knowledge, skills, abilities, understanding, self-awareness, sociability, effectiveness and high achievement of duties and commitment (Alimo-Metcalf, 1998; Huber, 2004). However, although human capital investment is worthy, actually determining the best return on investment (ROI) is difficult. In reference to the ASTD (2010) study, not knowing in which

group to invest (e.g. executives, managerial and supervisory, sales or customer service, etc.) or what will provide the highest ROI, can be troubling. Misguided investments can be costly or no investments at all can amplify opportunity costs.

For example, in the *2010 State of the Industry Report* (ASTD, 2010), managerial and supervisory staff was ranked as the group having the second largest content focus of training and development content. However, companies were only comfortable with providing 10.4% of training and development toward this group. Although there was a marked increase from the previous year, only 4.4% of the formal training and development content was geared toward executives. The combined focus of training and development content for executive, supervisory and management positions (which consists of upper-, mid-, and lower-level organizational leaders), accounted for only 15% of the total training and development content (ASTD, 2010).

At least management groups are receiving developmental attention. However, minimal training and development for organizational leaders is concerning because knowing where, or with whom, to invest in the development of human capital within organizations is an important factor that could affect the overall bottom line. ROI research from financial literature can be valuable in identifying the dollar value of human capital investment.

Much research has been conducted regarding methods of evaluating leadership development interventions, which is paramount to understanding the value of leadership interventions and outcomes. However, little research has been conducted in quantifying its value in the form of ROI. Fortunately, several meta-analyses spanning over 80 years of leadership development intervention studies provide a great foundation to estimate the return on investing in leadership development (Avolio et al., 2009; Avolio et al., 2010; Burke & Day, 1986; Collins & Holton, 2001). In particular, two most recent studies conducted by Avolio et al. (2009) and

Avolio et al. (2010) have specifically used standard utility analysis to quantify return on investing in leadership development interventions, which they called return on development investment (RODI).

Expanding upon this research (Avolio et al., 2010; Avolio et al., 2009), this literature review attempts to accomplish several objectives. First, it attempts to discuss leadership development outcomes and different methods of evaluation to provide a case for estimating RODI of leadership development intervention. Second, it describes computer simulation modeling and how this method could be useful in more accurately predicting ROI of leadership development intervention. Third, this literature review introduces a new concept of leadership diffusion. Breaking new ground, it argues that the benefits of using computer simulation modeling, in conjunction with RODI methodology, are paramount to accurately estimating the financial impact of the leadership diffusion effect, or cascading effect, of leadership development. The current study calls this diffusion of leadership, which is diffused through an organization from leadership development intervention, the return on leadership diffusion (ROLD).

Some Common Leadership Development Evaluation Approaches

Considerable emphasis has been placed on evaluating leadership development programs and how effectively they attain planned outcomes or impacts (Hannum, Martineau, & Reinelt, 2007). Hannum et al. (2007) further clarified this emphasis by demonstrating the following reasons for leadership development programs:

1. Demonstrate benefits from program experiences;
2. Fine-tune leadership development interventions to better meet its goals;
3. Expose links between leadership development experiences and organizational vision;

4. Promote learning-centered reflection; and,
5. Encourage comprehensive discussions about what works and why (p. 8).

Effectively evaluating leadership development programs is likely to produce greater clarity of whether the performance outcomes measured are appropriately linked to the goals of the organization. Numerous studies have demonstrated the impact of leadership development by evaluating outcomes and change occurrence (Meehan & Reinelt, 2007). These outcomes are defined in the context of “both intermediate outcomes (work climate) and longer-term outcomes (expected changes in organizational results defined by participating teams)” that should be based on behavior (Lemay & Ellis, 2007, p. 236). The W. K. Kellogg Foundation (2002) define outcomes more specifically as “the specific changes in program participants’ behavior, knowledge, skills, status and level of functioning” (pg. 2). They can be short-term (1-3 years) or long-term (4-6 years) whereas their impact should result 7-10 years after the intervention (Kellogg Foundation, 2002).

Outcomes have also been distinguished from outputs in that outcomes focus on actual behavior rather than application (Lemay & Ellis, 2007). As these outcomes manifest throughout the leadership development process, behaviors stemming from these outcomes should be primed for change, aligned with business needs, and link initial needs assessment with evaluation to meet overall organizational goals (Lemay & Ellis, 2007; Peters & Baum, 2007; Phillips & Phillips, 2007). Therefore, determining appropriate leadership development evaluation methods to identify necessary outcomes to resolve a problem, or support an opportunity, is important.

Several foundational approaches can be used to evaluate leadership development outcomes and assess intervention effects (Kellogg Foundation, 2002). W. K. Kellogg Foundation (2002) conducted a scan of 55 leadership development programs to identify common approaches

used to identify, document and evaluate leadership development outcomes. They discovered five common approaches: qualitative, theory of change, mixed methods, participatory, and experimental. Other approaches to evaluating leadership development outcomes that have been useful when evaluating financial impact of program intervention are ROI approaches (Hannum et al., 2007). A brief synopsis of these approaches will be discussed and will be useful in identifying the most adequate approach for evaluating return on leadership development investment (RODI).

Qualitative Evaluation Approaches

Qualitative evaluations and case studies are means of evaluating leadership development outcomes that are used to understand and describe program evaluation rather than produce quantitative results (Fitzpatrick, Sanders, & Worthen, 2004; Russon & Reinelt, 2004). Although these types of evaluation can lack a quantitative or measurable approach, they can be very beneficial to research such as providing focus for evaluative purposes. For example, W. K. Kellogg Foundation's (2002) qualitative scan of 55 change-oriented leadership programs found five key areas of focus from a review of evaluations (p. 6):

1. Increased demand for and focus on evaluating outcomes and impact.
2. Systematically linking program activities and intended outcomes and impact.
3. Aligning outcomes with program activities.
4. Focusing on short-term outcomes.
5. Barriers to conducting impact evaluations.

Another beneficial qualitative study was conducted by Lingham, Richley, and Rezanian (2006). Their research assisted the development and evaluation of training and leadership development programs. The study suggested a four-phase approach to design and evaluate

training programs: (1) initial design; (2) implementation and evaluation; (3) use of feedback to design quantitative measures; and (4) continuous training and evaluation. Qualitative evaluation approaches such as these and others offer valuable information and help advance research.

However, these approaches are not necessarily the best fit for use in estimating RODI simply because they do not provide an empirical means to measure quantitative effects of leadership development intervention.

Theory of Change and Logic Model Evaluation Approaches

The theory of change approach to evaluation was defined by Carl Weiss (1995) with the intention to design a system that would allow program developers to explain process changes by studying different premises, assumptions and hypotheses (Gutiérrez & Tasse, 2007). Often used for evaluating comprehensive community initiatives, the theory of change approach allows evaluators to seek multiple-level outcomes, describe how and why the program works, and even use this information within a logic model framework – all of which leads to individual, organizational and community change (Gutiérrez & Tasse, 2007). This approach uses a process called pathway mapping, which engages stakeholders to provide explicit program assumptions and specify desired outcomes and strategies.

Leadership development programs are often found to have a lack of change focus or theory of change (Russon & Reinelt, 2004). Gutiérrez & Tasse (2007) have suggested that theory of change approach is beneficial to: (1) help clarify a program's view of leadership through articulation of assumptions and premises, (2) assist in tracking and understanding the individual change process, (3) help determine individual change occurrence, to what extent, whether it will lead to broader outcomes, and (4) help determine which program components are contributing to change and affecting outcomes, and to what extent.

Theory of change models are often confused with logic models, and at times the terms are used synonymously, even to the point of describing theory of change as a type of logic model (Gutiérrez & Tasse, 2007; Hannum et al., 2007; Kellogg Foundation, 2002). Yet, although logic models and theory of change models have many similarities and may often be used interchangeably, they are not necessarily the same (Gutiérrez & Tasse, 2007). Some researchers say calling these two models the same depends on the design (Hannum et al., 2007).

Logic models are sequential models that are useful in describing the program being evaluated, what that particular program can do, and the link between investments and results. Typically, they focus on four main components: (1) inputs, (2) activities, (3) outputs, and (4) outcomes, and can be used in communication, evaluations, planning, implementations (Hannum et al., 2007), and continuous learning (Gutiérrez & Tasse, 2007; Kellogg Foundation, 2002; Leiderman, 2007; Torres, 2007; Umble, 2007). Logic Models can also be used to help identify program elements that provide useful evaluative data to discover ways to collect other data and measure progress. Considering two weaknesses of complexity and time consumption, logic models have uses other than just program evaluation.

Although it has been debatable whether theory of change or logic models are the same, the primary purpose of both is to “emphasize the theory of change that has influenced the design and plan for the program” (Kellogg Foundation, 2003; p. 9), including “illustrating how and why the program will work (p.9)” (Gutiérrez & Tasse, 2007; Hannum et al., 2007). They can be useful in the appropriate context. When estimating return on investment, a specific, quantitative measure to demonstrate the actual change occurrence is needed. Theory of change and logic models are both useful in program description, linkage, and can lead to many favorable uses and

outcomes. However, they can also be time and resource intensive, and can be challenging to use as a demonstrative tool to estimate financial returns of investment simply and clearly.

Participatory Evaluation Approaches

Participatory or collaborative evaluation approaches are characterized by using methods to “actively involve program stakeholders in designing, implementing and/or interpreting data” (Kellogg Foundation, 2005; p. 18), which ultimately involve taking advantage of everyone’s wisdom (Symonette, 2007). These evaluation approaches work to encourage stakeholders to share their views, support a more comprehensive understanding of the people and the issues involved, and build their capacity to get genuinely involved (Kellogg Foundation, 2002; Symonette, 2007).

An example of this type of evaluation approach is found in The Management and Leadership (M&L) Program of Management Sciences for Health (MSH). The approach uses a unique method involving participation to evaluate leadership development outcomes (Lemay & Ellis, 2007). This approach uses a structured process, emphasizing participation of managers and teams at all organizational levels and incorporates feedback and support while facing organizational challenges. M&L suggests that this method can be used at any level of an organization, and includes five key practices: (1) scan, (2) focus, (3) align, (4) mobilize and (5) inspire; and three key leadership competencies: (1) communication, (2) negotiation and (3) change management (Lemay & Ellis, 2007).

To gather both qualitative and quantitative data, three tools are suggested to monitor and evaluate the M&L programs: assessment of leadership practices, workgroup climate assessment, data sources and lessons learned (Lemay & Ellis, 2007). Considering this approach provides a structured methodology and can easily be used with mixed methods approaches, such as with the

strategic evaluation approach (Davidson & Martineau, 2007). However, the approach is still limited in its ability to quantitatively estimate RODI.

Mixed Methods Evaluation Approaches

Mixed methods evaluation approaches are quite common in leadership development program evaluation (Kellogg Foundation, 2002). They are often used to evaluate leadership development outcomes mixing an array of qualitative and quantitative methods such as surveys, interviews, observations, and focus groups. (Hannum, et al., 2007; Kellogg Foundation, 2002). Mixed method evaluation approaches are also commonly used and allow evaluators to collect a variety of information about outcomes that help determine program effectiveness and direction (Kellogg Foundation, 2002; Stufflebeam, 1999). As qualitative versus quantitative evaluation methods underwent controversy during the 1980s and 1990s, evaluators were encouraged to consider multiple sources and methods (Fitzpatrick, Sanders & Worthen, 2004). Thus, mixed methods evaluation approaches became a robust approach typically involving both a formative and summative component, which is analogous to Robert Stakes' popular comment, "when the cook tastes the soup, that's formative; when the guests taste the soup, that's summative" (Scriven, 1991).

Formative evaluations are diagnostic in nature and help evaluate the worth of a part of a program, using this information for program improvement. They are typically conducted during the development or improvement of a program, mainly with the intention to improve or remediate the program, and are primarily conducted by internal evaluators (program managers, trainers). Summative evaluations are judgmental and serve the purpose of determining the overall worth of a program or whether it should be adopted, continued or expanded, and are typically conducted by external evaluators (students, teachers, managers, employees, others who

could adopt program). At times it is difficult to distinguish between a formative and summative evaluation, and they are often intertwined that the same study can be used for summative purposes and later for formative as well (Fitzpatrick, Sanders & Worthen, 2004).

Mixed method evaluation approaches have been valuable in research considering their ability to combine both qualitative and quantitative methods. Yet, it is not necessarily the most efficient means to estimate RODI for means of this study since they are more effective when used to “increase validity in measurement...[or] to obtain a more accurate picture of the construct” (Fitzpatrick, Sanders & Worthen, 2004; p. 305). However, the quantitative properties of a mixed methods approach are useful to assess outcomes (Fitzpatrick, Sanders & Worthen, 2004), and are well suited to generating the quantitative data necessary to calculate RODI.

The evaluation approaches mentioned: logic models, theory of change models, and mixed methods assist evaluators in the evaluation itself, as well as in the design and outcome specification to ensure proper alignment with training and development goals. They all have more of a comprehensive evaluative aspect involving not only an evaluative implementation dimension but also a design dimension. Provided that the development program was designed with evaluation in mind (Caffarella, 2002; Fitzpatrick et al., 2004), the design should compliment the evaluation and vice-versa.

Further, when dealing with leadership development evaluation, Craig and Hannum (2007) mention that “two challenges faced by many, if not all, evaluators of leadership development initiatives are (1) the need to measure changes in leadership or leadership outcomes – too complex and sometimes nebulous areas and (2) determining the relationship between the leadership development initiative in question and the changes measured” (p.19).

The evaluation approaches mentioned have value in many ways and for many different purposes. However, it is questionable whether certain evaluation programs have sufficient means to address these two challenges just because they fall in these categories (Craig & Hannum, 2007). For example, throughout the decision-making process literature can be found supporting an anecdotal approach (Brinkerhoff, 2003; Mintzberg, 1975), which is analogous to using a qualitative method (or combination of several methods mentioned) to make decisions within organizations (Russ-Eft, 2007). This approach encourages decision-makers to seek out cases of organizational successes and then communicate these successes in the form of persuasive stories (Brinkerhoff, 2003; Russ-Eft, 2007). However, this anecdotal approach has very little basis in organizational research and has demonstrated that when managers use this approach to make decisions, they rely on subjective information that lacks quality (Mattson, 2003; O'Reilly, 1983; Russ-Eft, 2007). Researchers have stated that this approach is used simply because it is more easily understood, accessible and perceived as an effective means but not used because of its lack of effectiveness (O'Reilly, 1983; Russ-Eft, 2007).

Therefore, Craig and Hannum (2007) suggest the use of experimental and quasi-experimental approaches for evaluating leadership development intervention, as they “provide a means to address [the two] challenges” (p.19) that were previously mentioned. These more empirical evaluation approaches in conjunction with other measuring techniques such as utility analysis, can compliment each another when being used together for specific research needs, such as for calculating RODI (Avolio et al., 2009; Avolio et al., 2010; Russ Eft, 2007). The last two evaluative approaches that will be mentioned in this literature review, and that are useful when providing a more quantitative evaluation of RODI, are the experimental (also quasi-experimental) approach and the utility analysis approach.

The Value of Experimental and Utility Analysis Approaches

Experimental and Quasi-experimental Approaches

Experimental and quasi-experimental approaches provide a structured way to determine how an evaluation may be designed and implemented (Craig & Hannum, 2007). Both methods require some type of intervention, whereas a non-experimental approach is where observations are made but there are no interventions regarding what is being studied. Experimental designs involve the use of one or more control groups in which the subjects are randomly assigned to each group. Conducted properly, experimental designs can provide a means to more easily interpret results than quasi-experimental designs. The random assignment provides homogenous control with experimental groups providing more credibility to determine significance of cause and effect after the intervention occurs (Craig & Hannum, 2007).

Quasi-experimental designs are typically designed using control groups, but this may not always be the case. Should control groups be used, assignments are not random, which can further complicate interpretation and any potential cause-effect relationships. However, this does not mean that only an experimental design should be conducted. The type of design used depends upon the context in which the evaluation takes place and the types of change that will be measured (Craig & Hannum, 2007; Fitzpatrick, Sanders & Worthen, 2004). Experimental or quasi-experimental designs, clarity of objectives, sound measures, adequate sample sizes, timing of data collection, and environmental stability can all affect the decision of which design to use as well as present threats to validity or reliability.

Experimental and quasi-experimental evaluations are effective means of evaluating leadership development programs but used less frequently due to design difficulties (Hannum, Martineau & Reinelt, 2007; Kellogg Foundation, 2002; Russon & Reinelt, 2004). When

conducted properly they can provide valuable information. For example, in an experimental study conducted by Wielkiewicz (2000), an instrument was designed to evaluate college students' beliefs and thinking about leadership in organizations. The results indicated that individuals were more comfortable in organizations that had a leadership majority of hierarchical thinkers when they themselves thought hierarchically. Another experimental research example is found in a study conducted by Cunningham & Kitson (2000). They conducted a pretest/posttest design incorporating action research to study the effectiveness of an RCN Clinical Leadership Development Program. The results indicated a significant increase in leadership performance on several dimensions: self-management, team management, patient-centered care, networking and political awareness.

Another advantage of experimental and quasi-experimental approaches is that they can be great source of inference. For example, in relation to the Wielkiewicz (2000) study evaluating college students' beliefs and thinking about leadership in organizations, it was inferred that this organizational comfort encouraged individuals to continue rising to higher positional levels within that organization as their career goal. However, individuals preferring a more systemic type of thinking were less comfortable in a hierarchical organization and would more likely get frustrated in this type of environment. Their frustration came from their desire to point out feedback loops that needed attention, yet they would get little response from positional leaders who focus strictly on hierarchy for their information. Therefore, the neglect of feedback loops that systemic thinkers felt they deserved only enhanced their frustration in the hierarchical environment.

It is important for leadership development outcomes to be evaluated properly in order to determine returns on leadership development intervention. But not just any evaluation approach

can be used to study RODI. For example, over the last several decades, at least 500 or more date back to World War I (Avolio et al., 2009). Although this is encouraging, the evaluation methods reviewed used a variety of techniques but not all were be deemed appropriate for evaluating return on investment from a financial perspective. After identifying these 500 studies, Avolio and colleagues (2009) found only 200 that met their experimental and quasi-experimental criteria, and of those 200, only 140 had unique effect sizes (Avolio et al, 2009) that could be used to estimate RODI. This study provides a valuable contribution to the estimation of RODI by providing quantifiable data from both experimental and quasi-experimental evaluation approaches demonstrating the impact of leadership development interventions.

The ongoing challenges of finding an approach to quantify the impact of leadership development interventions and their RODI have overshadowed the evaluation of human capital. Hannum, Martineau & Reinelt (2007) state, “many organizations are looking for a relatively straightforward measure to illustrate the organizational impact of leadership development” (p. 559). Because of these challenges, some researchers have preferred experimental and quasi-experimental methods (Avolio et al., 2009) used to evaluate leadership outcomes and the impact on follower and organizational performance. Unfortunately, however, experimental and quasi-experimental methods alone are not sufficient for all evaluative purposes (Fitzpatrick et al., 2001). When tasked with identifying a means of evaluation that can report explicit financial results, such as the utility (or value) of an investment, the evaluative methodology chosen must be appropriate for the task at hand. Therefore, one solid means of evaluating the impact of leadership development intervention is to use an evaluation approach that has its base studying financial returns on investments, such as the utility analysis approach. In reference to this study,

the use of experimental and quasi-experimental data, as well as a utility analysis approach, is the most effective means of demonstrating the return on leadership development investment.

Utility Analysis Approaches

Fitzpatrick, Sanders, and Worthen (2004) write that amidst the many evaluation approaches, “there still exists a tendency to fall prey to the ‘law of the instrument’ fallacy (Kaplan, 1964) rather than adapt or develop evaluation methods to meet our needs” (p.64). This fallacy, they suggest as described by Kaplan (1964), is one that:

If you give a boy a hammer, suddenly everything he encounters needs hammering.

The same is true, [Kaplan (1964)] asserts, for scientists who gain familiarity and comfort in using a particular method or technique; suddenly all problems will be wrestled into a form so that they can be addressed in that fashion, whether or not it is appropriate (Fitzpatrick et al., 2001, p. 64).

This fallacy is analogous to the relationship between using more common approaches to evaluation leadership development versus using more appropriate techniques to evaluate monetary returns on investment. For various reasons many other types of evaluation have dominated the evaluation of leadership development intervention research. Yet, using evaluation methods such as utility analysis for studying RODI have struggled to become commonplace both in research and practice, regardless of their appropriateness to measure the financial returns of leadership development. This may be because little research or practice has been conducted using utility analysis within leadership development research, although its capability of calculating ROI for most any intervention is promising. Thus, a comprehensive review of utility analysis will provide a sound basis for its use to estimate RODI.

Utility analysis is defined as “a quantitative method that estimates the monetary value of benefits generated by any intervention based on the improvement it produces in worker productivity. [It] provides managers information they can use to evaluate the financial impact of any intervention, including a return on their investment in implementing it” (Bernstein, 1966). Introduced as early as the 1940s (Brogden, 1946; 1949), Brogden and Taylor (1950) further expanded utility analysis research. This was later refined by Lee Cronbach, who developed the Cronbach’s alpha correlation coefficient (Cronbach & Gleser, 1965). This research eventually led to the Brogden-Cronbach-Gleser model, as we know of it today.

Some of the original purposes of utility analysis were to provide mathematical models, using certain systematic procedures, to evaluate the organizational benefits from improving personnel selection (Bobko, Karren, & Parkington, 1983; Schmidt et al., 1979). Recognizing the focus on the use of psychological variables to evaluate human factors (Schmidt & Hunter, 1983), utility analysis was even further researched and extended over the years (Cascio, 1982; 1991; Cascio & Boudreau, 2011; Hunter et al., 1990; Reilly & Smither, 1985; Schmidt et al., 1979; Schmidt, Hunter, & Pearlman, 1982). Over time, its use has naturally extended to evaluating most any intervention attempting to improve human performance and its use provides a type of counter-balancing to the overuse of more subjective methods. Therefore, utility analysis is a means to provide evaluative rebalancing by using more empirically based, economic variables to determine the financial impact of an intervention (Cascio, 1991; Cascio & Boudreau, 2011; Hunter & Schmidt, 1982; Hunter et al., 1990; Schmidt et al., 1979).

Throughout the development of utility analysis research, the concept of ROI has become a popular expression used to demonstrate utility in the form of a percentage or monetary value –

earnings (net monetary benefits minus costs) divided by investment (project costs) – and is regularly used in finance today (Cascio & Boudreau, 2011).

ROI, also known as “Level 4,” is a growing point of interest in assessing the value of leadership development programs. Phillips and Phillips (2007) report a paradigm shift suggesting that organizations are defining program value more in terms of monetary benefits, and comparing these benefits to costs, the essence of ROI. Below are examples of organizations using ROI methodology to determine the financial value of their investment (p. 2):

- Apple Computer calculated the ROI for investing in process improvement teams.
- Sprint/NEXTEL developed the ROI on its diversity program.
- Wachovia developed the forecast and actual ROI for its negotiation program.
- A major hotel chain calculated the financial value and ROI of its coaching program.
- A major U.S. Defense Department agency developed the ROI for a master’s degree program offered by a major university.

Over the last few decades, researchers have spent a great deal of time studying the links between ROI and the evaluation of development programs (Cascio & Boudreau, 2011; Phillips, 1997). These efforts have led to two common methods to calculate ROI, which have appeared to lead the literature with regard to measuring ROI.

The first method was derived from Donald Kirkpatrick’s (1959) four-level hierarchy of evaluation, which not only includes ROI but has also been widely used and modified to assist in the development of many other ROI models (Kirkpatrick, 1979; 1996; Parry, 1996; Phillips, 1997; Rothwell, 1996). Building upon Kirkpatrick’s (1958, 1960) original research, Phillips and colleagues (1997; 2008; 2001) extended these four levels by adding a fifth level called return on investment, simply because Kirkpatrick included ROI in the fourth level which meant that both

improvement and the lack thereof were on the same level. Phillips (1997) felt this was confusing because in the case where too much money was spent on training, it could create a negative ROI (Stoel, 2004). Therefore, Phillips proposed the following five levels of evaluation: (1) Satisfaction / Reaction, (2) Learning, (3) Application / Implementation, (4) Business Impact, and (5) ROI.

The Phillips ROI methodology incorporates cost-benefit analysis and provides 12 guiding principles demonstrating the method for collecting data, isolating the program from unintended influences, converting benefits to monetary values, and calculating ROI (Phillips et al., 2001; ROI Institute, 2009, p. 2).

1. When conducting a higher-level evaluation, collect data at lower levels.
2. When planning a higher-level evaluation, the previous level of evaluation is not required to be ROI.
3. When collecting and analyzing data, use only the most credible sources.
4. When analyzing data, select the most conservative alternative for calculations.
5. Use at least one method to isolate the effects of a project.
6. If no improvement data are available for a population or from a specific source, assume that little or no improvement has occurred.
7. Adjust estimates of improvement for potential errors of estimation.
8. Avoid use of extreme data items and unsupported claims when calculating ROI. Use only the first year of annual benefits in ROI analysis of short-term solutions.
9. Fully load all costs of a solution, project, or program when analyzing ROI.

10. Intangible measures are defined as measures that are purposely not converted to monetary values.

11. Communicate the results of ROI Methodology to all key stakeholders.

Once at level five, at face value Phillip's ROI methodology uses a fairly simple cost-benefit analysis formula (Phillips, 1997; Phillips et al., 2001):

$$ROI (\%) = \frac{Program\ Benefits - Program\ Costs}{Program\ Costs} \times 100$$

Despite its popularity and supposed simplicity, reviewing the 12 guiding principles indicates that it is not as simple a process to calculate ROI at level five since it is important that all four of the previous levels are adequately and proactively covered (Phillips, 1997).

Phillips (1997) ROI methodology provides a comprehensive approach to calculating ROI but it can be quite complex, challenging and time consuming to arrive at the point at which ROI is actually calculated. For example, Phillips' (1997) proposes that the ROI methodology consists of a "chain of results" (p. 10) whereas each level builds upon one another. Satisfaction and reaction (Level 1) are necessary for learning (Level 2), which is necessary for application to change workplace behavior (Level 3), and change in behavior impacts business (level 4). Once these four levels have been demonstrated and converted into a monetary value, ROI is calculated (Level 5). This method is argued as being a more proactive approach to evaluation, yet with a marked concern that too much emphasis can be placed on ROI alone as the one answer to accountability issues (Stoel, 2004).

Phillips' (1997) ROI methodology is definitely a comprehensive and popular approach to calculating ROI. It provides five levels of evaluation, and each level is dependent upon the success of previous level, ending with the ROI calculation. Although this ROI methodology has

been successfully used in many different instances and has many strengths, it has also been criticized with certain limitations such as: (1) placing too much emphasis on subjective self-reports to isolate the effects of training, potentially leading to false conclusions regarding program success, (2) being too time consuming and expensive, and (3) lacking evidence suggesting that levels are correlated (Guerra-Lopez, 2008). Choosing which ROI method to use is more a matter of what the expected outcomes are, only then can the most appropriate method for the nature of what is being evaluated can be determined. Considering this study is not focused on the design elements of evaluation and is using meta-analytic already gathered, a more appropriate method of calculating ROI is needed.

Cascio and Boudreau (2011), and others (Cascio, 1991; Cascio & Ramos, 1986; Hunter & Schmidt, 1982), have also been instrumental in providing a means to evaluate human resource initiatives and programs to estimate ROI, particularly through the use of utility and cost/benefit methods. Their research has provided a means to determine the financial impact from areas such as absenteeism, turnover, employee attitude and engagement, workplace health (WPH) programs, work-life programs, job performance, employee selection and staffing programs, and various other human resource and training programs. Elaborating on utility theory and other research, they use another method of utility analysis to calculate the return on investment (ROI) (Cascio & Boudreau, 2011; Schmidt et al., 1982):

$$\Delta U = (N) (T) (d_t) (SD_y) - C$$

Where:

ΔU = gain to the organization in monetary units

N = number of employees trained

T = expected duration of benefits in trained group in years or portion of a year

d_t = difference in performance between the pre and post-test in SD units

SD_y = value of one standard deviation (SD) of performance change in monetary units

C = total costs of the training program

In contrast to Phillips ROI methodology, one of the benefits of using this method to calculate ROI is that it is not dependent on a series of levels, or subjective-reporting, to add validity to the methodology. The equation uses variables that can be calculated simply and objectively, along with calculation methods that have been validated through research literature (Cascio & Boudreau, 2011). For example, d_t can be substituted using effect sizes similar Avolio and colleagues (2010) in their estimation of returns from leadership development intervention. Another example of this formula's flexibility is in calculating SD_y , which Holton (2011), the developers of the Learning Transfer Systems Inventory (LTSI) and a unique ROI calculation, stated contains two critical factors that utility analysis is dependent upon:

1. The change in performance (skills or competencies) expressed in a standard deviation (SD) measure; and,
2. The value to the organization of a one SD change in performance (Holton, 2011, p. 2)

The first critical measure, change in performance expressed in a SD measure, is the more simple measure and can easily be determined by comparing pre- and post-test performance measures of two groups: a control group and experimental group. However, considering the difficulties of obtaining control groups when evaluating program outcomes, Schmidt, Hunter and Pearlman (1982) proposed an alternative approach to calculating change in performance. Their approach is to use pre- and post-test measures for a single group, allowing for change in performance to be normed, and then the calculation of the SD of that change in performance.

This approach is likely to result in a more conservative estimate of ROI due to the lower estimates of change in performance.

The second important measure, the value of a one SD change in performance, can be determined in three different ways. First, provided an organization has had the opportunity to conduct appropriate study, the first approach is to use the actual performance value to estimate the value of one SD change in performance. However, although estimating the actual performance value is more specific to the organization and advocated by training evaluation experts, it can be costly and is often impractical.

A second approach to estimating the value of one SD change in performance is the Percentile Performance Value Estimation, or what is called global estimation. Global estimation is a method that estimates the monetary value of job performance by identifying value at the 85th percentile (one SD above the average) and the 50th percentile (average). Then, the difference between these two monetary values is calculated, deriving the monetary value of one SD change in performance (Cascio & Boudreau, 2011; Holton, 2011; Hunter & Schmidt, 1982).

The third approach is salary-based estimation, which has proven to be a valuable method to use in utility analysis, providing added value estimating ROI (Cascio & Ramos, 1986). Salary-based estimation is supported by the principle of marginal revenue product (MRP) theory in labor economics, which links employee pay to an organization's profitability – if employee is overpaid, organization is less profitable; if underpaid, talent retention becomes a problem (Becker, 1964; Cartter, 1959). This economics foundation makes salary-based estimation a reasonable means of estimating ROI, demonstrating the link between employee compensation and organizational profit. It provides a conservative estimate as it does not incorporate any

contributions of capital, material or other intangibles into its calculation that could potentially enhance employee value (Cascio & Ramos, 1986; Packer, 1983).

Based on extensive meta-analysis research on estimating the value of one SD of performance change, Hunter and Schmidt (1982) reported that this SD of performance change is worth approximately 40% of the average salary of an employee. They demonstrated that for a change in one standard deviation of performance, the average value of production comprises 22.8% of salary and the average value of goods and services comprises 57% of salary. They concluded that on average, the economic value of one standard deviation of performance is 40% $(.228 / .57)$ (Cascio & Boudreau, 2011; Hunter & Schmidt, 1982). This research is valuable as it provides a valid and practical means of estimating ROI without the complications of intense and expensive studies to derive nearly equal values. Considering that salary data is concrete and often readily available, this salary-based approach is a sure way to quickly and effectively determine SDy for use in estimating RODI using the utility analysis formula.

The purpose of reviewing leadership and program evaluation approaches was to identify the most suitable approach(es) to meet the objectives of the current study, which uses computer simulation modeling to estimate the return on development investment (RODI) and return on leadership diffusion (ROLD). Although several evaluation approaches were discussed, experimental and quasi-experimental evaluation approaches as well as utility analysis appear to be the most appropriate methodology to meet the study objectives. This will not only allow researchers to build upon previous research conducted by Avolio et al. (2009; 2010), but will also provide a sound empirical basis for more accurately predicting the effects of both RODI and ROLD.

Using Meta-analysis to Determine Leadership Development Effectiveness

Considerable research has been conducted regarding the impact of leadership development; however, according to Avolio et al. (2009, p. 764)) most has been based on surveys and “small convenience samples with cross-sectional designs” and bi-variate correlations (Avolio et al., 2009; Bass, 1990; Lord & Hall, 1982). This has limited research in its ability “to verify and validate cause and effect relationships in the various theories of leadership...for a variety of reasons such as having a high degree of sampling error, lacking temporal precedence, and/or failure to manipulate leadership as an independent variable in or to examine its impact on performance outcomes” (Avolio et al., 2009, p. 764; Yukl, 2002). Considering these challenges and their potential effects on evaluation efforts of leadership development outcomes and intervention, it is important to continue conducting adequately designed, and empirically based, leadership development studies to further validate causality. At the same time, adequately determining the effectiveness of leadership development interventions require more than just a few, or even many, causally designed studies. It requires other methods of statistical analysis such as meta-analyses.

Meta-analyses are becoming an increasingly important statistical method that systematically and statistically analyze the results of a group of integrated (or combined) studies measuring the same phenomena. This allows the ability to identify relationships, have greater control, develop theory and draw conclusions (Hunter & Schmidt, 1990, 2004). They are often referred to as an “analysis of analyses” or the “statistical analysis of a large collection of analysis results from individual studies” (Glass, 1976, p. 3). More specifically, a meta-analysis is defined as a way “to estimate as accurately as possible the construct-level relationships in the population (i.e., to estimate population values or parameters), because these are the relationships of specific

scientific interests” (Hunter and Schmidt, 2004, p. 512). Although meta-analyses can be helpful in their comprehensive approach to analyzing study results, they can also be specifically designed with a limited scope.

For example, Avolio and colleagues (2009) report that much of previous meta-analytic leadership research is limited to studies examining single leadership theories and the impact on various outcomes. In their review of leadership literature from 1981 to 2008, Avolio and colleagues (2009) identified over 32 meta-analyses. Yet, all of these meta-analyses “examined one theory, and in many cases only one independent variable compared with a limited set of dependent variables/outcomes” (p. 765). However, Avolio and colleagues (2009) did identify two meta-analyses that covered different time periods spanning post World War I to 2001. Each of the two studies attempted to comprehensively review multiple leadership theories and the effects of managerial leadership development programs.

Burke and Day (1986) conducted the first comprehensive meta-analysis studying the effectiveness of managerial training from 70 studies emanating from 1952 to 1982. Their research was not only the first comprehensive attempt to apply meta-analysis to managerial training and development studies but is considered one of the foundations of empirical support for studying the effectiveness of development interventions.

As mentioned, Burke & Day’s (1986) meta-analysis included 70 published and unpublished studies to determine the effectiveness of managerial training and other training methods designed to improve learning and skills. The design methodology involved studies that contained at least one control or comparison group, evaluated program effectiveness of one or more programs, and involved managerial or supervisory personnel. In particular, Burke and Day

(1986) used particular training content areas, training methods and criteria to gather information, and categorize the studies.

The Burke and Day (1986) meta-analysis included six training content areas: (1) general management programs, (2) human relations/leadership programs, (3) self-awareness programs, (4) problem solving/decision making programs, (5) rater training programs, and (5) motivation/values training programs. Training methods included: lecture, lecture/group discussion, leader match, sensitivity training, behavioral modeling, lecture group discussion with role-playing or practice, and multiple techniques. Using Kirkpatrick's (1976) first three levels, Burke and Day (1986) developed four criterion-measure categories based on two dimensions: (1) level of criterion, and (2) subjectivity-objectivity.

The results of Burke and Day's (1986) meta-analysis indicated that "managerial training was moderately effective [but] more empirical research was still needed before any firm conclusions could be drawn" (p. 767). The meta-analysis provided mean effect sizes for each of the four criteria: subjective learning (.34), subjective behavior (.49), objective learning (.38), and objective results (.67). Although Burke & Day (1986) mentioned several limitations to their study, they also provided several important conclusions.

Burke and Day (1986) suggested that researchers needed to improve evaluation reporting of organizational interventions, which would assist in more comprehensive analyses to measure effectiveness of managerial training and other organizational interventions. They discouraged heavy emphasis on program content descriptions and labels to determine program worth. Instead, they suggested that future research should focus on investigating effectiveness of a variety of training methods and dependent variables to aid in decision making. They encouraged awareness that the trainer's experience and qualifications may have on training effectiveness, as well as encouraged

future research to study potential effects. They pointed out that their meta-analysis indicated “different managerial training methods do not necessarily lead to increased knowledge and job performance” (p. 243). However, it does provide a quantitative evaluation of “the degree to which the effectiveness of managerial training generalizes across settings for various training content areas, training methods, and outcome measures” (p. 243). Burke and Day (1986) suggested that their meta-analysis was a great foundation for more advanced meta-analytic studies that focus on managerial and general training.

Following these conclusions and recommendations, Collins and Holton (2004) expanded upon Burke and Day’s (1986) meta-analytic study by conducting their own meta-analysis to demonstrate positive outcomes as a result of managerial training. Picking up where Burke and Day (1986) concluded, Collins and Holton (2004) identified 103 leadership development studies reported in the research literature from 1982-2001. These managerial leadership development interventions spanned developmental relationships to feedback interventions and on-the-job interventions. Of the 103 studies, 83 were used to conduct their meta-analysis and determine the effectiveness of interventions regarding increased performance, knowledge and expertise at three levels: individual, group or organizational. Criteria were evaluated using the high-performance leadership competency model (Holton & Naquin, 2000) and the Results Assessment System (Swanson & Holton, 1999).

Collins and Holton (2004) used four research design types to answer their research questions: (1) post-test with control group, (2) pre and post-test with control group, (3) single group pre and post test, and (4) correlation (which was not completed since too few studies were found). Each design type was used to separately consider studies with lower validity measures from those with higher validity measures. Their research questions provided a frame of reference

to demonstrate the effectiveness of managerial leadership development across studies at measuring system, financial, expertise, and knowledge outcomes. Collins and Holton (2004) investigated potential moderator effects on training content, organization type, job classification level, publication type, measurement method, research design, and objective-subjective outcomes.

In support of Burke and Day's (1986) positive meta-analysis results, Collins and Holton (2004) also found that managerial training was "moderate to highly effective" (p. 142), producing positive outcomes for knowledge ($d = .96$ to 1.37), expertise ($d = .35$ to 1.01) and performance ($d = .39$). Although the study was originally intended to provide a comprehensive review of all managerial leadership development programs, Collins and Holton (2004) were only able to include formal training interventions due to the design of the study. However, despite this limitation and several others, the Collins and Holton (2004) meta-analysis not only confirmed Burke and Day's (1986) results, but also provided a significant expansion to their foundational meta-analytic research.

The Collins and Holton (2004) meta-analysis also provides confirmation to organizational leaders that, provided they implement appropriate managerial leadership development programs at the appropriate time with the appropriate personnel, their investment will produce substantial results. Their meta-analysis reported that not only were development programs designed with expertise and systems outcomes effective, but programs designed with knowledge outcomes were also found as highly effective. As a whole, organizations participating in the study were found to use a wide variety of formal training programs. However, a wide variance regarding program effectiveness was also detected, which Collins and Holton (2004) attributed to the possibility of poor needs analyses. Therefore, Collins and Holton (2004)

suggested that organizations should properly assess learning needs and be vigilant to the type of leadership development dimensions used to design their programs to ensure their appropriateness for the greatest outcome.

Collins and Holton (2004) also suggested that managerial leadership development programs should integrate multiple leadership perspectives from all organizational levels. The interventions included in their meta-analysis that did integrate multiple perspectives demonstrated effective results. Researchers also suggested further research to clarify the impact of managerial training; and in particular, the impact on organizational performance outcomes (Collins & Holton, 2004).

Not only did Collins and Holton's (2004) meta-analysis provide another empirical foundation for future study of the effects of managerial leadership development, but it also provided significant positive results similar to that of Burke and Day's (1986) meta-analysis. It provided significant conclusions and proposes several implications for future research. Collins and Holton (2004) suggested that future research should continue investigating the effects of managerial leadership development on outcomes to provide even more empirical evidence of the positive effects of intervention. For example, they stated that little research exists distinguishing theories that produced more positive effects; therefore, proposing a need for more research (Avolio, et al., 2009; Collins & Holton, 2004).

Collins and Holton (2004) states:

What is often overlooked regarding training but must be considered is the cost to the organization of trainees in the classroom – the return on investment made by the training program. This is important as large sums of money are invested in managerial leadership development programs

annually (Gibler, Carter, & Goldsmith, 2000). The cost for higher paid managers to be in a classroom, away from work to attend the training is substantial. While it is known that training programs are effective, organizations should do a cost analysis to determine the actual return on investment from training initiatives (Collins & Holton, 2001, p. 170).

A greater focus on the study of using cost-benefit analyses, such as the return on investment (ROI), can be an effective way to realize costs and help organizational leaders recognize the importance of estimating the value and return on leadership development interventions. This type of focus can also provide an effective and tangible means to help organizational leaders make faster and more informed decisions when considering human capital investments.

In an effort to address some of these concerns as well as provide an even more comprehensive meta-analytic study of the effects of leadership development intervention, Avolio and colleagues (2009) further expanded previous research covering both periods of the previous two meta-analyses (Burke & Day, 1986; Collins & Holton, 2001). They identified over 500 leadership development intervention studies that spanned post World War I to 2008, which included studies from both public and private organizations. Their objective was to study the intended causal impact of leadership interventions on organizational outcomes, and to what degree. Thus, Avolio et al. (2009) proposed three primary goals of the meta-analysis:

1. Review leadership literature regarding experimental and quasi-experimental studies, synthesizing what has been learned,
2. Determine if certain leadership theories and interventions have a greater impact than others, “and if so, how, when and in what way” (p. 778), and

3. Provide a greater empirical basis for future leadership research for both scholars and practitioners.

They also included a fourth goal, which could be described as a subset of the third goal, where they dedicated a section of their study to estimate the return on development investment (RODI).

To accomplish their objectives, Avolio and colleagues (2009) consolidated the 500 studies into 200 usable experimental and quasi-experimental studies, which generated 140 independent effect sizes from 13,656 participants. The study addressed two separate areas: (1) a meta-analytic section consisting of the meta-analysis research, data, and results; and, (2) using effect size results in a separate section of their study, they made the first attempt in leadership research to convert average effect sizes into returns on leadership development intervention.

Within the meta-analysis section, Avolio and colleagues (2009) conducted a quantitative review of leadership development intervention studies and then compared traditional leadership theories (theories up until the 1970s such as behavioral, contingency, trait, etc.) and newer theories (post 1980s such as charismatic, inspirational, transformational, visionary) and their intervention effects. One central research question that their meta-analysis sought to address was whether leadership development interventions had an impact on leadership outcomes and if they did, from which models or methods? Avolio and colleagues (2009) were also interested in identifying any differences in causal impact between research-manipulated leadership interventions versus training or developmental interventions. More specifically, their meta-analysis addressed three stated research questions as follows (Avolio, et al. (2009):

1. Does the impact of experimental/quasi-experimental leadership interventions differ comparing training or developmental versus other types of leadership interventions?

2. Does the impact of experimental/quasi-experimental leadership interventions differ as a function of whether it was based on newer leadership theory versus:
 - a. Traditional leadership theory?, or
 - b. Pygmalion leadership theory?
3. Does the impact of experimental/quasi-experimental leadership interventions based on newer, traditional, or Pygmalion theories differ for affective, cognitive, behavior and organizational performance outcomes? (p. 768)

Avolio and colleagues (2009) provided a robust methodology, which included a thorough coding method and literature search. Regarding the type of intervention, each study was sorted in 10-year increments, beginning post World War I, and then categorized based on type of intervention: actor or role play, scenario or vignette, leaders trained or developed, leader appointed or assigned, leaders' expectation, or others category. Leadership theories were coded into three categories: traditional (n = 41), newer (n = 40) and Pygmalion (i.e. self-fulfilling prophecy) (n = 19), after discovering that a sizable amount of the studies were designed in this manner.

Avolio and colleagues (2009) then determined whether traditional leadership theories (prior to 1980s) or newer leadership theories (post 1980s) had a greater effect and how this effect might vary across four dependent variables (outcomes): affective (feeling, emotions), cognitive (perception, processing of information), behavioral (observable actions) and performance (individual and group as well as organizational such as profit). Considering that "theoretical literature comprised of newer research repeatedly discusses what has been commonly referred to as the 'higher order' impact of these leadership styles on follower emotions or affect, cognitions, behavior and performance" (p.768), Avolio and colleagues (2009) made a reasonable assumption

that differences would exist between traditional and newer leadership theories, and that Pygmalion theory would be greater than traditional. However, their findings indicated that both traditional and newer leadership theories had moderately positive effects and did not significantly differ until moderators (leadership theories) were included in the analysis.

The first research question was addressed by demonstrating little difference between corrected effects sizes for type of intervention, training/developmental .65 (n = 3389) vs. other .71 (n = 7658), although training/development was lower.

Part (a) of the second research question (traditional research theory) was addressed by examining the effects of leadership intervention on newer versus traditional theories. The corrected effects sizes for traditional theories .67 (n = 3223) compared to newer theories .60 (n = 3847) were also slightly different, with newer theories actually slightly lower. Part (b) of the second research question (Pygmalion research theory) compared effect sizes for interventions based on Pygmalion leadership theory 1.38 (n = 1021) versus traditional theories .67 (n = 3223) and newer theories .60 (n = 3847). Pygmalion leadership had the largest effect size.

The third research question “examined the impact of experimental and quasi-experimental leadership studies from each category of leadership theory separately for affective, behavioral, and cognitive outcome variables in a hierarchical analysis” (p. 774). To avoid reporting all of the numerous statistical outcomes, the overall finding was that “effect sizes were generally higher for other versus training/developmental interventions” (p. 774).

Results of Avolio and colleagues (2009) meta-analysis further support the work of Burke and Day (1986) and Collins and Holton (2004) with a corrected average effect size of .67 and a standard deviation of .80, indicating that leadership development interventions have a positive impact on a variety of variables such as intervention types, leadership levels, organization types,

study quality and types of outcomes. Further, a moderately positive effect was reported for leadership interventions and the three theoretical categories: traditional, newer and Pygmalion. Avolio and colleagues (2009) also reported that although not stated in the research questions provided in the study, they researched a number of other variables and conducted exploratory analyses.

Using a type of utility analysis called Binomial Effect Size Display (BESD) (Rosenthal & Rubin, 1982), allowed Avolio and colleagues (2009) to compare “the likelihood of those in the ‘treatment’ or leadership intervention group experiencing ‘success’ with the treatment versus the likelihood of those in the control or comparison group experiencing similar success” (p. 772). Thus, they were able to convert the effect sizes into a more usable value to assist in the interpretation of results, which allowed them to examine the degree to which a leadership manipulation leads to greater followership in experimental versus comparison/control groups. The BESD analysis indicated that on average, those leaders in the treatment group (experimental condition) had a 66% change of success achieving positive outcomes whereas those in the comparison group experienced only a 34% chance of success (Avolio et al. (2009).

One of the variables studied was leadership level, where Avolio and colleagues (2009) calculated the effect sizes of high, middle and lower-level leaders and their effect on leadership development intervention. Results indicated that both high-level .51 ($n = 1295$, $SD = .31$) and middle-level leaders .51 ($n = 974$, $SD = .36$) had similar effects, with lower-level leaders .71 ($n = 8817$, $SD = .55$) having the greater overall leadership effect. This data is important to advancing the leadership research literature with regard to estimating return on investment. In a separate section of their meta-analysis, Avolio and colleagues (2009) “used a range of effect sizes from the meta-analysis, coupled with some standard human resource cost accounting methods to

estimate the possible return from leadership intervention” (p. 777). They called this the return on development investment (RODI) (Cascio, 1991; Cascio & Boudreau, 2011).

The important implications of each of these meta-analyses are that they demonstrate significant effects that leadership development interventions have on producing positive outcomes, and they also provide a basis to consider the impact of leadership development interventions in terms of a monetary RODI. This research prepared the way for Avolio et al. (2010) to publish an even more recent study, one of the first of its kind, that combines meta-analytic data with a common method of utility analysis to estimate RODI (Cascio & Boudreau, 2011; Hunter & Schmidt, 1982).

Although the current study does not calculate effect size values, they are an important variable used in RODI analysis. Thus, a basic understanding of these values can be found in research literature that provides meaning to effect size values (Cohen, 1977; Collins & Holton, 2004; Glass, McGaw, & Smith, 1981; Lipsey, 1990). Lipsey (1990) categorized effect sizes into three groups: (1) Small effects (less than .32), (2) Medium effects (.32 to .55), and (3) Large effects (greater than .55). Cohen (1977) suggested the following standards: (1) Minimal effects (.2), (2) Moderate effects (.5), and (3) Meaningful effects (.8). Collins and Holton (2004) used the following ranges in their interpretation of effect sizes for their meta-analysis: (1) Small effects = .32, (2) Medium effects = .32 to .65, and Significant effects = greater than .65. It was not necessary to assign values to the effect sizes in the current study but rather, important to provide the reader a frame of reference for effect size interpretation.

Estimating RODI Using Meta-analytic Data and Utility Analysis

Utility analysis and ROI research has been extended to evaluate interventions that attempt to improve human performance. More recently, it has been noted that ROI methodology is

becoming a useful means to help determine the financial impact of leadership development interventions and other organizational programs (Avolio et al., 2009; 2010; Cascio, 1991; Cascio & Boudreau, 2011). One important study demonstrating this is Avolio and colleagues' (2010) RODI research, which has provided a foundation toward further understanding ROI of human capital intervention and its theoretical underpinnings. Building on the RODI methodology reported in the Avolio, et al. (2009) study, Avolio and colleagues (2010) provide the first study solely dedicated to RODI estimation.

Return on development investment (RODI) is an estimate of the dollar value associated with making leadership development investments in human capital. In particular, Avolio and colleagues (2010) focused on the development of upper- (called “high” in Avolio et al. (2009)) and mid-level leaders, and upper- and mid-level followers. Then, they estimated RODI using a popular and well-researched method of utility analysis proposed by Casico and Boudreau (2010), which is a derivative of the Brogden-Cronbach-Gleser Model (Brogden, 1946, 1949; Cronbach & Gleser, 1965).

The equation used in their RODI study is illustrated using the following variables (Avolio, et al., 2010; p. 635):

$$RODI = (N)(T)(d_t)(SD_y) - C$$

Where:

N = number of participants in development intervention.

T = expected time duration of change in leadership behaviors (converted to fraction in years such that a year and 6 months would be 1.5).

d_t = effect size of intervention, also considered as the average difference in outcomes between trained participants and untrained counterparts.

SD_y = standard deviation of dollar valued job performance among untrained employees. When dollarized performance metrics are not available, the performance metric may be a function of 40% of annual salary. In this case, 40% of one's annual salary is a conservative estimate of that individual's dollar value to the firm in terms of performance.

C = total cost of training the expected number of participants.

Using the RODI methodology, Avolio and colleagues (2010) demonstrated substantial returns from investing in the development of upper- and mid-level leaders, as well as upper- and mid-level followers, ranging from (\$460,588) to \$5,811,600. This research is important to the advancement of leadership development intervention because it provides a clear financial RODI through use of utility analysis, which is a popular and well-studied method in the world of finance (Avolio et al., 2010). However, although this research provides a strong theoretical basis for determining RODI in particular, it has limited scope due to the assumptions, limitations and its estimation ability, including its ability to measure any returns on leadership diffusion.

One important variable limitation was the range of effect sizes used in the Avolio and colleagues (2010) study, which was the foundation of the RODI analysis. Effect sizes were included as variables in the RODI formula, symbolized as d_t , which signified the “true difference in performance between the trained and untrained groups in SD units” (Cascio & Boudreau, 2011, p. 290). As a matter of practicality, rather than attempt a nearly impossible task of generating a distribution of effect sizes using basic statistical and arithmetical means, Avolio and colleagues (2010) used the average effect size and two other points of measure for a high and low value. These high and low values were determined using “50 percent of the confidence interval, such that the high prediction is not as high as the meta-analysis would prescribe and the

low estimate not as low, in order to avoid over or under predicting the RODI” (Avolio et al., 2010, p. 636). These three effect sizes were assigned such that the (1) higher effect size was associated with upper-level leaders and the (2) average effect size associated with mid-level leaders. Avolio et al. (2010) determined both upper- and mid-level follower effect sizes by halving the effect sizes of upper- and mid-level leaders. To further simplify the analysis, a linear assumption was made to double the effect size for double the intervention length such that a 1.5-day training intervention extended to a 3-day intervention would entail twice the effect size.

Regarding intervention effect duration (T), or the influence duration that a leader would have on a follower as a result of the intervention, the Avolio et al. (2010) study assumed a single duration time that was used for all levels of leadership and followership. The researchers suggested, “it is plausible that leadership performance may decrease after the close of the intervention (training) as the participant begins to struggle to apply new skills and knowledge learned in the intervention” (Avolio, et. al., 2010, p. 639). The time of intervention effect duration assumed was 2 months (.167 years). However, the researchers admitted that their 2-month assumption was a conservative intervention effect estimate stating, “a highly salient event could affect someone for years as opposed to months” (p. 639). This is an important observation considering the growing conviction that leadership development effects could last much longer – even multi-year (Avolio, et al., 2010). Further, this notion that leadership may have longer-term effects supports the theory that a diffusion of leadership from one level of leader to another be a substantial contributor to the return on investment from leadership development intervention. Avolio et al. (2010) did make an effort to demonstrate this type of diffusion effect in their study.

The value of one SD of change in performance (SD_y), which required salary data, was also needed to calculate RODI. Avolio and colleagues (2010) conducted interviews to gather

salary data and then made salary assumptions for upper-, mid- and lower-level leaders. Specifically, they assigned a \$100,000 salary for upper-level leaders, \$75,000 for mid-level leaders, and \$50,000 for followers of mid-level leaders. Then, using the salary-based estimation approach as a valuable means to estimate RODI (Cascio & Ramos, 1986; Casico & Bordeau, 2011), Avolio and colleagues (2010) multiplied each average salary times 40%. This allowed them to effectively determine the economic value of one standard deviation of performance to be used as a variable in the RODI formula.

Their calculations indicated the following values associated with one standard deviation of performance: \$40,000 salary for upper-level leaders, \$28,000 for mid-level leaders, and \$20,000 for followers of mid-level leaders (Avolio et al., 2010). However, Avolio and colleagues (2010) did state that future research should consider the use of more representative salary data to estimate RODI. Considering the vast amount of salary data available such as from the United States Bureau of Labor Statistics or other data sources, this was a valuable suggestion since this could only further validate the estimation of RODI.

Avolio and colleagues (2010) estimated the cost (C) of leadership development intervention by developing a cost structure that was based mostly on data collected from Fortune 500 companies as well as trainee costs. This cost structure included three levels: (1) on-site, (2) off-site, and (3) on-line local. Each level included costs such as: (1) direct training costs (e.g., training facility, instructor, technology), including costs associated with the participant (meals, travel, hotel, production time,); (2) loss of production time, or the cost for participants being away from their jobs (e.g., loss of hourly salary and loss of work productivity); and, (3) time in participant salary, or the participant's daily wage salary multiplied by the time spent engaged in

the intervention. Costs were adjusted as well for the length of developmental intervention such as 1.5-day and 3-day training interventions.

The Avolio et al. (2010) RODI analysis was valuable in advancing estimation of return on investment from leadership development intervention. Results of their analysis reported that only a moderate effect size is needed to produce a positive substantial return on investments in leadership development intervention, ranging from a negative (\$460,588) to as high as \$5,811,600. This is evidence that even moderate efforts spent investing in human capital can be monetarily rewarding to organizations. Even further, Avolio and colleagues (2010) suggested that this type of analysis can be effective in helping organizations determine the value of a leadership development intervention before it is even implemented; thus, saving the organization money from making a poor investment.

As with any pioneering efforts in the field of academia, researchers often have certain study design limitations depending on the amount of research that precedes their efforts. Due to the fact that little to no research has been conducted regarding the estimation of RODI, the Avolio et al. (2010) study incorporated reasonable delimitations in their RODI analysis but also had certain limitations due to study design. Should these delimitations and limitations be reduced, this could even further validate the use of utility analysis to estimate the value of leadership development intervention and RODI.

Recognizing that leadership development is multi-level involves more than one person and can be diffused to others (Avolio et al., 2010; Berson & Avolio, 2004), Avolio and colleagues (2010) also attempted to estimate leadership effects that may diffuse from a higher level of leadership to a lower level. However, there were several limitations to their diffusion analysis. Being able to more accurately estimate the diffusion effects from leadership

development intervention could not only highlight the importance and value of further developing leaders and its RODI, but it could also provide greater encouragement for researchers to further study the effects of leader diffusion on organizational productivity.

Another limitation mentioned was that their assumptions and calculations were mostly conducted with data taken from larger organizations rather than small or medium-sized organizations, and they could have biased certain assumptions such as cost structure. Extending the RODI methodology by using more representative data could likely make estimating RODI for all organizations, regardless of size, more reasonable and practical.

Despite these limitations, Avolio and colleagues' (2010) approach is understandable given the limited ability to calculate RODI without the use of other statistical means, which could allow sensitivity of variables and the ability to stochastically model data using computer simulation modeling. Computer simulation modeling would allow the ability to address many of the delimitations and limitations of their RODI analysis regarding effect size distributions, salary representation, diffusion effects, and intervention effects. It can also provide a more practical means of reporting of results. Therefore, by reducing limitations of the previous study, computer simulation modeling could provide a better means to estimate or predict RODI. Additionally, computer simulation modeling can provide the ability to break new ground by estimating the return on investment of the diffusion of leadership from one level to the next (also known as cascading effect of leadership), which the current study calls the return on leadership diffusion (ROLD).

Leadership Diffusion (The Cascading Effects of Leadership)

Bass, Waldman, Avolio and Bebb (1987) first used the terms “cascading of leadership” and “falling dominoes” when referring to leaders at higher-level positions demonstrating

subsequent leadership effects that flow to lower-level follower behavior. Bass, et. al., (1987) provided evidence of research supporting cascading of leadership stating that subsequent behaviors of followers were exhibited similar to that of their top managers across a variety of industries (Bowers & Seashore, 1996; Misumi, 1985; Ouchi & Maguire, 1975; Stogdill, 1955). Stogdill (1955) reported that participatory leadership of subordinates at lower levels in the organization was found to be dependent upon the practice of leadership at higher levels, demonstrating a sense of hierarchical cascading effect trickling down to lower organizational levels. In more recent research literature, Avolio, Avery and Quiseberry (2010) hypothesized that leadership development is multi-level, involving multiple people and is “typically diffused and cascaded to others” (Berson & Avolio, 2004). Avolio, et al. (2010) uses an analogy to describe this hypothesis:

A CEO who improves upon his or her leadership abilities is likely to positively impact his or her direct team of VPs, who in turn may enhance the effectiveness of their direct and indirect followers as various types of performance associated with effective leadership cascades throughout an organization (p. 636).

This cascading effect is also described as a type of role-modeling process that has a transformational leadership component where senior level leader styles cascade to subsequent (lower) levels of the organization (Bass, 1990; Bass et al., 1987; Waldman & Yammarino, 1999). In a study testing a trickle-down model of the cascading of ethical leadership, Mayer et al. (2009) reported “a positive relationship between top management and supervisory ethical leadership” (p. 9) and that their results were “consistent with extant theory and research that top management leadership cascades down to employees” (Bass et al., 1987, p. 11; Bass, 1990). Hannah et al.

(2008) described similar cascading effects, speculating that social networks play a key role in the cascading effect of leadership. They hypothesized that an efficacious upper management team is expected to have a cascading leadership effect among its direct followers as well as its indirect followers through linkages from social network pathways (Hannah et al., 2008).

Shaping of behaviors is also connected to the cascading of leadership effect in that top level managers can shape subsequent follower behavior through systems and processes that are put into practice within the organization (Jansen, Vera & Crossan, 2009). In the current study, this cascading effect of leadership and shaping of leader behaviors is referred to as the diffusion of leadership or leadership diffusion. This semantic distinction was identified as being more fitting after a review of both cascading leadership as well as research conducted by Rogers (2003), who studied the diffusion of innovations. Rogers (2003) identified several characteristics that occur throughout the life of an innovation that affect the adoption of the innovation, such as its adoption rate. The adoption rate gives meaning to how, why, and at what rate an innovation (e.g., news and technology) is diffused and spreads throughout a culture.

Diffusion research began as early as 1943 but has roots in the 1900s from a French lawyer named Gabriel Tarde, who authored the book *The Laws of Imitation* (Tarde, 1903). Rogers (2003) stated:

Tarde identified the adoption or rejection of an innovation as a crucial outcome variable in diffusion research. He observed that the rate of adoption of a new idea usually followed an S-shaped curve over time. Astutely, Tarde recognized that the takeoff in the S-shaped curve of adoption begins to occur as opinion leaders in a system use a new idea... [Thus], Tarde's key word, 'imitation,' implies that an individual learns

about an innovation by copying someone else's adoption of the innovation, implying that diffusion is a social process of interpersonal communication networks (pg. 41).

Innovation as defined by Rogers (2003), "is the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). It is a two-way process of information exchange that can involve continuous cycles of communicating messages that mostly contain new ideas. It involves a type of social change that occurs when "new ideas are invented, diffused, and adopted or rejected, [which] lead to certain consequences" (p. 6). Diffusion can be planned or spontaneous, and related to its definition, has four main elements: (1) the innovation itself, (2) communication channels, (3) time, and (4) a social system (Rogers, 2003). This concept of diffusion parallels the current study in its relation to the diffusion of leadership from leadership development intervention.

Innovation, a part of the diffusion process, is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p.12). Specifically, Rogers (2003) suggested that diffusion occurs throughout an Innovation-Decision Process by stating:

The innovation-decision process is the process through which an individual (or other decision-making unit) passes from gaining initial knowledge of an innovation, to forming an attitude toward the innovation, to making a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. This process consists of a series of choices and actions over time through which an individual or a

system evaluates a new idea and decides whether or not to incorporate the innovation into ongoing practice (p.165).

The individual or decision-making unit goes through a process involving knowledge acquisition, an attitude formation, a decision to adopt or reject the innovation, implementation, and confirmation of the decision. This Innovation-Decision Process, though having some dependency on certain prior conditions (i.e., previous practice, felt needs/problems, innovativeness, norms of the social system (Rogers, 2003, p. 170), contains five stages: (1) Knowledge, (2) Persuasion, (3) Decision, (4) Implementation, and (5) Confirmation (Rogers, 2003).

Over time and after a series of choices and actions, the new idea is further evaluated and either consistently practiced or not, adopted or not adopted (Rogers, 2003). Certain characteristics of the decision-maker and the innovation can influence the Innovation-Decision Process. Characteristics such as socioeconomic status, personality, and communication behavior can impact the decision-making unit, especially during the knowledge stage. During the persuasion stage, the innovation itself can have five attributes, or innovation characteristics, that vary and influence the rate at which a decision is adopted or rejected: (1) Relative advantage, (2) Compatibility, (3) Complexity or simplicity, (4) Trialability, and (5) Observability (Rogers, 2003).

The entire Innovation-Decision Process is “essentially an information-seeking and information-processing activity in which an individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation” (Rogers, 2003, p. 14). As a whole, this process circles back to address the four main elements of the diffusion process previously mentioned, which involves: (1) the innovation itself, (2) communication channels, (3) time, and (4) a social system (Rogers, 2003).

Although studies in the research literature demonstrating the similarities of how the diffusion of leadership may occur are scant, there are theoretical parallels to the Diffusion of Innovations theory. For example, Rogers' (2003) Innovation-Decision Process is strikingly similar to the connection between a leader and follower, such as how a developed leader may diffuse leadership while the follower either adopts or rejects this leader diffusion. In addition, the process of leadership diffusion appears to contain very similar elements to the Diffusion of Innovations.

The first element, innovations, parallels leadership development interventions since they are often applied to individuals or a social system. Innovations are defined as containing newly perceived ideas, practices or objects that do not necessarily have to be a new ideas in an objective sense but just perceived as new by the individual or other adoption unit (Rogers, 2003). Similarly, leadership development interventions can easily contain information that appears “new” to the constantly developing leader, but this does not necessarily mean that the development intervention has to be a “new” theory or model.

The second element, communication channels, is defined as how a message gets from one to another such as interpersonal channels or mass media channels. Diffusion studies have shown that most individuals evaluate innovations based on subjective evaluations from those who either shared the innovation or have already adopted it (Rogers, 2003). One important aspect of the element of communication mentioned by Rogers (2003) is that of homophily and heterophily; the degree to which people interact because of similar (homophily) or different (heterophily) attributes. Thus, regarding leadership diffusion, previous research has reported that not only do social networks have an impact on leader diffusion but so does leader modeling, and it very reasonable to assume these two components are impacted by both homophily and

heterophily (Avolio et al., 2009, Avolio et al., 2010; Bass et al., 1987; Bass, 1990; Berson & Avolio, 2004; Bowers & Seashore, 1996; Hannah et. al, 2008; Jansen, Vera & Crossan, 2009; Misumi, 1985; Ouchi & Maguire, 1975; Stogdill, 1955; Waldman & Yammarino, 1999).

Time is the third element mentioned, which Rogers (2003) states can be measured three ways. First, the time element can be measured by the time that passes from the knowledge phase to the adoption or rejection (Innovation-Decision Process). The second way is the time by which an innovation is adopted due to the level of innovativeness. The third way is the time by which the rate of adoption of an innovation, typically measured by the number of individuals in a system that adopts in a particular period of time. Perhaps time is the most interesting method of measurement. It actually measures the speed of an innovation, which has been identified as following a normal, bell-shaped curve that when plotted cumulatively, resembles an S-shaped curve (Rogers, 2003). Leadership diffusion may well have similar S-shaped characteristics when most all members of a system or organization adopts and practice leadership. However, there is also the possibility of leadership diffusion defying the typical “leveling effect” to some degree since the ease of newly perceived leadership development opportunities may be infused and occur more often than individually planned or designed innovations.

The fourth element of the diffusion process is the social system. Rogers (2003) defines social system “as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal, ...[which] can be individuals, informal groups, organizations, and/or subsystems” (p. 23). Several variables identified in the social system that can have an impact on diffusion are the social structure, system norms, opinion leaders and change agents, types of innovation-decisions, and consequences (Rogers, 2003). Social systems can influence leaders in their diffusion ability and followers in their rate of adoptions or rejection such as highlighted by

Hannah et al. (2008), who report that a diffusion effect can be expected to occur from upper management to its followers through linkages from social network pathways.

In order to compare the Innovation-Decision Process to that of a diffusion of leadership experience from a higher-level leader (analogous to a change agent or opinion leader) to a lower level leader (analogous to an adopter), consider the following analogy. With regard to the concept and definition of innovation, this analogy illustrates a synonymous concept of a newly perceived leadership development innovation being diffused from a higher-level of leaderships to lower levels. The individual, or decision-making unit is synonymous with a follower or low-level leader.

Beginning with the knowledge stage as described by Rogers (2003), certain characteristics of the follower would play a significant role, such as socioeconomic characteristics, personality variables, and communication behavior. The follower would be challenged to assimilate these personal characteristics in context of the leadership development situation and be faced with learning about the leadership development principles at hand, including application and functionality, and begin using this knowledge to provide a basis for evaluation.

In the persuasion stage as described by Rogers (2003), which involves the five intrinsic characteristics mentioned previously, the follower would begin forming a certain favorable or unfavorable attitude toward the leadership development experience. This is an important stage as the follower is ultimately evaluating the information gained to reduce uncertainty about any consequences that may be associated with the development experience. This communication process of the leader becoming more amicable with regard to the leader's ability to communicate effectively his or her passion, convictions, philosophies, and facts can create a charismatic level

of persuasion that influences the follower. Making a decision to accept or reject this leader philosophy and charism could likely become more and more necessary as time goes on. The follower could likely begin to experience increasing pressure to either succumb to some level of acceptance of followership or grow more distant and avoid this leader influence.

Once followership is conceded, he-she (the “adopter”) is then compelled to implement a similar manner of living this leader-driven mentality throughout his or her own unique lifestyle. The decision stage is a where a choice is made to either adopt or reject the leadership development principles and practices being diffused. The implementation stage would involve an “overt behavior change as the new idea [or leadership development experience] is actually put into practice” (Rogers, 2003, p. 179).

The confirmation stage as described by Rogers (2003) would involve the seeking of reinforcement for the decision made to avoid a state of cognitive dissonance. Over time, his or her ability to continue this behavioral path of leader diffusion, amidst the unique trials that only a leader can attest, is solidified by follower confirmation that the decision to lead is productive, accepted, and possible. However, if there is an imbalance or great enough gap between new leader confidence and an ineffective leadership or lack of diffusion, there is the possibility of discontinuance, or the decision to reject this leader diffusion once adopted (Rogers, 2003).

The comparison above suggests that there is a social and psychological process that occurs regarding the diffusion of leadership. This process involves (1) a new leadership development experience or intervention (innovation), (2) leaders diffusing this leadership to followers who hopefully decide to adopt the intervention, and (3) implementation and confirmation of this decision (adoption). This ultimately leads to diffused leadership. In relation to the Innovation-Decision Model (Rogers, 2003), it is logical to conclude that leader diffusion

occurs when a follower is engaged or many followers are engaged in a process of becoming more knowledgeable of a purpose, mission, goal, vision, leadership principal or some other aspect or purpose of leader influence, then decide to follow, adopt and implement this leadership innovation as their own.

Rogers (2003) mentions that there is an innovation process that occurs within organizations. In particular, during the agenda-setting stage of this organizational innovation process, needs and problems are identified. Innovative ways are determined to address these needs and problems, all of which are recognized by discrepancies between actual performance and the organization's expectations, or performance gaps (Rogers, 2003). Rogers (2003) states that these performance gaps can actually initiate the innovation process. In the case of leadership development needs, it is reasonable to assume that the mere identification leadership gaps, likely recognized by performance gaps, would inevitably initiate leadership development intervention, either formally or by diffusion.

An even more striking observation of the Diffusion of Innovation theory is the S-shaped distribution of adoption of innovations, which can be useful in further understanding the nature of leadership diffusion (Rogers, 2003). In Rogers (2003) Diffusion of Innovations theory, those involved in the adoption process are categorized into one of 5 categories: (1) innovator, (2) early adopter, (3) majority adopter, (4) late adopter, and (5) laggard. Categories are assigned based on the rate of adoption as promoted by change agents or opinion leaders (Rogers, 2003). This adoption process has many parallels to that of the diffusion of leadership and the social and human factors involved. For example, Rogers (2003) states the following:

Many human traits are normally distributed, whether the trait is a physical characteristic, such as weight or height, or a behavioral trait, such as

intelligence or the learning of new information...If a social system is substituted for the individual in the learning curve, it seems reasonable to expect that experience with the innovation is gained as each successive member in the social system adopts it. Each adoption in the social system is in a sense equivalent to a learning trial by an individual (in fact, if the individual tries the innovation prior to adoption, each adoption is indeed a learning trial) (p. 273).

Further, Rogers (2003) states:

We expect a normal adopter distribution for an innovation because of the cumulatively increasing influences upon an individual to adopt or reject an innovation, resulting from the activation of peer networks about the innovation in a system. This influence results from the increasing rate of knowledge and adoption (or rejection) of the innovation in a system. We know that the adoption of new ideas resulting from information exchange through interpersonal networks. If the first adopter of an innovation discusses it with two other members of the system, each of these two adopters passes the new idea along to two peers, and so forth, the resulting distribution follows a binomial expansion, a mathematical function that follows a normal shape when plotted over a series of successive generations. The process is similar to that of an unchecked infectious epidemic (Bailey, 1975) (Rogers, 2003, p. 274).

It has been shown that internationally, “the adoption of an innovation typically follows a normal, bell-shaped curve when plotted on a frequency basis” (Rogers, 2003, p. 272). When this

data is plotted cumulatively, the result is an S-shaped curve. This demonstrates the rate of adoption begins relatively slowly, then speeds up until most all have adopted. The rate then begins to slow and level out as it gets closer to carrying capacity. This S-shaped curve has been confirmed to occur within organizations when the cumulative distribution of adopters of an innovation is plotted over time (Rogers, 2003).

S-shaped curves are based on an exponential growth relationship, which is considered one of the fundamental modes observed in the behavior of a system (Rogers, 2003; Sterman, 2000). Exponential growth has remarkable properties. For example, in the case of leadership diffusion, in theory would mean that it would take the same length of time for one leader to diffuse leadership to three lower-level leaders as it would for thirty leaders to diffuse leadership to ninety lower-level leaders; or, one hundred leaders to diffuse to three hundred – within the same time frame (e.g. two months as used in the Avolio et al. (2010) RODI analysis) (Sterman, 2000). Those 300 leaders would likely have some leader diffusion effect on those with whom they encounter, and it can go on, and on. This means that exponential growth has compounding properties such as found in population growths and compound interest. A minimum but consistent investment in an exponential environment can reap significantly high returns on investment over time and can be demonstrated using numerous exponential formulas depending on the nature of the system studied.

There are several different mathematical equations to calculate this exponential effect. Reverend Thomas Robert Malthus became one of the first pioneers of population growth theory after he authored his book “An Essay on the Principle of Population” (Malthus, 1826). He was later deemed the founder of The Malthusian Law or exponential law. Out of this law was born the Malthusian growth model, also called the simple growth model, which has been known for

its simplicity and usefulness in making short-term predictions. The Malthusian growth model equation is stated as below but is limited in its ability to make predictions greater than 10-20 years since it does not take into account carrying capacity. The reason for these limitations is due to the fact that it is a continuous exponential growth model and does not take into account a maximum population level (Pearl & Reed, 1920; Verhulst, 1838; Verhulst, 1977).

$$\frac{dN}{dt} = rN_o \text{ or } N(t) = N_o e^{rt}$$

Where:

$\frac{dN}{dt}$ = change in population (N) for every change in time (t),

N_o = initial population number,

e = base of the natural logarithm; approximately equal to 2.718281828,

r = growth rate (also called the Malthusian Parameter), and

t = time period (i.e. minutes, hours, weeks, months, years, etc.).

Pierre Francois Verhulst (1838; 1977) expanded upon the Malthusian growth model and developed the logistic growth model. Verhulst was a scientist interested in population growth. He theorized that population growth depends on both the population size and its upper limit. As the population starts to grow, it goes through an exponential growth phase. However, once growth reaches about half of the carrying capacity, it begins to slow down and eventually level off. This creates a sigmoid (S) curve and his formula is represented below. Pearl and Reed (1977) came to the same conclusion independently of Verhulst's research.

$$N_{t+1} = rN_t \left(\frac{K - N_t}{K} \right)$$

Where:

N_{t+1} = population size at the next time period (i.e. the next hour, day, year, etc.),

r = the Malthusian factor (the multiple that determines the growth rate),
 r = time period (i.e. minutes, hours, weeks, months, years, etc.),
 K = carrying capacity (the total number of the population to be affected), and
 N_t = population size at time t .

The model's simplicity and popularity, especially in population biology, has been useful for scientists and has become a foundation for research in many fields (Bergon et al., 1996; (Bergon, Harper, & Townsend, 1996; Brauer & Castillo-Chavez, 2000; Edelstein-Keshet & Ermentrout, 1998; Kingsland, 1982). Considering the limitation of the Avolio et al. (2010) RODI analysis, this formula may well be the most appropriate to estimate a possible return on leadership diffusion.

Leadership is multi-level, involves more than one person and effects are typically diffused and cascaded to others. Further, leadership diffusion is used synonymously with a term found in leadership development literature referred to as the "cascading effect of leadership," also known as the "falling dominoes effect" (Avolio, et al., 2010; Bass, 1990; Bass et. al., 1987; Berson & Avolio, 2004; Bowers & Seashore, 1996; Hannah et al., 2008; Mayer et al. (2009); Misumi, 1985; Ouchi & Maguire, 1975; Rogers, 2003; Stogdill, 1955; Waldman & Yammarino, 1999). This diffusion effect was stated well by Avolio et al. (2010) with the following example:

[A] CEO who improves upon his or her leadership abilities is likely to positively impact his or her direct team of VPs, who in turn may enhance the effectiveness of their direct and indirect followers as various types of performance associated with effective leadership cascades throughout an organization (p. 636).

It was further postulated that there are several parallels to the leadership diffusion process compared to the Diffusion of Innovations theory as proposed by Everett Rogers (2003). When leadership development intervention occurs, this parallels the Innovation-Decision Process, which not only identifies certain ideas or practices and influences those who follow, but also inspires and encourages them to adopt and practice these ideas. Further, performance gaps can initiate innovation, which in the case of leadership development may also stimulate the leadership development intervention process as well as the diffusion process.

The mathematical depiction of how innovations are adopted within a system has many parallels to the concept of how leadership could likely diffuse throughout an organization. The logistic growth model, a popular model based on exponential growth, estimates the number of additional leaders formed by diffusion from the effects of leadership development intervention. Using this model in conjunction with computer simulation modeling would allow the ability to determine an approximate number of individuals impacted from higher-level leaders who were exposed to a leadership development intervention, demonstrating a leadership diffusion effect from a higher level of leadership to a lower level. The use of a computer simulation model would allow the variables of the logistic equation, as well as other variables, to be automatically randomized and simulated a near unlimited number of times. This would allow researchers to simulate RODI analysis as many as 10,000 times or more with random variable inputs. In the event that this is possible, it would provide a valuable addition to Avolio and colleagues' (2010) research.

Using Computer Simulation Modeling to Estimate RODI and ROLD

There are a variety of ways to determine the effectiveness of leadership development intervention using utility analysis methodology. However, from a practical standpoint, using

traditional means to conduct study after study in an attempt to further validate findings is surely necessary, however not always the most practical or effective means. Individual or traditional study designs can limit research potential in a variety of ways. For example, certain study objectives may need more complex methods than traditional research can provide. For example, the scale of the study may be too large or small, it may need faster, more robust manipulation, there may be ethical issues, or the study may pose some type of danger to subjects. Computer simulation modeling provides a possible solution to dealing with these types of issues by reducing certain practical limitations that often plague non-simulation studies. Due to its breadth and ability to study complex situations that traditional research cannot support, the use of computer simulation modeling has become increasingly popular in expanding our understanding of collective behavior in areas such as anthropology, psychology, economics, sociology and business (Goldstone & Janssen, 2005; Kelton et al., 2010; Kenrick, Li, & Butner, 2003; Kirman & Zimmerman, 2001; Kohler & Gumerman, 2000; Latane & Bourgeois, 2000; Macy & Willer, 2002; Srbljinovic & Skunca, 2003). Therefore, it is fitting to describe computer simulation modeling as having a “role similar to mathematics in the natural sciences” (Srbljinovic & Skunca, 2003; p. 3).

Computer simulation modeling stems from a computational model methodology and has progressively become more useful since its inception over 40 years ago (Kelton, Sadowski, & Swets, 2010). Throughout this time, it has been applied to various issues in top-management and other applications (Forrester, 1999; Kelton, Sadowski, & Swets, 2010). Despite its use in the automobile, steel, and aerospace industries from 1950 to 1970, simulation did not manifest in business until around the late 1980s. Its popularity up to this point was not void of growth. The period between the 1950s and 1960s has been termed the pioneering period of simulation with

the 1970s described as the onset of a period of innovation (Robinson, 2005). This innovation period led to a type of simulation revolution as the computer industry became more feasible and applicable to organizations (Robinson, 2005). Although dramatic change subsided, simulation maturity evolved throughout business in the 1980s, then through the 1990s to the present. Since the 1990s, simulation has become more useful in earlier stages of projects, providing a greater impact on and use for systems analysis, design, and implementation with social systems (Kelton et al., 2010; Robinson, 2005).

In a growing technological world, computer simulation modeling has steadily become even more useful across inter- and intranet networks providing remote analysis, more end-user flexibility with programmable software, and the ability to assist in strategic and operational decision making (Kelton et al., 2010). It can be used effectively as an experimental approach to understand, and mimic, system behavior (Forrester, 1999; Kelton, Sadowski, & Swets, 2010). Social scientists have recreated systems to mimic real data to validate the efficacy of computer simulation modeling.

A classic example of computer simulation modeling that demonstrates how leadership might diffuse throughout an organizational culture can be found in Axelrod's (1997) cultural research. (Axelrod, 1997) simulated population culture using a computer simulation model called the Cultural Model. The Cultural Model examined beliefs and attitudes and their convergence or divergence in a population over time. In his study, Axelrod (1997) used the term culture "to indicate the set of individual attributes that are subject to social influence" (p. 204) and added that "people are more likely to interact with others who share many of their cultural attributes, and interactions between two people tend to increase the number of attributes they share" (p. 206). Thus, he was able to accurately model real past behavior that had already occurred.

Ironically, the Cultural Model is relevant to the social influence within the process of leadership diffusion.

Axelrod (1997) also described seven purposes of simulation conducted within the social sciences: (1) prediction, (2) training, (3) performance, (4) proof, (5) entertainment, (6) education, and (7) theory. However, depending on the nature of the research and precluding data, the determination of the main criteria or what type of simulation to use over another is debatable (Lorenz & Jost, 2006). To help aid this process, Lorenz and Jost (2006) proposed three criteria to consider: (1) what (object of the simulation study), (2) why (purpose of the study) and (3) how (simulation method).

Considering there is no known research that has attempted to study the financial impact of leadership development intervention and diffusion (the what) in order to better predict return on leadership development (the why), the current study proposes discrete-event computer simulation modeling (how) be used. To support this conclusion, Brailsford and Hilton (2001) provide several points that illustrate the applicability of discrete-event computer simulation when comparing technical differences between discrete-event and other methods such as system dynamics:

1. Systems (such as healthcare) can be viewed as networks of queues and activities.
2. Objects in a system are distinct individuals (such as patients in a hospital), each possessing characteristics that determine what happens to that individual.
3. Activity durations are sampled for each individual from probability distributions and the modeler has almost unlimited flexibility in the choice of these functions and can easily specify non-exponential dwelling times.
4. State changes occur at discrete points of time.

5. Models are by definition stochastic in nature.
6. Models are simulated in unequal time steps, when “something happens.”

Considering these points, and that using computer simulation modeling to predict return on development investment (RODI) and diffusion investment (ROLD) is still in very early stages of development, the discrete-event method is more suitable than the complexity of agent-based, dynamic systems or continuous models. Other modeling techniques may provide additional insight to the impact of leadership development interventions. Further, it can reasonably be argued that these modeling techniques would allow for a robust design by including interactions between agents (agent-based), continuous looping of model behavior (continuous), or a modeling that replicates the changing nature of interactions within systems (dynamic) (Forrester, 1999; Kelton, Sadowski, & Swets, 2010; Sterman, 2000). However, a discrete-event simulation model provides a much less complex means of estimating RODI, and the use of these other simulation models are beyond the scope of the current research. For example, although agent-based models could effectively model human behavior such as specifying rules and consequences of agent interaction, discrete-event simulation modeling limits the study to non-interaction of agents (Canessa & Riolo, 2003). Further, it is still too early in the developmental stages of research regarding RODI estimation using computer simulation modeling to know whether an agent-based model, or any other model for that matter, would adequately suppress RODI (lower RODI), more accurately predict, or amplify the results (increase RODI).

Additional levels of complexity would not only complicate interpretation of results but also require further study to determine the type and level of effect that certain extraneous factors (e.g., developmental readiness, personality, and attitude) may have on leadership development intervention effects (Srblijinovic & Skunca, 2003). Although this would be valuable research to

further advance the field of leadership development intervention and RODI, more foundational research studying RODI using computer simulation modeling needs to be conducted. To further validate the use of discrete-event modeling, Robinson (2005) provides several applications (p. 25):

1. Emulation to aid the design of control systems
2. Scheduling
3. Predicting future performance
4. Real-time control
5. Training

Although several of these applications could be associated with simulating RODI, one important application is to predict future performance associated with leadership development interventions. This could provide organizational leaders the ability to predict future outcomes and make more informed decisions whether to invest in a leadership development intervention in the first place, even potentially assisting these leaders in program design by identifying the most appropriate intervention with the highest RODI.

Discrete-event simulation is described as being a method that is dynamic and stochastic, or random (Law & Kelton, 1982). It provides a system that allows for change in a finite set of variables with specific instances in time. For example, March (1991) studied exploitation and exploration in organizational learning using discrete event simulation, hypothesizing that through refining exploitation faster than exploration, adaptive processes would be more effective short-term but self-destructive long-term. This study used different variable entities: reality, organizational code, and individuals, to determine the trade-off between the exploitation of current knowledge and the exploration of new ideas. March (1991) explained, “Exploration

includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution” (p. 71). The impact of exploration versus exploitation of learning is seen in the case where an unbalanced, greater focus on exploration could result in an abundance of new ideas with little competence, posing a greater cost to the organization than benefit. However, too heavy a focus on exploitation of learning could paralyze the organization, causing it to settle on current organizational competencies rather than allowing new learning and ideas to stimulate organizational learning and practice.

Regarding the simulation design and entities used, “reality” was defined as the organization’s environment and was represented by a string of 1s and -1s, whereas “organizational code” was represented as conventional wisdom or organizational culture, and represented by 1s, 0s (no opinion) and -1s. Lastly, “individuals” were defined as members of the organization, whose knowledge varies and is represented by 1s, 0s and -1s. This allowed the model to simulate variables in a variety of ways such as holding reality constant, while randomizing organizational code and individuals. As time moves forward, reality would remain constant while both the individual learning rate and organizational learning rate vary (March, 1991).

The value of the March (1991) discrete-event computer simulation model is its ability to model the effects of learning outcomes and explore the tension between exploration and exploitation of learning. Results of the simulation indicated:

1. The higher the learning rate, the quicker the system can achieve equilibrium.
2. A heterogeneous mix of learning (slow and fast) has a greater effect than a homogenous set of learners.

3. Faster individual learning does not necessarily lead to faster organizational learning.
4. The greater the turnover, the less average socialization time and individual knowledge. Thus, if people learn quickly, moderate amounts of turnover can speed up organizational learning.

Considering the cost of turnover in organizations, which is 1.5 to 2 times the salary of the individual (Cascio, 1991), this model demonstrates that certain amounts of turnover could actually be of value. Thus, it would be interesting to further study the value of minimal turnover and its impact on exploration versus the cost. Simulation modeling is validated as it can provide a means to speculate a construct and further develop the theory if it is appropriate.

However, assigning values of 1s, 0s and -1s is not the only way to use discrete-event simulation modeling. It can be designed to use quantified empirical data from research to conduct multiple mathematical computations in one instance. This is an advantage over more traditional research methods since computer simulation modeling provides the ability to create distributions of data and randomized the variables as they are entered into the computations. In discrete-event simulations, events are the main focus and when events happen, changes in the system occur at discrete points of time. Further, the “the activity duration of these events [can be] sampled from probability distributions” (Chahal & Eldabi, 2010, p. 189). Thus, in the current study, discrete-event simulation is used in order to model probability distributions of variables of leadership development intervention using current meta-analytic data to predict future RODI and ROLD. This simulation technique allows the researcher to create multiple probability distributions of the data, or events, and randomly assign values to the RODI equation, simulating tens of thousands of individual studies and creating a probability distribution of tens of thousands of variables.

The lack of computer simulation research studying RODI appears to limit the potential value that other types of simulation modeling could provide when estimating the effects of RODI and the diffusion of leadership. The current study's RODI results could likely be suppressed due to this discrete-event limitation, since RODI estimates are likely to be lower for leaders as there are no continuous effects. However, this study design will provide a great foundation for future research, whereas it is most appropriate to begin using more simplistic modeling at such an early stage of RODI research. Therefore, the current study recommends the use of agent-based, dynamic, and continuous modeling in future research but suggests that work should be done to more adequately lay the theoretical foundation for computer simulation modeling of leadership development intervention.

Summary

Several leadership development evaluation approaches such as qualitative, participatory, theory of change, logic models and mixed methods have value in many ways and for many different purposes. However, using experimental and quasi-experimental approaches for evaluating leadership development intervention in conjunction with standard utility analysis provides an empirical means to meet the objectives of the current study, which uses computer simulation modeling to estimate and predict the return on development investment (RODI) and return on leadership diffusion (ROLD) (Avolio et al. 2009; Avolio et al., 2010; Russ-Eft, 2007).

Using meta-analytic data from Avolio and colleagues (2009) and a robust RODI methodology, Avolio et al. (2010) provided support for the research of Burke and Day (1986) and Collins and Holton (2004) demonstrating a moderate to high effect size of .67 from leadership development intervention. They also converted effect sizes into more usable values to advance previous leadership research by estimating RODI, demonstrating significant effects that

leadership development interventions have on producing positive outcomes. Their results indicated that only a moderate effect size is needed to produce a positive substantial return on investments in leadership development intervention, ranging from a negative (\$460,588) to as high as \$5,811,600. This is evidence that even moderate efforts spent investing in human capital can be monetarily rewarding to organizations, help determine the value of leadership development intervention value before it is even implemented, and protect organizations from making poor investments.

Recognizing that leadership development is multi-level involves more than one person and can be diffused to others (Avolio et al., 2010; Berson & Avolio, 2004), Avolio and colleagues (2010) attempted to estimate leadership development effects that may diffuse from a higher level to a lower level of leadership. However, due to scant research regarding the estimation of RODI, Avolio and colleagues' (2010) study incorporated both delimitations and limitations in their RODI analysis that if reduced, could further validate the use of utility analysis to estimate the value of leadership development and RODI.

The leadership diffusion process parallels Diffusion of Innovations theory as proposed by Everett Rogers (2003), as the occurrence of leadership development intervention parallels the Innovation-Decision Process. This process identifies certain ideas and practices that influence followers, and also inspires and encourages followers to adopt and practice these ideas and practices. Performance gaps can initiate innovation and stimulate both the leadership development intervention and the diffusion process.

Another parallel was the S-shaped mathematical depiction demonstrating how innovations are adopted within a system, which is similar to how leadership could likely diffuse throughout an organization. The logistic growth model could estimate the number of additional

leaders formed by diffusion from the effects of leadership development intervention. Using this model in conjunction with computer simulation modeling would allow the ability to determine an approximate number of individuals impacted from the diffusion of leadership from a higher level of leadership to a lower level.

Although other types of computer simulation modeling could be useful to estimate RODI and are encouraged for future research, this literature review discusses the applicability of discrete-event simulation modeling and how it would best allow sensitivity of variables. It also addresses several of the delimitations and limitations of the Avolio et al. (2010) RODI analysis. This literature review also allows distributions of variables using as many as 10,000 randomly generated data points, which could be randomly sampled and used as variable inputs for the RODI equation. Overall, computer simulation modeling could provide a better means to estimate or predict RODI and break new ground by estimating RODI and ROLD.

CHAPTER 3: RESEARCH DESIGN AND METHOD

The essence of this simulation methodology is to generate probability distributions from known salary, effect size, intervention effect duration and intervention cost data, and then randomly sample values from these distributions to estimate return on development investment (RODI). The presentation of this simulation methodology as an analytical technique is different than in a traditional study.

Certain study objectives need more complex methods than traditional research can provide to address issues whereas the scale of the study may be too large or small or it may need faster, more robust data manipulation or sensitivity of variables such as in this study. Computer simulation modeling provides a solution to deal with these types of issues by reducing certain practical limitations that often plague non-simulation studies.

Computer simulation modeling has been used to study complex situations that traditional research cannot support, and has been described as having “role similar to mathematics in the natural sciences” (Kelton et al., 2010; Kenrick et al., 2003; Kirman & Zimmerman, 2001; Kohler & Gumerman, 2000; Latane & Bourgeois, 2000; Macy & Willer, 2002; Srbljinovic & Skunca, 2003, p. 3). Further, computer simulation modeling provides flexible programming for the end-user and can be effectively used as an experimental approach to understand and mimic system behavior (Forrester, 1999; Kelton, Sadowski, & Swets, 2010).

A discrete-event computer simulation model was used in this research as the statistical technique to estimate RODI and return on leadership diffusion (ROLD). Discrete-event computer simulation is a robust method that is dynamic, stochastic, and provides a system that allows for change in a finite set of variables with specific instances in time (Law & Kelton, 1982). Therefore, discrete-event simulation was an ideal study design, especially considering that

multiple distributions were in need of calculation and computer technology supported probabilistic calculation of all values necessary; something that is nearly impossible to do by hand with simple arithmetic methods.

To further validate the fit of the discrete-event computer simulation modeling, several areas of application were reviewed for model fit (Robinson 2005):

1. Emulation to aid the design of control systems
2. Scheduling
3. Predicting future performance
4. Real-time control
5. Training (p. 25)

Although several of these applications could be associated with simulating RODI, one of the most important applications is to predict future performance and the RODI from investing in leadership development interventions. This can provide organizational leaders with the ability to not only predict future outcomes, but also make more informed decisions about whether to invest in a leadership development intervention in the first place; not to mentioned assist leaders in program, identifying the most appropriate intervention for with the highest return on investment.

Study Design

This study was designed to estimate RODI of leadership development intervention using several design techniques: known meta-analysis to gather data for the current analysis, return on investment (RODI) as the unit of analysis, and discrete-event computer simulation modeling as the method of analysis and other data for salary, costs, etc.

A current RODI study (Avolio et al., 2010) was also used to gather data and to compute variables needed to estimate RODI. This RODI study and utility analysis research provided the

RODI methodology and framework to estimate RODI as well as the rationale for calculating different variables such as Costs (*C*), intervention effect duration, and performance values. A sizable body of research supports utility analysis, both in social and financial sciences, and its use in predicting returns on investment (Cascio, 1982; Cascio, 1991; Cascio & Boudreau, 2011; Hunter, Schmidt, & Judiesch, 1990; Reilly & Smither, 1983; Schmidt, Hunter, McKenzie, & Muldrow, 1979; Schmidt, Hunter, & Pearlman, 1982).

Unit of Analysis

The unit of analysis for this study was return on development investment (RODI), which was calculated using the standard utility analysis formula (Cascio & Boudreau, 2011; Holton, 2011). Avolio et al. (2010) used an RODI calculation to determine whether leadership development is worth the investment. They specifically discussed the appropriateness of using Cascio and Boudreau's (2011) ROI methodology, which is a modification of the Brogden-Cronbach-Gleser Model (Cascio & Boudreau, 2011), as a method that "allows for evaluating leadership development intervention effectiveness over multiple points in time, rather than at a fixed beginning and end date" (Avolio et al. 2010, p. 635). This methodology has also been used to calculate the ROI of human resource interventions of various training programs including leadership development interventions (Cascio & Boudreau, 2011).

The RODI equation used in the Avolio et al. (2010; p. 635) RODI analysis, as well as in the current study, is listed below:

$$RODI = NTdSDy - C$$

Where:

N = the number of participants engaged in the development intervention

T = the intervention effect duration or the expected duration of change in leadership behaviors

d = the effect size of the intervention or difference between means of trained and untrained participants

SD_y = the value of one standard deviation of performance or 40% of an individual's salary

C = the total training cost of all participants

Data for Analysis

Previous research (ASTD, 2009, 2010; Avolio et al., 2009, 2010; Cascio & Boudreau, 2011; Holton, 2011; U.S. Department of Labor, 2010) provided the information to calculate random distributions of data for effect sizes, d , intervention effect duration, T , the average performance value for individual performance, SD_y , total intervention cost, C , intervention (training) length, IL , and the percent of behavioral objectives relevant to individual performance, P .

Effect size data for leadership development intervention studies was used from research conducted by Avolio et al. (2009) and Avolio et al. (2010), which provided effect size means and standard deviations. These effect sizes represented results of a substantial number of leadership development intervention studies across multiple leadership theories from post World War II to 2008. This research was supported by two previous meta-analyses (Collins & Holton, 2001; Burke & Day, 1986) – all three of which reported moderately positive effects and demonstrated a wide range of effect sizes.

Since financial returns are typically estimated on an annual basis and as an adequate comparison to the Avolio et al. (2010) study, intervention effect duration, T , was based on a

maximum of one year for all leader levels. Salary data was gathered from the United States Bureau of Labor Statistics (U.S. Department of Labor, 2010), which provided data for the average performance value for individual performance, SD_y (Cascio & Boudreau, 2011) and total intervention cost, C . Cost, C , was also calculated using data from the American Society for Training and Development (ASTD) (2009, 2010) and consisted of leadership development intervention cost variables such as lost production time, time in participant salary, and direct training costs. Data for the percent of behavioral objectives relevant to individual performance, P , required the intervention (training) length, IL , which also consisted of intervention length data from ASTD (2009) for upper-level leaders as well as Avolio et al. (2009, 2010) for mid- and low-level leaders.

Method of Analysis

The method of analysis was a discrete-event computer simulation model. Computer coding for the simulated RODI analysis was programmed into *Micro Saint Sharp Meta-Analysis, Version 3.5*, a discrete-event simulation software tool supported by Alion Science and Technology. Alion Science and Technology provides support and capability in areas consisting of human-systems integration, human factors engineering, computer simulation and modeling, and custom software development. Micro Saint Sharp software was chosen because of its flexibility and compatibility with providing simulation solutions to areas such as human factors and other process- and systems-oriented industries that contain human interaction. It also provides a framework to develop a computer model of the process to generate a random distribution of outcomes for predictive purposes, including the ability to incorporate sensitivity analyses for changing variables (Alion Science, 2011).

Probability distributions for each variable were generated, and computer simulation

modeling used random values from those distributions to conduct 10,000 replicates or runs (Allen, 2011) to estimate RODI. Ten thousand replicates are typical in research and provide an adequate number of decimals, which using Micro Saint simulation software, allowed for seven decimal places for each calculation in the current study (Allen, 2011). The outcome was a distribution of RODI outcomes that more accurately predicted return on leadership development interventions (RODI) and leadership diffusion (ROLD).

For all comparisons of RODI, the monetary difference and percent change was used. The monetary value was the difference between the initial value (V_1 , the simulated RODI estimate of interest) and the compared value (V_2 , the Avolio et al. (2010) estimate or other simulated estimate in comparison), illustrated in the following formula:

$$\text{Difference in Monetary Value } (V_d) = V_2 - V_1$$

The percentage change was the difference between the initial value (V_1 , the simulated RODI estimate of interest) and the compared value (V_2 , the Avolio et al. (2010), and then divided by the absolute value of the initial value (V_1); multiplied by 100. The formula is illustrated below:

$$\text{Percent Change } (\% \Delta) = \frac{(V_2 - V_1)}{|V_1|} \times 100$$

Research Questions

The current study addressed whether leadership development interventions provide attractive returns on development investment (RODI), and, whether a working simulation model that randomly incorporates adequate statistical data drawn from meta-analyses and other representative data sources can be used to estimate and predict RODI. Therefore, the following research questions, which included methodological rationale to aid interpretation, guided this discrete-event computer simulation study.

Research Question One

Can the Avolio et al. (2010) RODI analysis be replicated using discrete-event computer simulation modeling by programming variables N , d , T , SDy , and C into the RODI equation?

The variables used to validate and replicate the Avolio et al. (2010) results using the discrete-event simulation model are presented in Table 3.1. Values from each variable in the RODI equation (N , T , d , SDy , C) were taken from the Avolio et al. (2010) RODI analysis to duplicate results for upper- and mid-level leaders at 1.5 and 3-day interventions.

In the first row of Table 3.1, the variable N represented the number of leaders for each level leader/follower: upper-level leaders, mid-level leaders, upper-level followers, and mid-level followers. The variable d in the second row of Table 3.1 represented effect sizes and were reported as three values for each level (low, average, high): Upper- and mid-level leaders had the same effect size values and upper- and mid-level followers had the same values. As demonstrated in the third row of Table 3.1, the variable SDy represented the value of one standard deviation of performance, which was calculated by multiplying 40% times the salary levels for upper- (\$100,000) and mid-level (\$75,000) leaders, and mid-level followers (\$50,000). The variable T in the fourth row of Table 3.1 represented intervention Time (2 months or .167 years) and the same value was used for each level.

Last, in the fifth row of Table 3.1, Avolio et al. (2010) only assumed leadership development intervention costs for upper- and mid-level leaders, since upper- and mid-level followers were assumed to have no intervention cost. However, although costs were associated with upper- and mid-level leaders in the Avolio et al. (2010) study, exact calculated costs were not specifically reported. Therefore, the current study calculated these costs solving for Cost (C)

in the RODI equation ($C = N \times T \times d \times SDy / RODI$) with regard to the 3-day intervention. Thus, values for the average effect size (d), intervention effect duration (T), performance value (SDy), number of leaders (N), divided by RODI, were used to solve for C . Once C was solved at each leader level, it was entered into the RODI formula for simulation to duplicate the Avolio et al. (2010) RODI estimation.

Table 3.1

Variables and values used to validate RODI simulation methodology and replicate Avolio et al. (2010) RODI results.

<i>RODI Variable</i>	<i>Data Source</i>	<i>Upper-Level Leader Data</i>	<i>Mid-Level Leader Data</i>	<i>Upper-Level Follower Data</i>	<i>Mid Level Follower Data</i>
N	Avolio (2010)	30	100	100	1000
d	Avolio (2010)	Low = .15 Average = .52 High = 1.19	Low = .15 Average = .52 High = 1.19	Low = .03 Average = .25 High = .46	Low = .03 Average = .25 High = .46
SDy	Avolio (2010)	\$40,000	\$28,000	\$28,000	\$20,000
T	Avolio (2010)	.167	.167	.167	.167
C	Avolio (2010)	\$126,846	\$259,908	N/A ^a	N/A ^a

Note. N is number of leaders; d is effect size; SDy is standard deviation of one change in performance; T is intervention effect duration, .167 equals 2 months; C is the total cost of intervention for 3 days of intervention.

^a Avolio et al. (2010) assumed no intervention cost for upper- or mid-level followers.

Once values for all variables were calculated, they were entered into the Micro Saint Simulation Software and ran one time per each leader level, matching the minimum, maximum, and average effect size simulation results to the Avolio et al. (2010) results. This single run time simulation was meant to conduct a single mathematical calculation similar to which was conducted by hand in the Avolio et al. (2010) RODI analysis. In addition, 10,000 replicates were conducted to test the random effects of the simulation (Allen, 2011).

Research Question Two

Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax assumptions of effect size (d), performance value (SD_y), intervention effect duration (T), and total cost (C) than estimated in the Avolio et al. (2010) RODI analysis?

As represented the first row of Table 3.2, for all simulation scenarios in Research Questions Two, Three, and Four, and for adequate comparison purposes, the only variable that was kept identical to Avolio et al. (2010) study was N for those leaders participating in leadership development intervention.

Creating a Random Distribution of Effect Sizes (d)

To determine the appropriateness of the meta-analysis used to gather effect size data, the current study used the following satisfactory criteria as defined by Cooper (1984):

1. A sizable body of literature was available to draw from.
2. Studies used in the meta-analysis are empirically based.
3. Studies revolving around the meta-analytic topic demonstrate mixed results.

Further, although there are no exact details required to design or analyze a simulation model, Kelton, Sadwoski and Swets (2010) provide several design aspects that assists with both a framework for model design and guide for model use:

1. The system is well understood.
2. Simulation goals are clear.
3. A representative model is formulated.
4. The conceptual model is translated into modeling software.
5. The model is validated.

6. Any experiments are designed.
7. Experiments are computed using the model.
8. Results are analyzed.
9. Results are interpreted.

Table 3.2

Effect size (d) minimums, maximums, means and standard deviations of normal distributions generated from 10,000 computer simulation model runs based on average effect size means and standard deviations from Avolio et al. (2009).

<i>RODI Variable</i>	<i>Data Source</i>	<i>Upper-Level Leader Data (UL)</i>	<i>Mid-Level Leader Data (ML)^a</i>	<i>Low-Level Leader Data (LL)^b</i>
N	Avolio et al. (2010)	30	100	1000
d	Sampled for normal distribution based on Avolio et al. (2009)	Max = 1.67	Max = 1.85	Max = 2.76
		$M = .52$	$M = .52$	$M = .72$
		Min = -.68	Min = -.87	Min = -1.41
		$SD = .31$	$SD = .36$	$SD = .55$
SDy	Avolio et al. (2010)	\$40,000	\$28,000	\$20,000
T	Avolio et al. (2010)	.167	.167	.167
C	Avolio et al. (2010)	\$126,846	\$259,908	N/A ^c

Note. N is number of leaders; d is effect size; SDy is standard deviation of one change in performance; T is intervention effect duration, .167 equals 2 months; C is the total cost of intervention for 3 days of intervention.

^a Mid-level leaders are synonymous with Upper-level followers in Avolio et al. (2010), and Middle leadership level in Avolio et al. (2009). ^b Low-level leaders are synonymous with Mid-level followers in Avolio et al. (2010), and Lower leadership level in Avolio et al. (2009). ^c Avolio et al. (2010) assumed no intervention cost for mid-level followers, also called low-level leaders in the current study.

Using the normal distribution function of the Micro Saint Sharp simulation software, separate random distributions of effect sizes (d) were generated using the mean and standard deviation (M , SD) of each leader level as reported in Table 3.2, second row. Effect size (d) means and standard deviations of each leader level were separately entered into the computer simulation model using the normal distribution function and then assigned a variable code (e.g.

Upper-level leaders - d_{UL} ; Mid-level leaders - d_{ML} ; Low-level leaders - d_{LL}). Variable coding allowed for more ease in manipulating variables and provided the ability to easily change variables if needed to adjust for sensitivity levels.

The normal distribution function generated 10,000 random effect sizes (d) to create a distribution of effect sizes for each separate leader level independent of one another (Allen, 2011). This included minimum, maximum, means and standard deviations for the distributions for each leader level (See Table 3.2). The simulation model was also programmed to randomly assign an effect size (d) value from within the distribution to the d variable of the RODI equation to calculate RODI for each leader level.

Randomizing Salary Using a Triangular Distribution to Calculate Individual Performance Value (SD_y)

This part of the research question addressed the limitation of the Avolio et al. (2010) study whereas salary values were determined from interviews with mostly large corporations. The current study used a representative data set from the United States Bureau of Labor Statistics (2010) in conjunction with a triangular distribution function to generate salary distributions for each leader level. A triangular distribution is a common distribution used in computer simulation modeling and is generated from three sets or estimates of data: mode, minimum and maximum. It allows the ability to create a distribution in somewhat a triangle shape when graphed to mimic the shape of the actual distribution. (Kelton et al., 2010).

Performance values (SD_y) were calculated for each leader level using categorical salary data from the U.S. Department of Labor (2010). The Management Occupations (Major Group) salary category was chosen, which provided a representative sample of data to create upper-, mid-, and low-level leader categories. Salary data consisted of a mean salary ($\mu = \$105,440$; $n = 6,022,860$) and percentile ranges, which are stated in the Table 3.3. This Major Group was

comprised of 30 groups ranging from Chief Executives, (4.5% of the total group; n = 273,500), to a large group of managers (95.5% of the total group; n = 6,022,860) that spanned multiple industries (U.S. Department of Labor, 2010). This data was used to generate a random distribution of salary values to be multiplied by 40%, which is reported as a valid measure of performance value by Casico and Boudreau (2011).

Table 3.3

Percentile Wage Estimates for Management Occupations (Major Group) from the United States Department of Labor, Bureau of Labor Statistics (2010).

<i>Description</i>	<i>Mean</i>	<i>Percentile Wage Estimates</i>				
		<i>10th (Min)</i>	<i>25th</i>	<i>50th</i>	<i>75th</i>	<i>90th (Max)^a</i>
Management Occupation (Major Group)	\$105,440	\$44,860	\$63,760	\$91,440	\$130,980	\$185,992 ^a

Note: ^a Calculated using the percentage increase (42%) between the 10th and 25th percentiles, and then multiplied by the 75th percentile. Data for all other percentiles were provided by the United States Bureau of Labor Statistics (U.S. Department of Labor, 2010).

Given the data available from the U.S. Department of Labor (2010), the most appropriate means to generate a distribution of salary data was determined to be a triangular distribution, which required the mode, minimum and maximum. After reviewing all data reports, only mean, median and the 10th, 25th, 50th, and 75th rankings were reported in the U.S. Department of Labor (2010) data. No data for the 90th percentile ranking was reported for this category, since the U.S. Department of Labor (2010) did not report a salary value for percentile rankings when the salary was “equal to or greater than \$80.00 per hour or \$166,400 per year” (U.S. Department of Labor, 2010). Unfortunately, the salary values for the 90th percentile in the Management Occupations group fit these criteria. Therefore, a computational method was needed to determine the missing 90th percentile value.

First, the 90th percentile value was estimated. Between the 10th (\$44,860) and 25th percentiles (\$63,760), equal to 15 percentile units, the percentage increase of salary value was 42%. This percentage increase value was used to calculate the percentage increase from the 75th percentile to the 90th. Thus, the resulting 90th percentile value for the Management Occupations group was \$185,991 (75th percentile value of \$130,980 x 1.42). An assumption was made that the percent increase between each percentile range was approximately the same. To further validate this assumption the percentage increase between the 25th and 50th percentiles (43.4%) was compared to the 50th and 75th percentiles (43.2%), whereas the results were very similar. Logic suggested the same percentage increase would be the similar between the 10th and 25th percentile and the 75th and 90th percentile.

Since minimum and maximum were not provided, the 10th percentile values reported by the U.S. Department of Labor, Bureau of Labor Statistics (2010), and the calculated 90th percentile values were used to represent the minimum and maximum values of the Management Occupation category (Minimum (10th percentile) = \$44,860 and Maximum (90th) = \$185,992). Using the 10th and 90th percentile values was justified since this method provides a potentially more conservative estimate than using actual minimum and maximum values. Using these percentile rankings actually constricts the salary range.

Once the minimum and maximum values were calculated, the difference in salary range was calculated between the two, equaling \$141,132 (\$185,992 – \$44,860 = \$141,132). This range was divided to get three equal salary ranges within the Management Occupation group to assign upper-, mid-, and low-level leader salary levels (\$141,132 / 3 = \$47,044).

The successive bisection algorithm was used as the basis to calculate the mode for the triangular distribution since it is an equation used when only mean, minimum and maximum

values are known (Kotz & van Dorp, 2004). Mean values for each range were used to compute mode for each leader level. The successive bisection algorithm equation consisted of:

$$\text{Mode} = \text{Mean} \times 3 - \text{Minimum} - \text{Maximum}$$

Mode for each leader level using the successive bisection algorithm were reported in Table 3.4 for upper-, mid-, and low-level leaders, including minimum and maximum for each leader level: row one, upper-level leaders; row two, mid-level leaders; and, row three, low-level leaders.

Table 3.4

Minimum, maximum and mode of salary values of the Management Occupation group used to generate triangular distributions of salary data for each leader level.

<i>Leader Level</i>	<i>Salary data used to calculate SDy</i>		
	Min	Max	Mode
Upper	\$138,950	\$185,992	\$162,474
Mid	\$91,905	\$138,949	\$115,427
Low	\$44,860	\$91,904	\$68,382

After mode, minimum and maximum values were calculated, they were used in conjunction with the triangular distribution function within the Micro Saint Sharp simulation software to generate a random salary distribution for each leader level. To determine individual performance value (*SDy*), each salary value within the salary distribution was randomly sampled and multiplied by 40%, which is an estimate of a leader's dollar value to the organization in terms of performance (Avolio et al., 2010; Casio & Boudreau, 2011). Individual performance value (*SDy*) was variably coded as follows: Upper-level leaders (*SDyUL*); Mid-level leaders (*SDyML*); and, Low-level leaders (*SDyLL*). Mean and standard deviation values of for each leader level are illustrated Table 3.5, third row.

The formula used to calculate SDy is illustrated below:

$$SDy = \text{Randomly sampled salary value from triangular distribution} \times 40\%$$

Table 3.5

Means and standard deviations of relaxed variable for performance value (SDy) calculated from randomly sampled salary values from normal distribution based on U.S. Department of Labor (2010) salary data multiplied by 40% of salary value.

<i>RODI Variable</i>	<i>Data Source</i>	<i>Upper-Level Leader Data (UL)</i>	<i>Mid-Level Leader Data (ML)^a</i>	<i>Low-Level Leader Data (LL)^b</i>
<i>N</i>	Avolio et al. (2010)	30	100	1000
<i>d</i>	Sampled for normal distribution based on Avolio et al. (2009)	Max = 1.67	Max = 1.85	Max = 2.76
		<i>M</i> = .52	<i>M</i> = .52	<i>M</i> = .72
		Min = -.68	Min = -.87	Min = -1.41
		<i>SD</i> = .31	<i>SD</i> = .36	<i>SD</i> = .55
<i>SDy</i>	Salary sampled for normal distribution based on U.S. Department of Labor (2010) x 40%	Min = \$55,590	Min = \$36,856	Min = \$18,000
		Max = \$74,360	Max = \$55,380	Max = \$36,661
		<i>M</i> = \$65,075	<i>M</i> = \$46,131	<i>M</i> = \$27,207
		<i>SD</i> = \$3,799	<i>SD</i> = \$3,833	<i>SD</i> = \$3,866
<i>T</i>	Avolio (2010)	.167	.167	.167
<i>C</i>	Avolio (2010)	\$126,846	\$259,908	N/A ^c

Note: *N* is number of leaders; *d* is effect size; *SDy* is standard deviation of one change in performance; *T* is intervention effect duration, .167 equals 2 months; *C* is cost of intervention for 3-days. For each leader level, *SDy* is calculated using random salary values from a triangular distribution x 40%.

^a Mid-level leaders are synonymous with Upper-level followers in Avolio et al. (2010), and Middle leadership level in Avolio et al. (2009). ^b Low-level leaders are synonymous with Mid-level followers in Avolio et al. (2010), and Lower leadership level in Avolio et al. (2009). ^c Avolio et al. (2010) assumed no intervention cost for mid-level followers, also called low-level leaders in the current study.

Randomizing the Intervention (Training) Effect Duration (T)

This part of the research question addressed the limitation of the Avolio et al. (2010) article whereas they used a fixed value of 2 months for the duration of intervention effects rather than using a random distribution of intervention effect duration values.

A random distribution of the intervention effect duration values (T), between zero and one year, was generated using the triangular distribution function of the Micro Saint Sharp simulation software. Data needed to create the triangular distribution was the mode, minimum and maximum values.

Known intervention effect duration data consisted of only the minimum (0) and maximum (1-year) intervention effect duration values. A one-year RODI estimate was used to generate annual returns on investment and for accurate comparisons with previous RODI research (Avolio et al., 2009, 2010). Using the minimum and maximum values, the mean (.50) was calculated. Then, using the successive bisection algorithm as describe previously, the mode (.50) was calculated. To generate the triangular distribution, the mode (.50), minimum (0), and maximum (1) values were entered into the triangular distribution function in the Micro Saint Sharp simulation software.

This method allowed for random distribution of 10,000 values (Allen, 2010) between 0 and 1 year to be used as random input data for the RODI formula. This variable was coded as (T) in the discrete-event simulation model, which allowed for more ease in manipulating variables and therefore, providing the ability to easily change variables if needed to adjust for sensitivity levels. The mean and standard deviation values are listed in row four of Table 3.6.

Calculating Costs (C)

This part of the research question addressed the limitation of the Avolio et al. (2010) article whereas they used a fixed value for costs generated from interviews and data from mostly large corporations, rather than using a random distribution generated from a representative sample of costs factors. To calculate Cost (C) in the current study, three different measures were

used: (1) Direct Training Costs (ASTD, 2010; Avolio et al., 2010), (2) Time in Participant Salary (Avolio et al., 2010), and (3) Lost Production Time (Avolio et al., 2011).

Table 3.6

Means and standard deviations of relaxed variable for intervention effect duration (T) between 0 and 1-year, calculated from randomly sampled values from normal distribution based on comparable intervention effect duration range used in the Avolio et al. (2010) study.

<i>RODI Variable</i>	<i>Data Source</i>	<i>Upper-Level Leader Data (UL)</i>	<i>Mid-Level Leader Data (ML)^a</i>	<i>Low-Level Leader Data (LL)^b</i>
N	Avolio et al. (2010)	30	100	1000
d	Sampled for normal distribution based on Avolio et al. (2009)	Max = 1.67	Max = 1.85	Max = 2.76
		$M = .52$	$M = .52$	$M = .72$
		Min = -.68	Min = -.87	Min = -1.41
		$SD = .31$	$SD = .36$	$SD = .55$
SDy	Salary sampled for normal distribution based on U.S. Department of Labor (2010) x 40%	Min = \$55,590	Min = \$36,856	Min = \$18,000
		Max = \$74,360	Max = \$55,380	Max = \$36,661
		$M = \$65,075$	$M = \$46,131$	$M = \$27,207$
		$SD = \$3,799$	$SD = \$3,833$	$SD = \$3,866$
T	Sampled for normal distribution based on one year based on Avolio et al. (2010)	Min = 0	Min = 0	Min = 0
		Max = 1	Max = 1	Max = 1
		$M = .50$	$M = .50$	$M = .50$
		$SD = .21$	$SD = .21$	$SD = .21$
C	Avolio et al. (2010)	\$126,846	\$259,908	N/A ^c

Note: N is the number of leaders; d is effect size; SDy is standard deviation of one change in performance; T is intervention effect duration, .167 equals 2 months; C is cost of intervention for 3-days. For each leader level, SDy is calculated using random salary values from a triangular distribution x 40%.

^a Mid-level leaders are synonymous with Upper-level followers in Avolio et al. (2010), and Middle leadership level in Avolio et al. (2009). ^b Low-level leaders are synonymous with Mid-level followers in Avolio et al. (2010), and Lower leadership level in Avolio et al. (2009). ^c Avolio et al. (2010) assumed no intervention cost for mid-level followers, also called low-level leaders in the current study.

Direct Training Costs (i.e. total expenditures) were calculated using the same method for mid- and low-level leaders. For mid- and low-level leaders, the *2010 ASTD State of the Industry Report* calculated a Direct Expenditure costs including costs such as salaries for training staff, administrative costs and non-salaried delivery costs (ASTD, 2010). These costs were gathered

from organizations that consisted of public and private organizations, both national and international, which were engaged in learning and performance improvement as well as talent development. The average Direct Expenditures reported for all organizations surveyed in 2009 was \$1,081.18 for 31.87 learning hours used per employee. Direct Training Cost for mid- or low-level leaders was variably coded as (DTC_{ML} or DTC_{LL}). To accurately calculate a daily DTC , Direct Expenditure (\$1081.18) was divided by learning hours (31.87 hours), and then multiplied times eight hours (8 hours) to establish a daily cost intervention. Then, this daily cost was multiplied by a random value from the number of days engaged in the intervention or, intervention (training) length distribution (coded IL_{ML} or IL_{LL}), which consisted of a value between one and seven days. An example of the formula used to calculate a daily DTC for a mid-level leader is illustrated below.

$$DTC_{ML} = \$1,081.18 \times 31.87 \text{ hours} \times 8 \text{ hours/day} \times IL_{ML}$$

Where:

DTC_{ML} = Direct Training Cost for mid-level leaders

IL_{ML} = Mid-level leader value from Intervention (training) Length distribution;
between 0 and 16 days.

For upper-level leaders, American Society for Training and Development (2009) reported a \$12,370 upper-level (executive) leader direct training cost for an average of 5.625 days of leadership development intervention. To accurately calculate a daily DTC , the DTC for upper-level leaders (\$12,370) was divided by the average number of intervention (training) days (5.625 days). Then, this daily value was multiplied by a random value from the number of days engaged in the intervention or, intervention (training) length distribution (coded IL_{UL}), which consisted of

a random value between zero and sixteen days. The formula used to calculate a daily *DTC* for an upper-level leader is illustrated below.

$$DTC_{UL} = \frac{\$12,370}{5.625} \times IL_{UL}$$

Where:

DTC_{UL} = Direct Training Cost for upper-level leaders

IL_{UL} = Upper-level leader value from Intervention (training) Length distribution; between 0 and 16 days.

Costs associated with Time in Participant Salary and Lost Production Time was calculated as a daily wage value. The daily wage was justified by randomizing the intervention (training) length; thus one day of intervention was proportional to one day of salary wage. This allowed the amount of daily salary to adjust proportionately with the number of days an individual participated in the intervention.

Daily wages were calculated for each leader level by programming the computer simulation model to randomly sample a salary value from the distribution and divide by the number of workdays in a year (260). The following equation illustrates the daily wage calculation:

$$DW = \text{Annual Salary} / 260 \text{ days}$$

Where:

DW = Daily wage

Annual salary = the value of the randomly selected salary value from the distribution.

260 days is the number of work days per year (5 work days per week x 52 weeks per year)

Once daily wages were calculated, Time in Participant Salary (variably coded *TPS*) was determined. *TPS* is the participant's daily wage salary multiplied by the time spent engaged in the intervention, or the intervention (training) length (*IL*) (Avolio et al., 2010). For each level leader, the following variable codes were used: *TPS_{UL}* (upper-level leaders), *TPS_{ML}* (mid-level leaders), and *TPS_{LL}* (low-level leaders). *TPS* was calculated using the following formula:

$$TPS = DW \times IL$$

Where:

TPS = Total Participant Salary for a specified leader level

DW = Daily wage, a randomly sampled value from the salary distribution of the specified leader level divided by 260 working days.

IL = Value from Intervention (training) Length distribution for a specified leader level; or number of days engaged in the intervention

The computer simulation was programmed to multiply the daily wage times a randomly sampled value from the intervention (training) length distribution, which was a random value from the 10,000 values (Allen, 2010) associated with the appropriate leader level distribution. For example, if a leadership development intervention lasted two days and the leader's daily wage was \$384 (based on a \$100,000 random annual salary), then the Time in Participant Salary would be equal to \$768.

Lost Production Time (variable coded as *LPT*) was the opportunity cost for participants "who directly impact revenue for the organization (e.g. sales)" including "costs as both hourly/salary and as lost sales for that time invested in training" (Avolio et al., 2010, p. 637). Avolio et al. (2010) suggested a conservative calculation of Lost Production Time (*LPT*), which was double the salary rate. Therefore, in the current study Lost Production Time (*LPT*) was

estimated as twice the daily salary rate; or, two times the daily wage (salary rate), and then multiplied by the intervention time. Therefore, the formula used to calculate Lost Production Time (*LPT*), consisted of the following:

$$LPT = 2 \times DW \times IL$$

Where:

LPT = Loss Production Time for a specified leader level

DW = Daily wage, a randomly sampled value from the salary distribution of the specified leader level divided by 260 working days.

IL = Value from Intervention (training) Length distribution for a specified leader level; or number of days engaged in the intervention

Finally, to compute the Total Cost (*C*), Micro Saint Sharp simulation software was programmed to calculate Direct Training Costs (*DTC*), Time in Participant Salary (*TPS*), and Lost Production Time (*LPT*) and then add these variables together to arrive at a total cost for each simulation run. This method provided a representative value of Total Cost (*C*) based on multiple randomly distributed cost variables. Minimums, maximums, means and standard deviations are illustrated in row five of Table 3.7. The formula for this calculation for each leader level consisted of the following:

$$\text{Total Cost } (C) = (DTC + TPS + LPT) \times N$$

Where:

Total Cost (*C*) = Total cost of all participating in the intervention

DTC = Direct training cost such as salaries for training staff, administrative costs and non-salaried delivery costs multiplied by time engaged in the intervention

TPS = Time in participant salary or the daily wage multiplied by the time engaged in the intervention

LPT = Opportunity cost, or 2x daily wage, multiplied by time engaged in the intervention

N = Number of leaders participating in the intervention

Table 3.7

Means and standard deviations of relaxed variable for Total Cost (*C*), calculated from randomly sampled values from normal distributions based on cost data from ASTD (2009, 2010).

<i>RODI Variable</i>	<i>Data Source</i>	<i>Upper-Level Leader Data (UL)</i>	<i>Mid-Level Leader Data (ML)^a</i>	<i>Low-Level Leader Data (LL)^b</i>
<i>N</i>	Avolio et al. (2010)	30	100	1000
<i>d</i>	Sampled for normal distribution based on Avolio et al. (2009)	Max = 1.67	Max = 1.85	Max = 2.76
		<i>M</i> = .52	<i>M</i> = .52	<i>M</i> = .72
		Min = -.68	Min = -.87	Min = -1.41
		<i>SD</i> = .31	<i>SD</i> = .36	<i>SD</i> = .55
<i>SDy</i>	Salary sampled for normal distribution based on U.S. Department of Labor (2010) x 40%	Min = \$55,590	Min = \$36,856	Min = \$18,000
		Max = \$74,360	Max = \$55,380	Max = \$36,661
		<i>M</i> = \$65,075	<i>M</i> = \$46,131	<i>M</i> = \$27,207
		<i>SD</i> = \$3,799	<i>SD</i> = \$3,833	<i>SD</i> = \$3,866
<i>T</i>	Sampled for normal distribution with maximum of one year intervention effect duration.	Min = 0	Min = 0	Min = 0
		Max = 1	Max = 1	Max = 1
		<i>M</i> = .50	<i>M</i> = .50	<i>M</i> = .50
		<i>SD</i> = .21	<i>SD</i> = .21	<i>SD</i> = .21
<i>C</i>	Sampled for normal distribution based on ASTD (2009, 2010) data.	Min = \$0	Min = \$200,287	Min = \$994,943
		Max = \$1,897,437	Max = \$1,469,746	Max = \$9,019,261
		<i>M</i> = \$689,064	<i>M</i> = \$766,084	<i>M</i> = \$4,225,870
		<i>SD</i> = \$288,706	<i>SD</i> = \$247,998	<i>SD</i> = \$1,426,217

Note: *N* is number of leaders; *d* is effect size; *SDy* is standard deviation of one change in performance; *T* is intervention effect duration, .167 equals 2 months; *C* is total cost of intervention for 3-days. For each leader level, *SDy* is calculated using random salary values from a triangular distribution x 40%.

^a Mid-level leaders are synonymous with Upper-level followers in Avolio et al. (2010), and Middle leadership level in Avolio et al. (2009). ^b Low-level leaders are synonymous with Mid-level followers in Avolio et al. (2010), and Lower leadership level in Avolio et al. (2009).

Research Question Three

Which method of discrete-event computer simulation modeling will allow relaxed Effect Size (d), Performance Value (SDy), Intervention Effect Duration (T), and Total Cost (C) to better estimate the return on development investment (RODI): (a) Developing only upper-level leaders and diffusing to mid- and lower-level leaders? (b) Developing upper- and mid-level leaders and diffusing only to lower-level leaders? Or, (c) Developing all three levels; upper-, mid- and low-level leaders?

Research Question 3a: Developing Only Upper-level Leaders and Then Diffusing to Mid- and Lower-level Leaders?

This part of Research Question 3 was separated into three parts, which were simulated and added together to create a cumulative RODI incorporating leadership diffusion: (1) Intervention of upper-level leaders, (2) Diffusion of leadership to mid-level leaders, and (3) Diffusion of leadership from new mid-level leaders to lower-level leaders.

All variables calculated for this Research Question (T , d , SDy and C) were programmed and randomly computed, simultaneously, with Micro Saint Sharp simulation software to estimate RODI using the RODI equation below. The variable N (number of leaders) was entered manually. This method allowed for RODI to be computed using all distributions and randomizations as described in Research Question 2. However, in order to calculate the diffusion effect of leadership, this required a modification to the RODI equation, which used the same variables except Cost.

$$RODI = NTdSDy - C$$

Where:

N = the number of participants engaged in the development intervention

T = the intervention effect duration or the expected duration of change in leadership behaviors

d = the effect size of the intervention or difference between means of trained and untrained participants

SD_y = the value of one standard deviation of performance or 40% of an individual's salary

C = the total training cost of all participants

Intervention of Upper-level Leaders

To develop only upper-level leaders and then diffuse to leaders at lower levels, random distributions were generated for upper-level leaders and used to calculate RODI for this leader level: a random distribution for effect size, d ($\mu = .51$, $SD = .31$), a triangular distribution for the performance value of an individual, SD_y , ($\mu = 65,075$, $SD = \$3,799$), and a triangular distribution for intervention effect duration, T ($\mu = 5.62$, $SD = 2.36$). In addition, Cost (C) was calculated ($\mu = \$22,874$, $SD = \$4,496$), which included a direct training cost constant along with triangular distributions for time in participant salary and lost production time.

Calculating the diffusion effects using logistical growth equations

The diffusion aspects in the current study require no intervention costs to diffuse leadership. Intervention costs were only associated with groups that were formally developed (trained), which in this objective (3a) was upper-level leaders. Therefore, the RODI of diffused leadership to non-developed mid- and lower-level leaders involved similar RODI calculations used for developed leaders except with no Cost (C) variable. Since only a portion of mid-level leader is affected by the diffusion of leadership, the logistic differential equation was used to calculate this diffusion effect, or return on leadership diffusion (ROLD).

$$RODI = (ROLD)(T)(d)(SDy)$$

Where:

$ROLD = \frac{dN}{dt}$, or the rate of change in leader population respective of time t . The return of new (diffused) leaders from a lower level subtracted from the total number of higher level leaders participating in the intervention within some time period after the intervention

T = intervention effect duration or the expected duration of change in leadership behaviors

d = effect size of the intervention or difference between means of trained and untrained participants

SDy = standard deviation of valued job performance or 40% of the participant's salary (Cascio & Boudreau, 2011).

C = total training cost of all participants

Return on leadership diffusion (ROLD) was calculated by using a derivative equation of Pierre Francois Verhulst (1838; 1977) logistic growth model. This differential equation, which incorporates a carrying capacity, was used since the Verhulst's logistic growth model calculates the total population; original population plus the new population. The original number of leaders added to the new leaders (total leader population) calculated by the differential equation creates a sigmoid, S-shaped curve, found in the diffusion of innovations research (Rogers, 2003).

Although there are several ways to calculate this difference, a derivative of the logistic growth formula called the logistic differential equation was used, with variables described in the context of leaders.

$$\frac{dN}{dt} = rN_0 \left(\frac{K - N_0}{K} \right); \text{thus,}$$

$$ROLD = rN_0 \left(\frac{K - N_0}{K} \right)$$

Where:

$\frac{dN}{dt}$ = Also called ROLD or the rate of change in leader population respective of time

t . The return of new (diffused) leaders from a lower level subtracted from the total number of higher level leaders participating in the intervention within some time period after the intervention

t = the time period (e.g. annually or per year)

r = the rate of leader diffusion (randomly sampled effect size x randomly sampled intervention effect duration)

N_0 = the total number of leaders participating in the leadership development intervention at time 0 (i.e. before the intervention)

K = the carrying capacity (the total number of the leaders that can be affected – Higher plus Next level leaders)

The original logistic growth equation, which was what the logistic differential equation was based on, is represented below. This equation was not used because the main output needed to calculate RODI incorporating ROLD was the growth in the number of new leaders, $\frac{dN}{dt}$, or the change in leader population respective of time. The standard logistic growth equation only calculates the total number of leaders after the intervention (i.e. N_t represents the total number leaders after the intervention), not the difference. However, to illustrate the sigmoid, or S-shaped, effect, either the logistic growth equation can be used to generate data or the differential equation. If the differential equation is used, the data generated must be added to the original population data to create cumulative data.

$$N_t = \frac{KN_0}{(K + N_0)e^{-rt} + N_0}$$

Where:

N_t = population at some time (t) period, such as after an intervention.

K = carrying capacity (the total population that can be affected by growth)

N_0 = population at time 0, such as before a leadership development intervention

e = Euler's constant: 2.71828

r = growth rate

t = time period (e.g. annually or per year)

Diffusion of Leadership to Mid-level Leaders

The 30 developed upper-level leaders and their diffusion effect on the carrying capacity of 100 mid-level leaders was calculated and used as the value for *ROLD* in the RODI diffusion equation, which was multiplied by a random normal distribution generated for effect size, d ($\mu = .51$, $SD = .36$), a triangular distribution for the performance value of an individual, SDy , ($\mu = \$46,161$, $SD = \$3,833$), and a triangular distribution generated for intervention effect duration, T ($\mu = 3.84$, $SD = 1.24$). This entire RODI equation incorporating the return on leadership diffusion (ROLD) was added to the RODI of 30 developed upper-level leaders.

$$RODI = N_{UL}T_{UL}d_{UL}SDy_{UL} - C_{UL} \\ + ROLD_{UL}T_{ML}d_{ML}SDy_{ML}$$

Where:

N_{UL} = number of leaders participating in the leadership development intervention.

T_{UL} = intervention effect duration of upper-level leaders

d_{UL} = effect size of the intervention or difference between means of trained and untrained upper-level leaders.

SDy_{UL} = standard deviation of valued job performance or 40% of upper-level leader salary

C_{UL} = total cost of intervention for upper-level leaders

$ROLD_{UL}$ = return on leadership diffusion or rate of change in leader population from upper-level leaders diffusing leadership to mid-level leaders, respective of time t .

ROLD From the Diffusion of Leadership From New Mid-level Leaders to Lower-level Leaders

The newly developed mid-level leaders and their diffusion effect on the carrying capacity of 1000 low-level leaders was calculated and used as the value for $ROLD$ in the RODI diffusion equation, which was multiplied by a random normal distribution generated for effect size, d ($\mu = .71$, $SD = .55$), a triangular distribution for the performance value of an individual, SDy , ($\mu = \$27,707$, $SD = \$3,866$), and a triangular distribution generated for intervention effect duration, T ($\mu = 3.84$, $SD = 1.24$). This entire RODI equation incorporating the $ROLD$ was added to the RODI of 30 developed upper-level leaders and the RODI of mid-level leaders incorporating $ROLD$.

$$\begin{aligned} RODI &= N_{UL}T_{UL}d_{UL}SDy_{UL} - C_{UL} \\ &+ ROLD_{UL}T_{ML}d_{ML}SDy_{ML} \\ &+ ROLD_{ML}T_{LL}d_{LL}SDy_{LL} \end{aligned}$$

Where:

T_{ML} = the intervention effect duration or the expected duration of change in leadership behaviors of mid-level leaders

d_{ML} = the effect size of the intervention or difference between means of trained and untrained participants of mid-level leaders

SDy_{ML} = the standard deviation of valued job performance or 40% of mid-level leader salary

$ROLD_{ML}$ = Return on leadership diffusion or rate of change in leader population from mid-level leaders diffusing leadership to low-level leaders, respective of time t .

The logistic differential equation was programmed into the Micro Saint Sharp simulation software. Variable coding dN was used to calculate ROLD and then used as a substitute for N (number of participants participating in leadership development intervention) in the RODI formula. An example of how dN was calculated and then incorporated into the RODI is stated below.

$$ROLD_{UL} = rN_{UL} \left(\frac{K_{UL+ML} - N_{UL}}{K_{UL+ML}} \right)$$

Where:

$ROLD_{UL}$ = Return on leadership diffusion or rate of change in leader population from upper-level leaders diffusing leadership to mid-level leaders, respective of time t .

t = the time period (e.g. annually or per year)

r = the rate of leader diffusion (randomly sampled effect size x randomly sampled intervention effect duration)

N_0 = the total number of leaders participating in the leadership development intervention at time 0 (i.e. before the intervention)

K = the carrying capacity (the total number of the leaders that can be affected – higher plus next level leaders)

$$\begin{aligned} ROLD_{UL} &= (.51 \times .417)(30) \left(\frac{130 - 30}{130} \right) \\ &= (.213)(30) \left(\frac{100}{130} \right) \end{aligned}$$

$$= (6.39)(.77)$$

$$= 4.92 \text{ New Mid-level leaders}$$

Then, for diffusion of mid-level to low-level leaders:

$$\begin{aligned} ROLD_{ML} &= rN_{ML} \left(\frac{K_{ML+LL} - N_{ML}}{K_{ML+LL}} \right) \\ &= (.51 \times .333)(4.92) \left(\frac{1100 - 4.92}{1100} \right) \\ &= (.213)(4.92) \left(\frac{1095.08}{1100} \right) \\ &= (1.05)(.996) \\ &= 1.05 \text{ New Low-level leader} \end{aligned}$$

The diffusion effect, ROLD, of 30 upper-level leaders in this scenario resulted in 4.92 new leaders, or 5 new leaders, since technically you cannot have a fraction of a human being. Note that this equation scenario was calculated using an effect size of .51 with an intervention effect duration of five months (.417). These five ($n = 4.92$) mid-level leaders, using an effect size of .51 with an intervention effect duration of three months (.333), and then diffused leadership to one ($n = 1.05$) low-level leader. The RODI equation with these ROLD values incorporated into the equation is illustrated below.

$$\begin{aligned} RODI &= (30) T_{UL} d_{UL} SDy_{UL} - C_{UL} \\ &\quad + (4.92) T_{ML} d_{ML} SDy_{ML} \\ &\quad + (1.05) T_{LL} d_{LL} SDy_{LL} \end{aligned}$$

Research Question 3b: Developing Upper- and Mid-level Leaders and Then Leadership Diffusing to Lower-level Leaders?

The main difference between Research Question 3a and 3b is that RODI was calculated for both upper- and mid-level leaders, assuming they participated in the leadership development intervention. Then, the diffusion effect was added for lower-level leaders.

$$\begin{aligned} RODI &= N_{UL}T_{UL}d_{UL}SDy_{UL} - C_{UL} \\ &+ N_{ML}T_{ML}d_{ML}SDy_{ML} - C_{ML} \\ &+ ROLD_{ML}T_{LL}d_{LL}SDy_{LL} \end{aligned}$$

Research Question 3c: Developing Upper-, Mid-, and Low-level Leaders?

The last research question addressed developing all three levels of leadership and then calculating RODI. Using the same formulas, the RODI equation for developing all leader levels is stated below:

$$\begin{aligned} RODI &= N_{UL}T_{UL}d_{UL}SDy_{UL} - C_{UL} \\ &+ N_{ML}T_{ML}d_{ML}SDy_{ML} - C_{ML} \\ &+ N_{LL}T_{LL}d_{LL}SDy_{LL} - C_{LL} \end{aligned}$$

Research Question Four

Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax a fifth variable, P , as suggested by Holton (2011) and Cascio and Boudreau (2011), in addition to relaxing variables d , SDy , T , and C and incorporating the effects of leadership diffusion?

All variables, methods and calculations used to address Research Question 3 were used for Research Question 4, except an additional variable, P , was added. P is the percentage of behavioral outcomes relevant to an individual's performance. Along with other variables, P was

added to the equation, programmed and randomly computed, simultaneously, with Micro Saint Sharp simulation software to estimate RODI using the formula RODI formula:

$$RODI = (N)(T)(d)(SDy)(P) - C$$

Again, the variable N (number of leaders) was entered manually. This method allowed for RODI to be computed using all distributions and randomizations as was described in Research Question 2 and 3. However, in order to calculate P , a separate equation method was used as well as two separate distribution functions to generate distributions of intervention length: Poisson distribution for upper-level leaders and triangular distribution for mid- and low-level leaders

A Poisson distribution is commonly used when modeling a random number of events that occur in a fixed period of time; and, although there are a variety of ways that a Poisson distribution can be modeled, it is typically used when only the parameter value known is the mean (Kelton, 2010). Thus, only the mean intervention length ($M = 5.625$) for executive leaders was provided in the ASTD (2009) executive development study, which was used to generate a Poisson distribution for intervention length for upper-level leaders.

For each calculation of intervention length for upper-level leaders, the computer simulation would randomly draw values from the 10,000-value distribution generated for intervention length, and divide by the maximum length of intervention from the distribution. The maximum intervention length for upper-level leaders was 16 days. The Poisson distribution generated a random distribution, variably coded as P , which provided the standard deviation and average percentage of behavioral objectives the training intervention covered that were relevant to individual performance. An example of how P was used for intervention length is denoted in

the following: 16 days of training would cover 100% of behavioral objectives relevant to individual performance; eight days would cover 50%.

The formula used to calculating each simulation run of P for upper-level leaders was as follows:

$$P_{UL} = \frac{\text{Random value from the Intervention Length Distribution}}{16}$$

Mid- and low-level leaders had a different intervention length compared to upper-level leaders. For mid- and low-level leaders, the maximum intervention length was seven days. A random distribution of P for mid- and low-level leaders provided the standard deviation, and average percentage of behavioral objectives the training intervention covered, that were relevant to individual performance. Similar to the upper-level leader example above, seven days of training would cover 100% of behavioral objectives relevant to individual performance; 3.5 days would cover 50%. The formula used to calculating each simulation run of P for mid- and low-level leaders was as follows:

$$P_{ML \text{ or } LL} = \frac{\text{Random value from the Intervention Length Distribution}}{7}$$

Summary

This section addressed the methodology used to address each research question and reviewed the study design, data for analysis, unit of analysis and method of analysis. It addressed the methodology used to determine: (1) if the Avolio et al. (2010) RODI analysis could replicated using discrete-event computer simulation modeling by programming variables N , d , T , SDy , and C into the RODI equation, (2) if a better estimate of RODI could obtained using discrete-event computer simulation modeling to relax assumptions of variables d , SDy , T , and C than estimated in the Avolio et al. (2010) RODI analysis, (3) which method of discrete-event computer simulation modeling will allow relaxed variables d , SDy , T , and C to better estimate

the return on development investment (RODI), and (4) whether a better estimate of RODI could be obtained using discrete-event computer simulation modeling to relax a fifth variable, P , as suggested by Holton (2011) and Cascio and Boudreau (2011), as well as relaxing variables d , SDy , T , and C , than estimated in the Avolio et al. (2010) RODI analysis. Further, this section addressed the methodology used to program the computer simulation model and generate random distributions of data, which were used in the simulation to estimate and predict RODI.

CHAPTER 4: RESULTS

The data were analyzed using computer simulation modeling to determine whether creating random distributions of variables, then using these distributions of values to be randomly entered into a ROI equation, provides a more accurate estimate of RODI. To guide this results section, the study objectives were formulated into research questions. The following research questions will be used to discuss results.

1. Can the Avolio et al. (2010) RODI analysis be replicated using discrete-event computer simulation modeling by programming variables: number of participants (N), effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) into the RODI equation?
2. Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax assumptions of variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) than estimated in the Avolio et al. (2010) RODI analysis?
3. Which method of discrete-event computer simulation modeling will allow relaxed variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) to better estimate the return on development investment (RODI): (a) Developing only upper-level leaders and diffusing to mid- and lower-level leaders? (b) Developing upper- and mid-level leaders and diffusing only to lower-level leaders? or, (c) Developing all three levels; upper-, mid- and lower-level leaders?
4. Will a better estimate of RODI be obtained using discrete-event computer simulation modeling to relax a fifth variable, percentage of behavioral objectives met (P), as suggested by Holton (2011) and Cascio and Boudreau (2011), in addition to relaxing

variables: effect size (d), intervention effect duration (T), performance value (SDy), and Cost (C) and incorporating the effects of leadership diffusion?

Research Question One Results

The first objective was to determine whether the Avolio et al. (2010) RODI analysis could be replicated using discrete-event computer simulation modeling by programming variables N , d , T , SDy , and C into the RODI equation.

Two different methods were used to validate that the RODI equation entered into the computer simulation model was capable of replicating results. The first method used exact variables in the Avolio et al. (2010) study, which were entered directly into the RODI equation for one run of the simulation model to simulate one arithmetic calculation. Table 4.1 illustrated the results and the ability of the computer simulation model to accurately compute and replicate RODI reported in the Avolio et al. (2010) RODI study.

Table 4.1

Comparison of computer simulation to Avolio et al. (2010) study, 1.5-day results, using identical N , d , T , SDy , and C variables; and, a random distribution method.

<i>Leader Level</i>	<i>RODI Method</i>	<i>Return on Development Investment (RODI)</i>		
		<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
Upper	Avolio et al. (2010)	(\$94,733) -146%	\$39,535 61%	\$173,803 269% ^a
Upper	Single Model Run	(\$94,733) -146%	\$39,535 61%	\$173,803 269%
Mid	Avolio et al. (2010)	(\$211,334) -150%	\$101,948 72%	\$415,240 294% ^a
Mid	Single Model Run	(\$211,334) -150%	\$101,948 72%	\$415,240 294%

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^a Avolio et al. (2010) limited their results to a maximum RODI of 200%; however, to illustrate the comparison, the percent RODI was calculated.

For upper-level leaders, a comparison of rows one and two, comparing the Avolio et al. (2010) study and the single run of the simulation model, reported no differences in arithmetical calculations of 1.5 day training intervention. The same RODI equation, variables, and appropriate values were used in the single simulation run as were used in the Avolio et al. (2010) study.

For a comparison of mid-level leader results to the Avolio et al. (2010) study results, the same method was used as described for upper-level leaders. For mid-level leader comparison, rows four (Avolio et al. (2010) study) and five (Simulation study) reported no differences in arithmetical calculations of 1.5 day training intervention. The same RODI equation, variables, and appropriate values were used in the single simulation run as were used in the Avolio et al. (2010) study.

Rows four and five in Table 4.1 reported no differences in arithmetical calculations of 1.5 day training intervention between Avolio et al. (2010) study and the single model calculation (using the same RODI equation, variables, values, and a single RODI calculation). Again, this method used identical variables and values except for effect sizes, whereas a random distribution of values from 1.19 (highest effect size) to -.13 (lowest effect size) (Avolio et al., 2010) were generated and then sampled from the distribution to estimate RODI.

The importance of this research question was to establish a baseline with the Micro Saint Discrete-event Simulation software that was identical to the Avolio et al. (2010) research methodology used to estimate RODI.

Research Question Two Results

The second objective was to determine whether a better estimate of RODI could be obtained using discrete-event computer simulation modeling to relax assumptions of variables d ,

SD_y , T , and C than was estimated in the Avolio et al. (2010) RODI analysis. To analyze and compare data, the Avolio et al. (2010) 3-day program results were used for comparison and presented in Table 4.2.

Table 4.2

Comparison of Avolio et al. (2010) study to computer simulation with no diffusion effects.

<i>Leader Level</i>	<i>RODI Method</i>	<i>Return on Development Investment (RODI)</i>		
		<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
30 Upper	Simulation, no diffusion	(\$2,242,169) -414%	(\$181,019) -8%	\$1,997,765 1305%
30 Upper	Avolio et al. (2010)	(\$186,966) -147%	\$81,570 64%	\$320,106 252% ^a
	Difference in RODI ^b	\$2,055,203 92%	\$262,589 145%	(\$1,677,659) -83%
100 Mid	Simulation, no diffusion	(\$3,045,431) -685%	\$544,651 118%	\$5,695,701 2479%
100 Mid	Avolio et al. (2010)	(\$400,188) -154%	\$226,396 87%	\$852,980 328% ^a
	Difference in RODI ^b	\$2,645,243 87%	(\$318,255) -58%	(\$4,842,721) -85%
1000 Low	Simulation	(\$27,875,536) -1341%	\$5,646,474 168%	\$63,709,718 3195%

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^a Avolio et al. (2010) capped returns at 200%; therefore, the actual percentage was calculated. ^b The difference between the Avolio et al. (2010) results and the computer simulation model study results.

It is important to note that in all cases for comparisons between the simulation study and the Avolio et al. (2010) study, low and high returns in the Avolio et al. (2010) study were calculated using one standard deviation above and below the mean. However, the computer simulation study used distributions, therefore, both low and high returns for all RODI estimates greatly exceed one standard deviation above and below the mean. This explains why at times, low or high returns from the computer simulation greatly exceeded the comparative results in the Avolio et al. (2010) study.

To estimate RODI of 30 upper-level leaders participating in leadership development interventions, computer simulation model results in row three in Table 4.2 indicated that the Avolio et al. (2010) RODI analysis underestimated both low and high return estimates. For low return, losses were underestimated by \$2,055,203 (92%), and for high return, gains were underestimated by \$1,677,659 (83%). For average return, Avolio et al. (2010) overestimated by \$262,589 (145%), and although they reported a gain the actual RODI was a loss of nearly \$200 thousand dollars.

For RODI of 100 mid-level leaders participating in leadership development interventions, computer simulation model results in row six in Table 4.2 indicated that the Avolio et al. (2010) RODI analysis underestimated all returns. For low return, losses were underestimated by \$2,645,243 (87%). For both average and high return estimates, the Avolio et al. (2010) RODI study underestimated average gains by \$318,255 (58%) and underestimated high gains by \$4,842,721 (85%).

Table 4.2 results indicated that Avolio et al. (2010) consistently overestimated low returns of upper- and mid-level leaders and significantly underestimated and overestimated returns of upper- and mid-level leaders. Average results were the most comparable; however, the Avolio et al. (2010) study still overestimated RODI for upper-level leaders by 145% and underestimated average returns of mid-level leaders by 58%.

Avolio et al. (2010) did not compute an RODI for low-level leaders. Although they reported a “mid-level follower” RODI, which this study calls low-level leader, their calculation consisted of only the diffusion effect and did not include any costs for intervention. Therefore, only simulated results are reported for RODI of 1000 low-level leaders in row seven of Table 4.2. Compared to other simulated results in Table 4.2, rows one and four, intervention of 1000

low-level leaders reported significant average (168%) and high returns (3195%), which is likely due to the higher effect sizes for this leader level and lower costs. However, there is a significantly greater negative low return (-660%), which suggests that there are potentially much greater risks for leadership development intervention at this leader level compared to upper or mid leader levels.

Overall, the second objective was met whereas better estimates of RODI were obtained using discrete-event computer simulation modeling and relaxing assumptions of variables d , SDy , T , and C , than those estimates reported in the Avolio et al. (2010) RODI analysis. These results indicated that the Avolio et al. (2010) study underestimated low return losses and high return gains for both upper- and mid-level leaders. Average returns between the computer simulation model and the Avolio et al. (2010) study were more comparable but still under or overestimated. Therefore, arithmetically calculating RODI as conducted in Avolio et al. (2010), without using more representative data including distributions of variables, significantly underestimates or overestimates RODI returns. Overall results indicated that there are similar but significant risks in developing upper- and mid-level leaders than reported in the Avolio et al. (2010) study with more risk in developing upper-level leaders. However, the simulation model reported that the greatest risk is in the development of low-level leaders, yet they also provide the greatest potential gain.

Research Question Three Results

The third objective was to determine which method of discrete-event computer simulation modeling would allow relaxed variables d , SDy , T , and C to better estimate the return on development investment (RODI): (a) Developing only upper-level leaders and diffusing to mid- and lower-level leaders? (b) Developing upper- and mid-level leaders and diffusing only to

lower-level leaders? or, (c) Developing all three levels; upper-, mid- and lower-level leaders.

These three parts, or components, of Research Question 3 will be addressed and then an added component referred to as 3(d), which compared simulation results with diffusion to simulation results without diffusion.

To address parts 3(a) and 3(b) of Research Question 3, the return on leadership diffusion (ROLD), consisting of the number of mid- and low-level leaders affected by the diffusion of developed upper-level leaders, was calculated. Part 3(c) of Research Question 3 did not incorporate leadership diffusion since all leader levels participated in the leadership development intervention (See Table 4.3).

Table 4.3

Comparison of diffusion effects from leaders exposed to intervention at the next higher level.

# of Expected Leaders from Diffusion	Diffusion Level	ROLD Method	Return on Leadership Diffusion (ROLD)		
			Low Return	Average Return	High Return
8 ^a	Mid	Simulation	(\$724,987)	\$102,921	\$1,706,520
100	Mid	Avolio et al. (2010)	\$28,056	\$233,800	\$430,192
		Difference in RODI ^b	\$714,931 104%	\$130,879 127%	(\$1,706,090) -75%
26 ^c	Low	Simulation	(\$1,653,981)	\$294,113	\$5,940,694
1000	Low	Avolio et al. (2010)	\$200,400	\$1,670,000	\$3,072,800
		Difference in RODI ^b	\$1,854,381 112%	\$1,375,887 468%	(\$2,867,894) -48%

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^aThis ROLD is based on diffusion from 30 developed upper-level leaders in one year time frame. ^bThe difference between the Avolio et al. (2010) results and the computer simulation model study results. ^cThis ROLD is based on diffusion from 100 developed mid-level leaders in one year time frame.

The first row of Table 4.3 reported that 30 developed upper-level leaders provided a ROLD resulting in 8 new mid-level leaders ($M = 7.65$, $SD = 5.91$, $NUL = 30$, $K = 130$, where K is the carrying capacity of upper- and mid-level leaders, and NUL is number of upper-level

leaders), as compared to 100 mid-level leaders diffusion used in the Avolio et al. (2010) study. See Figure 4.3.1 for an example of the S-shaped curve generated from the diffusion effect of 30 upper-level leaders who diffused leadership to 8 low-level leaders.

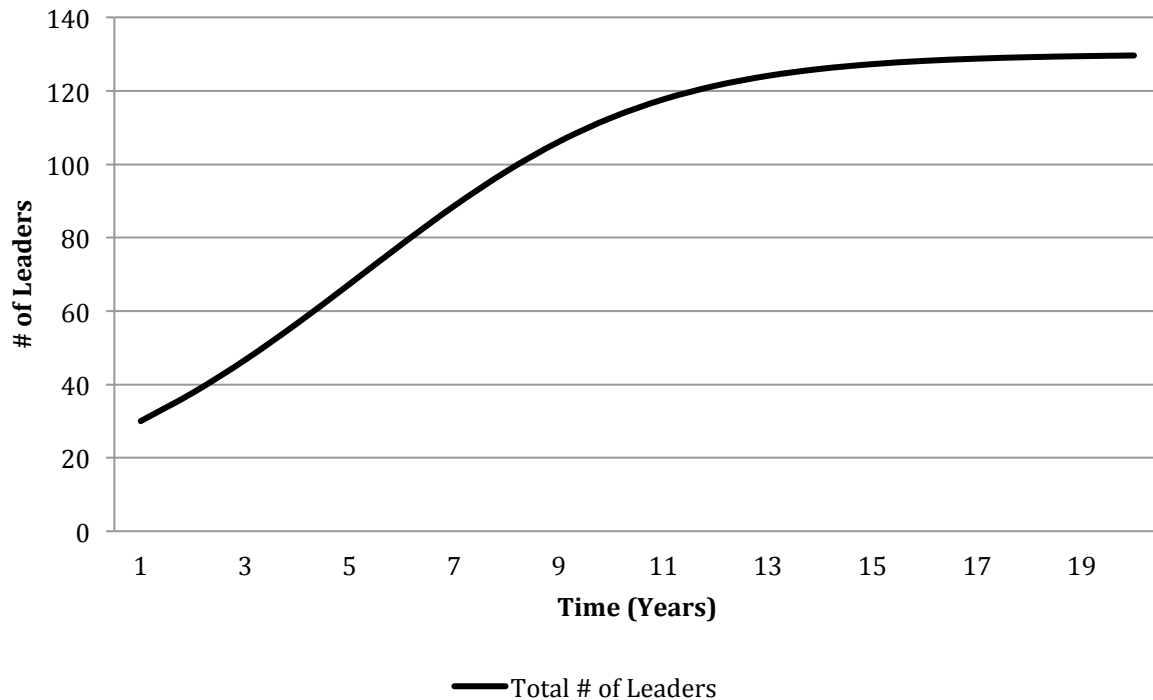


Figure 4.3.1

S-shaped curve generated from the diffusion effect of 30 upper-level leaders who diffused leadership to 8 low-level leaders

The third row of Table 4.3 reported that 100 mid-level leaders provided a ROLD resulting in 26 new low-level leaders ($M = 25.91$, $SD = 22.33$, $NML = 100$, $K = 1100$, where K is the carrying capacity of mid- and upper-level leaders, and $dNML$ is number of low-level leaders from mid-level leader diffusion), as compared to 1000 mid-level leaders used in the Avolio et al. (2010) study. See Figure 4.3.2 for an example of the S-shaped curve generated from the diffusion effect of 100 mid-level leaders who diffused leadership to 26 low-level leaders.

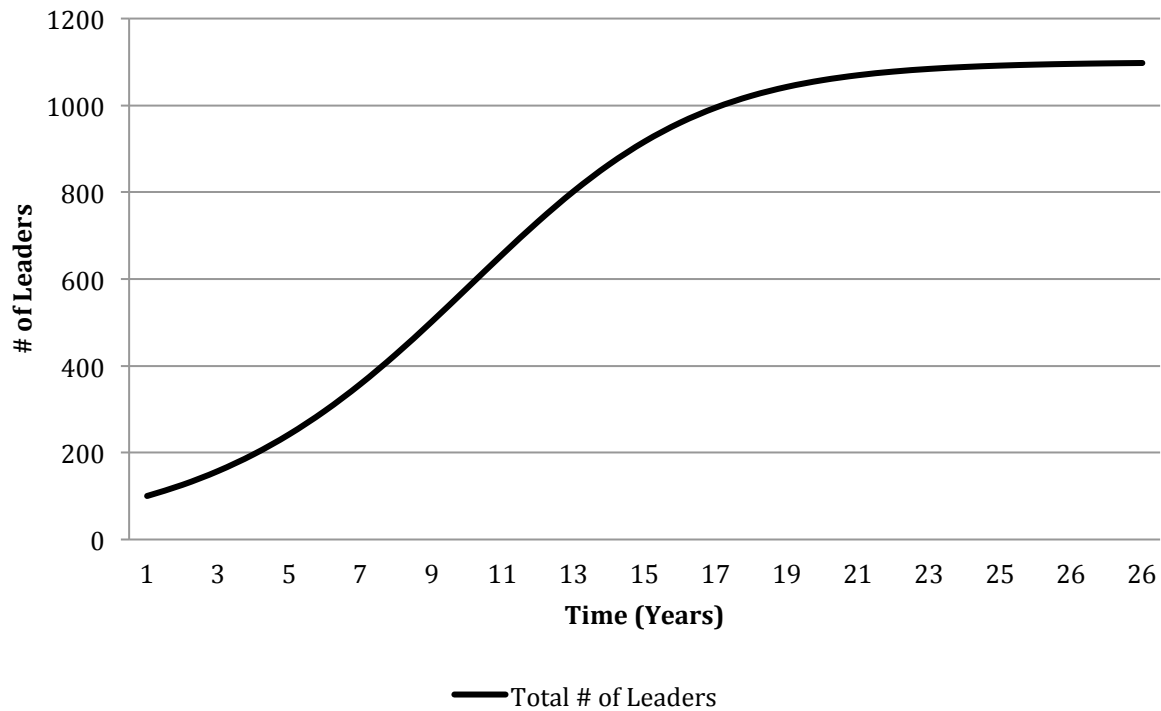


Figure 4.3.2

S-shaped curve generated from the diffusion effect of 100 mid-level leaders who diffused leadership to 26 low-level leaders

For ROLD comparisons between eight mid-level leaders estimated using computer simulation compared to 100 mid-level leaders estimated in the Avolio et al. (2010) study, row three of Table 4.3 indicated that the Avolio et al. (2010) study overestimated gains for low returns by 104% and for average returns by 127%. For high returns, the Avolio et al. (2010) study underestimated gains by 75%.

For ROLD comparisons between 26 mid-level leaders estimated using computer simulation compared to 1000 low-level leaders in the Avolio et al. (2010) study, row six of Table 4.3 indicated that the Avolio et al. (2010) study overestimated gains for low returns by 112% and for average returns by 468%. For high returns, the Avolio et al. (2010) study underestimated gains by 48%.

It was questionable whether the negative low returns were appropriate in the simulation results since there were no intervention costs associated with leadership diffusing to lower level leaders. However, although there are no costs for diffusion, there could be soft costs such as the time invested by the upper-level leader given to the mid-level leader. However, it is important to note that potential diffusion costs were not modeled in this study.

The overestimated results of the Avolio et al. (2010) study are particularly interesting considering the fact that the researchers used half the effect size to calculate their ROLD. Thus, the overestimations and underestimations reported would likely have been much greater should whole effect size values been used. Further, even with a substantially lower number of leaders from using the computer simulation model to generate a more accurate diffusion effect of leadership, high returns were much higher than those reported in the Avolio et al. (2010) study. Results further indicated a significantly greater gain on the high return side per leader when using computer simulation modeling, even though there were approximately 75% less leaders.

For example, the average return was lower with the computer simulation model results compared to the Avolio et al. (2010) results, whereas its ROLD was based on only 8% of the total number of mid-level leaders (8 leaders out of 100). This 8% of new additional leaders contributed as much as 44% of the total ROLD from 100 mid-level leaders in the Avolio et al. (2010) study. Similarly for low-level leaders estimated with the computer simulation model, its ROLD was based on only 2.6% of the total number of low-level leaders (26 leaders out of 1000). This 2.6% contributed as much as 18% of the total ROLD from 1000 low-level leaders reported in the Avolio et al. (2010) study.

3(a). Developing Only Upper-level Leaders and Diffusing to Mid- and Lower-level Leaders

The RODI from 30 developed upper-level leaders diffusing to eight mid- and two low-level leaders was compared to the Avolio et al. (2010) results for 30 upper-level leaders diffusing to 100 mid- and 1000 low-level leaders (See Table 4.4). The ROLD from 30 developed upper-level leaders, consisting of the number of mid-level leaders affected by the diffusion of 30 developed upper-level leaders, was calculated. The distribution of RODI for intervention of 30 upper-level leaders diffusing to 8 mid- and 2 low-level leaders is illustrated in Figure 4.4.1.

The computer simulation model indicated that 30 developed upper-level leaders diffused leadership to eight additional new mid-level leaders, who in turn diffused leadership two additional new low-level leaders ($\mu = 2.30$, $SD = 3.29$, $NML = 8$, $K = 1008$, where K is the carrying capacity of upper- and mid-level leaders, and $dNUL$ is number of mid-level leaders from upper-level leader diffusion).

The 30 developed upper-level leaders who participated in a leadership development intervention were added to the ROLD of the 8 additional new mid-level leaders and 2 additional new low-level leaders. This cumulative RODI consisting of a total of 40 leaders was compared to 130 leaders (30 upper-level and 100 mid-level) reported in the Avolio et al. (2010) study.

Results in row three, Table 4.4, indicated that the Avolio et al. (2010) study overestimated RODI gains in all three return columns: low returns by \$2,548,687 (102%), average returns by \$670,986 (1568%), and high returns by \$450,691 (12%). Therefore, the significant overestimation of gains is likely a result of overestimating the number of leaders expected from leadership diffusion.

Table 4.4

Comparison of computer simulation with diffusion to Avolio et al. (2010) study.

<i>Leadership Intervention</i>	<i>Diffusion #, Level</i>	<i>RODI Method</i>	<i>Return on Development Investment (RODI)</i>		
			<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
30 Upper	8 Mid & 2 Low	Simulation w/ diffusion	(\$2,507,197) -364%	(\$63,392) -9%	\$3,814,022 554%
30 Upper	100 Mid & 1000 Low ^a	Avolio et al. (2010)	\$41,490 ^b 33% ^c	\$607,594 1,565%	\$4,264,713 3,038% ^c
		Difference in RODI ^d	\$2,548,687 102% ^c	\$670,986 1,568%	\$450,691 12% ^c
30 Upper & 100 Mid	26 Low	Simulation w/ diffusion	(\$4,935,053) -403%	\$663,876 66%	\$9,988,795 1675%
30 Upper & 100 Mid	1000 Low	Avolio et al. (2010)	(\$386,754) ^b -100%	\$1,977,966 511%	\$4,275,886 1,106%
		Difference in RODI ^d	\$4,548,299 92%	\$1,314,090 198%	(\$5,712,929) -57%
30 Upper, 100 Mid & 1000 Low	None	Simulation no diffusion	(\$26,211,021) -609%	\$6,024,412 130%	\$65,818,409 1811%
N/A		Avolio et al. (2010)	N/A	N/A	N/A

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^a Avolio et al. (2010) used half the effect sizes of upper- and mid-level leaders to estimate the effects of upper-level follower (mid-level leader) and mid-level follower (low-level leader). ^b To get a cumulative RODI, intervention and diffusion values for leader and follower levels from the Avolio et al. (2010) results were added together.

^c Intervention costs remained unchanged in the Avolio et al. (2010) study, which deflated low returns and inflated high returns. Simulated results include distributions of costs. ^d The difference between the Avolio et al. (2010) results and the computer simulation model study results.

3(b) Developing Upper- and Mid-level Leaders and Diffusing Only to Lower-level Leaders

The RODI from 30 upper-level leaders and 100 mid-level leaders who participated in a leadership development intervention diffusing to 26 low-level leaders was compared to the Avolio et al. (2010) results for 30 developed upper-level leaders and 100 developed mid-level leaders diffusing to 1000 low-level leaders (See Table 4.4). The distribution of RODI for

intervention of 30 upper-level leaders and 100 mid-level leaders, who diffused leadership to low-level leaders, is illustrated in Figure 4.4.2.

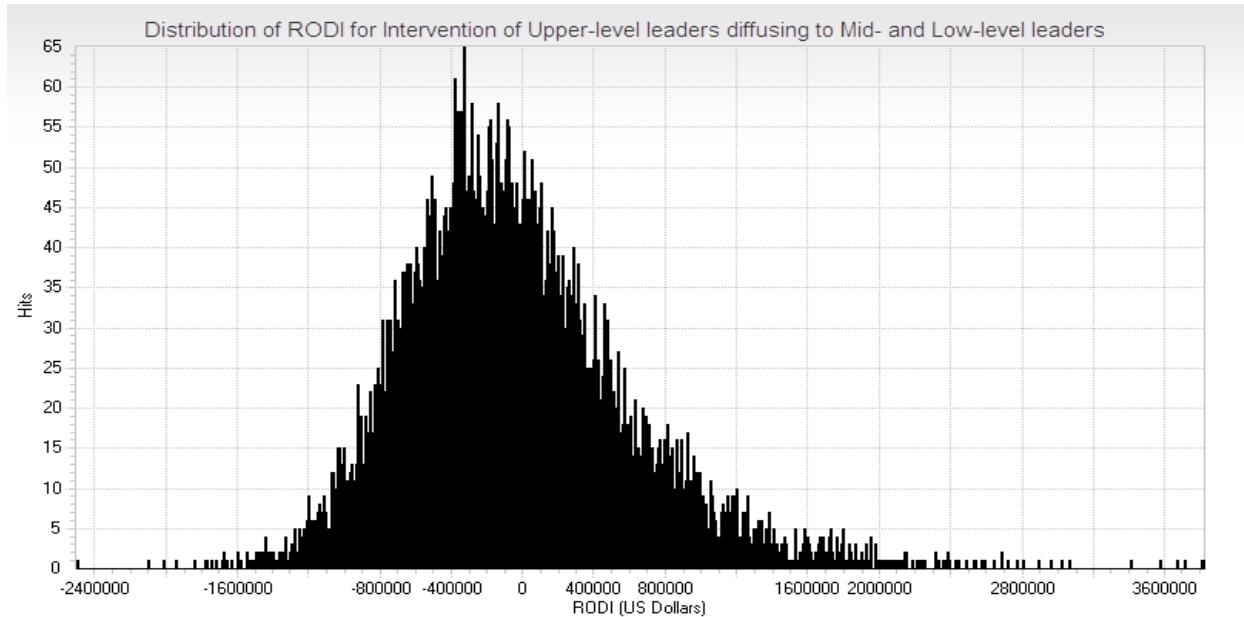


Figure 4.4.1

Distribution of 10,000 RODI for intervention of 30 upper-level leaders diffusing to 8 mid- and 2 low-level leaders

The ROLD from 100 developed mid-level leaders, consisting of the number of low-level leaders affected by the diffusion of 100 developed mid-level leaders, was calculated. As illustrated in row four of Table 4.4, 100 developed mid-level leaders provided a ROLD resulting in 26 additional new low-level leaders ($\mu = 25.91$, $SD = 22.33$, $NML = 100$, $K = 1100$, where K is the carrying capacity of mid- and upper-level leaders, and $dNML$ is number of low-level leaders from mid-level leader diffusion), as compared to 1000 mid-level leaders used in the Avolio et al. (2010) study. The 30 upper-level leaders and 100 mid-level leaders who participated in a leadership development intervention were added to the ROLD of the 26 low-level leaders. This cumulative RODI consisting of a total of 156 leaders was compared to 1130 leaders (30 upper-level, 100 mid-level and 1000 low-level) reported in the Avolio et al. (2010) study.

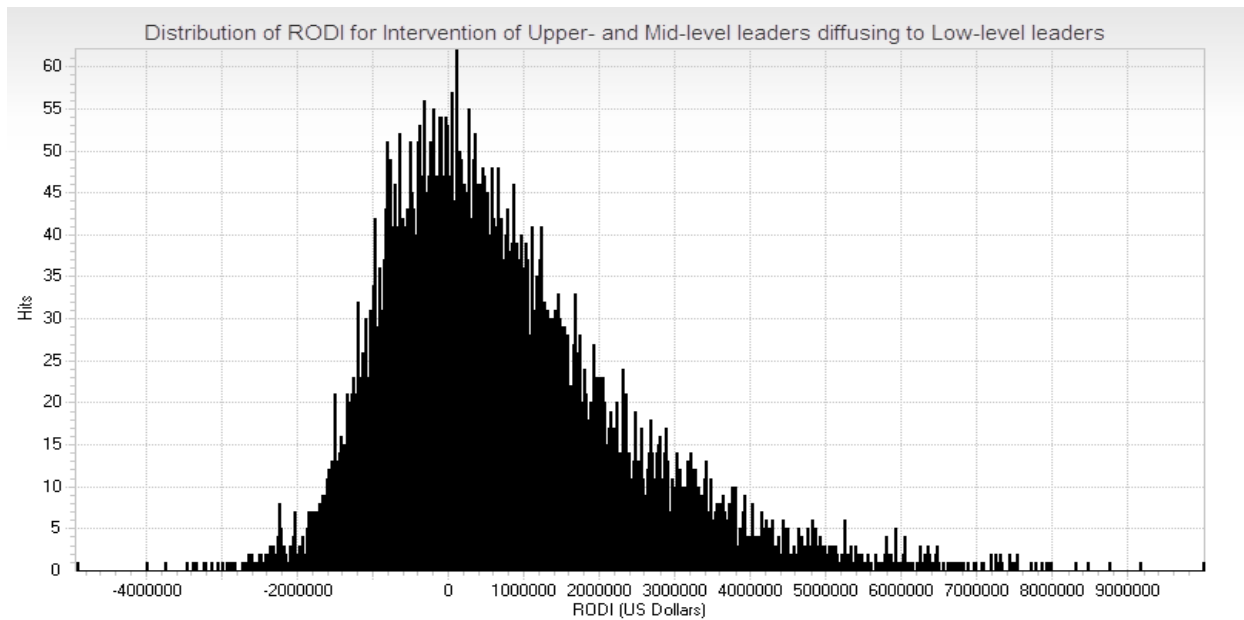


Figure 4.4.2

Distribution of 10,000 RODI for intervention of 30 upper-level and 100 mid-level leaders, who diffused leadership to 26 low-level leaders

Results in row three, Table 4.4, indicated that the Avolio et al. (2010) study overestimated gains in the low return column by \$2,548,687 (102%) and in the average returns column by \$670,986 (1,568%). High returns were also overestimated in the Avolio et al. (2010) study by as much as \$450,691 (12%). Therefore, the significant overestimation of returns is likely a result of the Avolio et al. (2010) study overestimating the number of leaders expected from leadership diffusion as well as using only one standard deviation above and below the mean to calculate low and high returns.

Results in row six of Table 4.4 indicated that the Avolio et al. (2010) study overestimated gains in the low return column by \$4,548,299 (92%) and in the average returns column by \$1,314,090 (198%). High returns were underestimated in the Avolio et al. (2010) study for this intervention level by \$5,712,929 (-57%). Therefore, the significant overestimation of returns is again, a likely result of the Avolio et al. (2010) study overestimating the number of leaders

expected from leadership diffusion as well as using only one standard deviation above and below the mean to calculate low and high returns. The underestimation of the high returns with the Avolio et al. (2010) study is likely a result of the growing number of leaders using simulation, who have a higher benefit to cost ratio.

3(c) Developing All Three Levels; Upper-, Mid- and Lower-level Leaders

To address part 3(c) of Research Question 3, RODI was calculated and summed for 30 upper-level leaders, 100 mid-level leaders, and 1000 low-level leaders who participated in the leadership development intervention (See row seven, Table 4.4). The distribution of RODI for intervention of 30 upper-level, 100 mid-level, and 1000 low-level leaders with no diffusion, is illustrated in Figure 4.4.3.

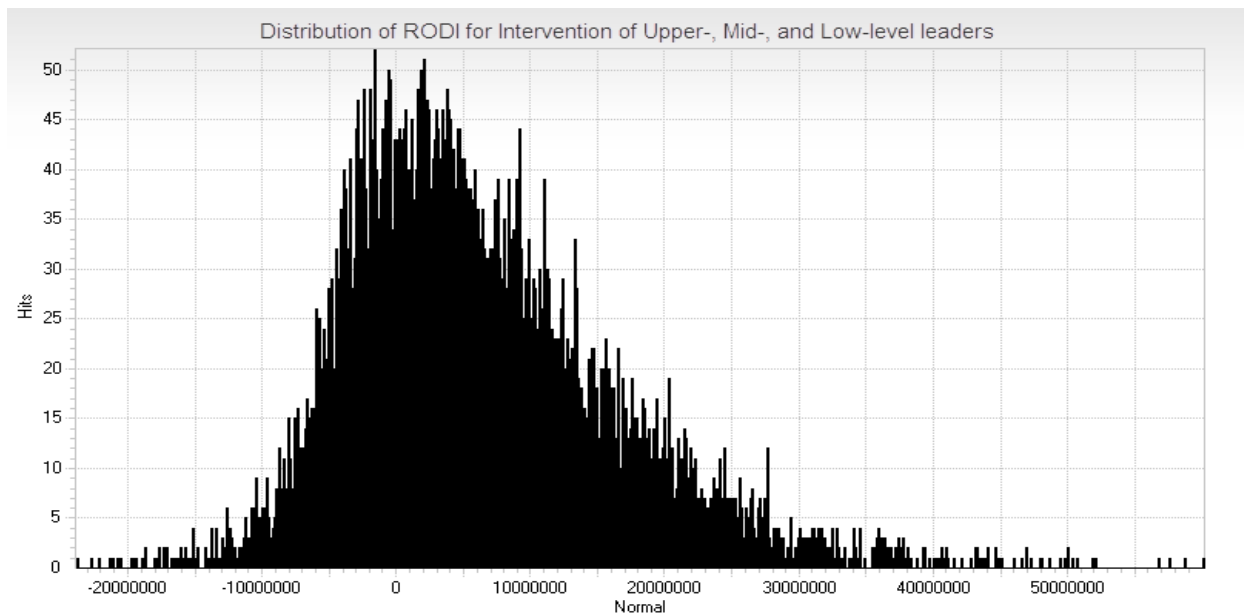


Figure 4.4.3

Distribution of 10,000 RODI for intervention of 30 upper-level, 100 mid-level, and 1000 low-level leaders with no diffusion

This intervention level produced the highest average returns at \$6,024,412 (130%) and the highest high returns at \$65,818,409 (2,037%). However, this intervention level also produced

the lowest returns at -\$26,211,021 (-609%). There were no leadership diffusion effects incorporated since all leader levels participated in the intervention. In addition, there were no comparisons to Avolio et al. (2010) results since researchers did not report RODI for developed low-level leaders.

Comparisons between the computer simulation model results and the Avolio et al. (2010) results in rows three and six of Table 4.4 indicated that for all returns except one, Avolio et al. (2010) significantly overestimated RODI gains between 12 and 1,567%. The Avolio et al. (2010) high returns from developing 30 upper-level leaders, 100 mid-level leaders and diffusing to 1000 low-level leaders, which were significantly lower than the high returns estimated with the computer simulation model, indicated an underestimation of RODI by \$5,712,929 (57%) (See row six in Table 4.4). Although the computer simulation model's returns were typically less than Avolio et al. (2010) results, they still provided positive high returns for most all intervention scenarios. Additionally, the computer simulation model results indicated significantly positive average returns when developing upper- and mid-level leaders with leadership diffusing to low-level leaders, and when developing all leader levels.

Gaps in high returns and gaps in low returns between the simulated RODI and Avolio et al. (2010) RODI estimates were likely due to the fact that the Avolio et al. (2010) study used only one standard deviation above and below the mean for estimates. The computer simulation model, on the other hand, used distributions extending well beyond only one standard deviation on either side of the mean. The results indicated that no returns were very comparable. The next objective will illustrate a comparison of the intervention effects of leadership development between computer simulation model results incorporating leadership diffusion and computer simulation model without incorporating leadership diffusion.

3(d) Comparisons Between Computer Simulation Model Results Incorporating Leadership Diffusion and Computer Simulation Model Without Leadership Diffusion

Computer simulation model results compared to Avolio et al. (2010) results indicated that the Avolio et al. (2010) results significantly overestimated RODI gains in most all cases, even when compared to returns reported in Avolio et al. (2010). See Table 4.5.

Table 4.5

Comparison of computer simulation with diffusion compared to developed leader-levels with no diffusion.

<i>Intervention #, Level</i>	<i>Diffusion #, Level</i>	<i>RODI Method</i>	<i>Return on Development Investment (RODI)</i>		
			<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
30 Upper	8 Mid, 2 Low ^a	Simulation w/ diffusion	(\$2,507,197) -364%	(\$63,392) -9%	\$3,814,022 554%
30 Upper	None	Simulation no diffusion	(\$2,242,169) -325%	(\$181,019) -26%	\$1,997,765 290%
		Difference in RODI ^b	\$265,028 11%	(\$117,627) -186%	(\$1,816,257) -48%
30 Upper, 100 Mid	26 Low ^c	Simulation w/ diffusion	(\$4,935,053) -403%	\$663,876 66%	\$9,988,795 1675%
30 Upper, 100 Mid	None	Simulation no diffusion	(\$3,688,208) -258%	\$383,735 39%	\$6,365,279 1820%
		Difference in RODI ^b	\$1,246,845 25%	(\$280,141) -42%	(\$3,623,516) -36%
30 Upper, 100 Mid & 1000 Low	None	Simulation no diffusion	(\$26,211,021) -609%	\$6,024,412 130%	\$65,818,409 1811%

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^a These 8 ROLD are based on diffusion from 30 developed upper-level leaders. The 2 ROLD are based on diffusion from 8 mid-level leaders - all in one year time frame. ^b The difference between the Avolio et al. (2010) results and the computer simulation model study results. ^c This ROLD is based on diffusion from 100 developed mid-level leaders in one year time frame.

For a more adequate comparison of the effects of leadership diffusion, Table 4.5 compares the intervention effects of leadership development between computer simulation model

results incorporating leadership diffusion and computer simulation model without incorporating leadership diffusion. When not accounting for ROLD, true gains or losses can be misconstrued. Row three, Table 4.5, demonstrated that 30 upper-level leaders who participate in a leadership development intervention are the only group that are used to calculate RODI, gains for low, average and high returns are not properly estimated. For example, without including ROLD when calculating RODI, computer simulation results overestimated gains (or underestimated losses) for the low return by 11%. Further, gains for both average and high returns were also underestimated. For average returns, gains were underestimated by 186%; and, for high returns, gains were underestimated by 48%.

Row six, Table 4.5, indicated similar results. When developing upper- and mid-level leaders who participate in a leadership development intervention but not including the ROLD of low-level leaders, computer simulation results overestimated gains (or underestimated losses) for the low return by 25%. For average returns, gains were underestimated by 42% and for high returns, gains were underestimated by 36%.

Therefore, Table 4.5 demonstrates that when incorporating the effects of leadership diffusion, there is a minimal increase in losses (between 11 - 25%) but a moderate (36%) to substantial (186%) increase in gains. Considering that leadership diffusion is considered free, it is wise to consider its value when estimating RODI.

Overall, the objectives of Research Question 3 were met. Variables d , SDy , T , and C were relaxed to better estimate RODI by (1) developing only upper-level leaders and diffusing to mid- and lower-level leaders, (2) developing upper- and mid-level leaders and diffusing only to lower-level leaders, and (3) developing all three levels; upper-, mid- and lower-level leaders. Computer simulation results were compared to the Avolio et al. (2010) results, and were demonstrated to

provide significantly more accurate RODI estimates. Further, the effects of leadership diffusion was further studied, which also demonstrated that by accounting for ROLD when estimating RODI, estimates may have a slightly greater loss but potential for significantly higher gains.

Results further indicated that developing all leader levels produced, even without the effects of leadership diffusion, a significantly more positive RODI than can result on average from only developing upper-level leaders, or both upper- and mid-level leaders. However, should the diffusion effects on those below low-levels leaders be accounted for, it is likely that these effects will continuously increase gains with minimal costs. Therefore, when taking into account the effects of leadership diffusion versus no leadership diffusion, on average, this produces higher gains and a more positive RODI.

Although leadership development investments may often lead to significant positive payoffs for the organization, actual payoffs depend on factors that affect the quality of the leadership development intervention, length of time engaged in the intervention, and the total cost of the intervention. Thus, one area that was not accounted for in this comparison was the degree to which the leadership development intervention met the behavioral objectives relevant to individual performance. Thus, Research Question 4 addresses this issue.

Research Question Four Results

The fourth objective was met by adding a variable, P , to adjust for inflated, or over- or underestimated RODI estimates from assuming that training programs include 100% of behavioral objectives relevant to an employee's performance (Cascio & Boudreau, 2011). Results indicated that when including P in the RODI equation, RODI is more reasonably estimated due to the inclusion of an additional randomly distributed variable fluctuating from 0

to 100%. This percentage accounted for the variability of the leadership development intervention containing behavioral outcomes relevant to individual performance. See Table 4.6.

Without incorporating P when using the computer simulation model to estimate RODI, percentage results in Table 4.6 (rows three, six and nine) indicated a 22 to 34% overestimation of all losses in the low returns column, as well as overestimations of gains for both average (from 86 to 720%) and high returns (from 36 to 183%).

The greatest overestimation was in row nine of Table 4.6 for the average return from all leader levels participating in leadership development interventions, which was overestimated by \$5,290,165, or 720%. This overestimation likely occurred because of the high number of leaders, especially low-level leaders, developed with no adjustment for P . No adjustments for P assumed that all leadership development interventions covered 100% of behavioral objectives for not only all upper- and 100 mid-level leaders, but also for all 1000 low-level leaders. However, this is an unlikely occurrence, and is one of the main reasons why estimating RODI without some adjustment for P can create a biased estimate that can significantly overestimate both RODI losses and gains.

Although the average return reported in row nine of Table 4.6 had the largest RODI gap when comparing computer simulation results with P and without P , it was the only average intervention scenario that demonstrated a positive RODI (\$734,247 or 24%), after being adjusted for P .

This suggested that for leadership development interventions to demonstrate a positive RODI, program designers and trainers must design and implement leadership development intervention meeting a high percentage of behavioral outcomes that are relevant to individual performance. These results also suggested that time is a significant factor and the more time, the

longer the possible engagement in the leadership development, which can increase positive RODI results.

Table 4.6

Comparison of computer with diffusion compared to leader-level intervention with added *P*, or percentage of behavioral objectives relevant to person's performance.

<i>Intervention Level</i>	<i>Diffusion Level</i>	<i>RODI Method</i>	<i>Return on Development Investment (RODI)</i>		
			<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
30 Upper	8 Mid, 2 Low ^a	Simulation w/ diffusion & <i>P</i>	(\$1,901,748) -445%	(\$442,751) -55%	\$1,343,767 770%
30 Upper	8 Mid, 2 Low	Simulation w/ diffusion, no <i>P</i>	(\$2,507,197) -364%	(\$63,392) -9%	\$3,814,022 554%
		Overestimation of simulation with no <i>P</i> ^b	(\$605,449) -32%	\$379,359 86%	\$2,470,255 183%
30 Upper, 100 Mid	26 Low ^c	Simulation w/ diffusion & <i>P</i>	(\$4,031,220) -298%	(\$315,951) -19%	\$7,334,565 1966%
30 Upper, 100 Mid	26 Low	Simulation w/ diffusion, no <i>P</i>	(\$4,935,053) -403%	\$663,876 66%	\$9,988,795 1675%
		Overestimation of simulation with no <i>P</i> ^b	(\$903,833) -22%	\$979,827 310%	\$2,654,139 36%
30 Upper, 100 Mid & 1000 Low	None	Simulation no diffusion, w/ <i>P</i>	(\$19,501,642) -415%	\$734,247 24%	\$47,540,915 1052%
30 Upper, 100 Mid & 1000 Low	None	Simulation no diffusion, no <i>P</i>	(\$26,211,021) -609%	\$6,024,412 130%	\$65,818,409 1811%
		Overestimation of simulation with no <i>P</i> ^b	\$6,709,379 -34%	\$5,290,165 720%	\$18,277,494 38%

Note. Losses are denoted in parentheses; underestimations are denoted in negative percentages.

^a These 8 ROLD are based on diffusion from 30 developed upper-level leaders. The 2 ROLD are based on diffusion from 8 mid-level leaders - all in one year time frame. ^b The difference between the simulation results with *P* and the simulation results without *P*. ^c This ROLD is based on diffusion from 100 developed mid-level leaders in one year time frame.

After adjusting for *P* the average returns for both intervention of 30 upper-level leaders diffusing to mid- and low-level leaders in row one, Table 4.6, as well as intervention of 30 upper-level leaders and 100 mid-level leaders then diffusing to low-level leaders in row four,

indicated negative RODI. Specifically, row one of Table 4.6 indicated that intervention of only upper-level leaders diffusing to mid- and low-level leaders demonstrated the most negative RODI of -\$442,741, or -55%, from a -9% loss without adjusting for *P*. These results indicated that in the first year, average costs of upper-level leadership development intervention outweigh average benefits, thereby costing the organization a loss of 55% more than was invested. However, emphasizing a very well designed leadership development program and implementation could benefit the organization with a gain as high as 770% RODI. On the contrary, a poorly designed leadership development program and intervention could cause the organization to incur a 445% loss to the organization.

High returns of intervention for upper-level leaders then diffusing to mid- and low-level leaders demonstrated the highest overestimation of gains compared to other intervention levels. Table 4.6, row three reported an overestimation of 183% for upper-level leaders when not adjusting for *P*. All other intervention levels demonstrated overestimations ranging between 36 and 38%. These results suggested that high returns for upper-level leaders could be significantly overestimated if the percentage of behavioral objectives covered by the leadership development program is not accounted for. This significant overestimation is likely due to the length of intervention that it typically takes to develop upper-level leaders, which is 16 days, and the higher costs associated with upper-level leader development versus mid- and low-level leaders. Thus, if leadership development programs are not adequately designed and implemented for upper-level leaders, this poses the greatest potential for a loss of investment or more (a loss as great as -445%). See Figure 4.6.1 for the distribution of RODI of only upper-level leaders diffusing to mid- and low-level leaders with adjustments for *P*.

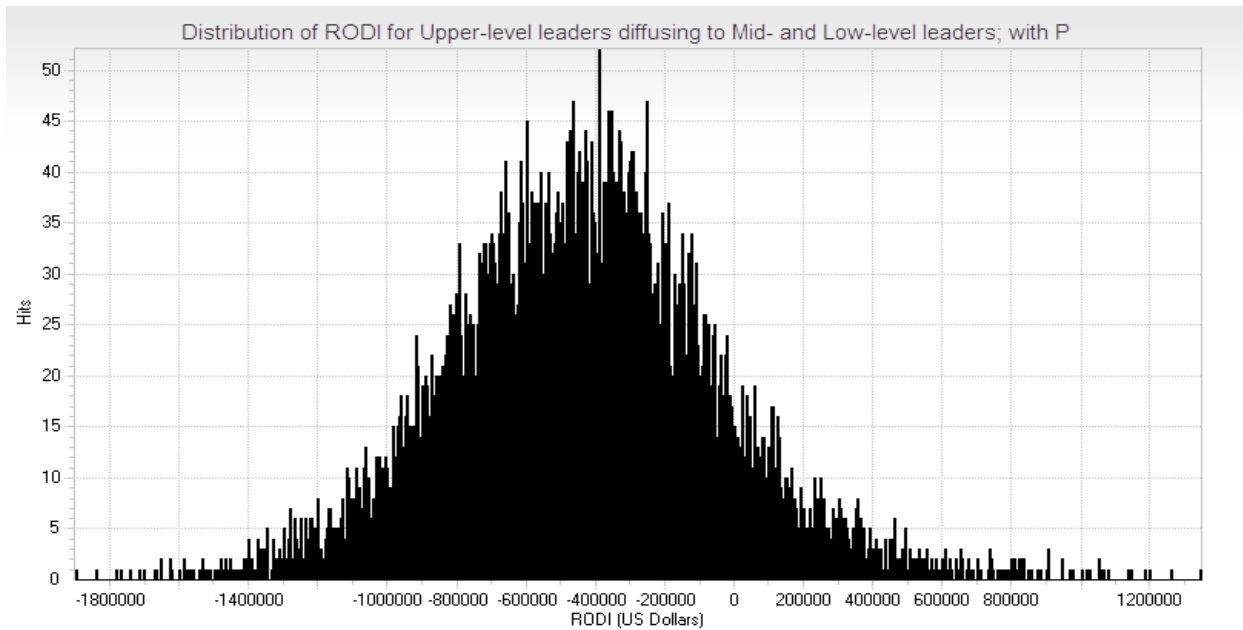


Figure 4.6.1

Distribution of 10,000 RODI values for 30 upper-level leaders with mid- and low-level diffusion, and adjustments for P .

Another costly scenario was the intervention of 30 upper-level leaders and 100 mid-level leaders, who then diffused to low-level leaders as indicated in row four of Table 4.6. Results demonstrated that this intervention level produced a 19% loss (-\$315,951) from the effects of a mediocre leadership development intervention, with a potential loss of 298%. Again, a well-designed leadership development program and intervention could benefit the organization with as high as a 1,966% gain. On the contrary, although this intervention level had the least potential loss for low return, a poorly designed leadership development program and intervention could cost the organization as much as -298% of its investment.

Interestingly, the intervention of 30 upper-level leaders and 100 mid-level leaders, who then diffused to low-level leaders as indicated (Row four of Table 4.6) indicated the greatest potential for positive gain but only developing all leader levels can produce a positive average

RODI in the first year. See Figure 4.6.2 for the distribution of 10,000 RODI values of upper-and mid-level leaders diffusing to low-level leaders, with adjustments for P .

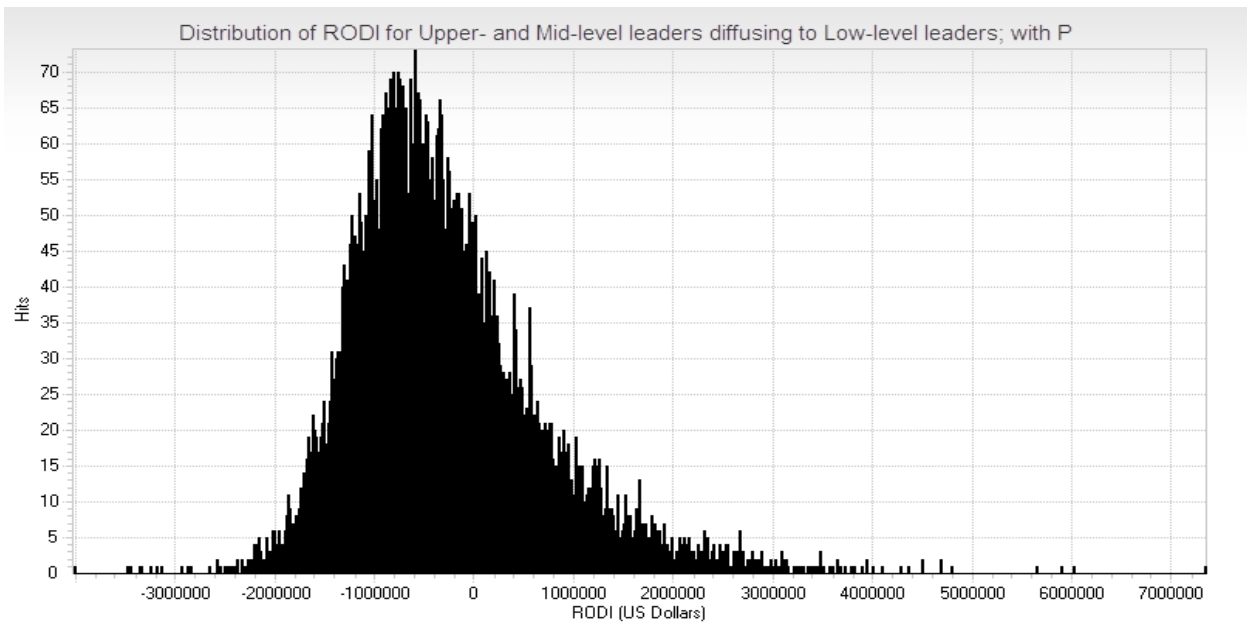


Figure 4.6.2

Distribution of 10,000 RODI values for 30 upper-, 100 mid-level leaders with low-level diffusion, and adjustments for P .

Thus, according to these results, although there is less risk in the intervention of 30 upper-level leaders and 100 mid-level leaders as opposed to developing all three leader levels, there is a slim chance that a gain will be recognized in the first year. Therefore, if an organization needed an immediate (within on year) gain from the leadership development intervention, their best investment may well be to invest in all leader levels. Developing only upper-level leaders provides the greatest risk in the first year and developing upper- and mid-level leaders provides less risk on average but still a risk. See Figure 4.6.3 for the distribution of 10,000 RODI values for the intervention of all leader levels: 30 upper-, 100 mid-, and 1000 low-level leaders, with adjustments for P .

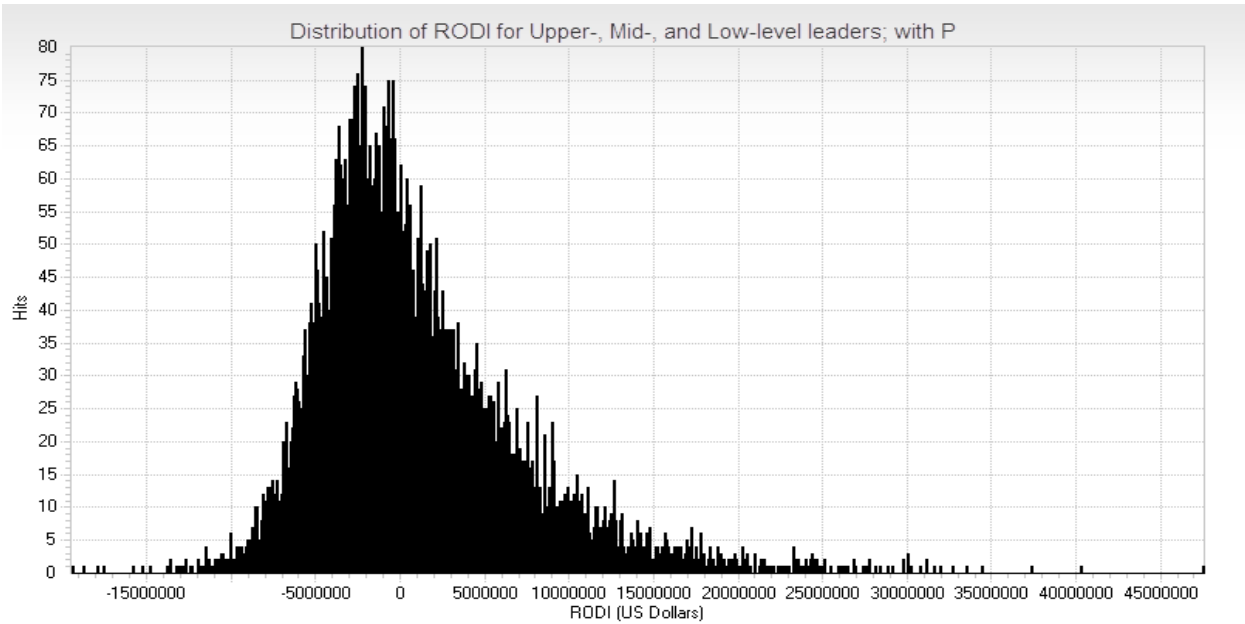


Figure 4.6.3

Distribution of 10,000 RODI values for the intervention of all leader levels: 30 upper-, 100 mid-, and 1000 low-level leaders, with adjustments for P .

These results suggested that unless a leadership development intervention is contains a quality design and appropriately covers a high percentage of behavioral objectives that are relevant to individual performance, the changes of the organization benefitting with a gain from their investment is slim. An average leadership development intervention will at best, only likely produce a 24% return on their investment. Thus, if organizational leaders combined quality leadership development intervention design and implementation with the continuous effects of leadership diffusion, this could produce substantial results. As a matter of fact, Tables 4.7 (a, b, and c) reported the results of computer simulation modeling for all three intervention levels adjusted for P , and also demonstrated results of an initial leadership development investment in year one and its effect over five years. The results were surprising.

Table 4.7a illustrated the intervention of 30 upper-level leaders with diffusion effects on eight additional new mid-level leaders, who diffused leadership to two additional new low-level

leaders over five years. Although the first year (row one) demonstrated an average loss of 55%, the second year had an amazing recovery, resulting in a 60% gain. Gains continued to progress leading to the third year producing an 80% gain, fourth year a 112% gain and the fifth year, a 146% gain.

Table 4.7a

Computer simulation of intervention and diffusion over five years, including P for 30 upper-level leaders and diffusion to mid- and low-level leaders.

<i>Year</i>	<i>Intervention Level</i>	<i>Diffusion #, Level</i>	<i>Return on Development Investment (RODI)</i>		
			<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
0-1	30 Upper	8 Mid, 2 Low	(\$1,901,748) -445%	(\$442,751) -55%	\$1,343,767 770%
1-2	30 Upper	17 Mid, 8 Low	(\$283,939) -69%	\$323,995 60%	\$1,855,561 798%
2-3	30 Upper	27 Mid, 18 Low	(\$331,508) -75%	\$439,114 80%	\$1,975,746 913%
3-4	30 Upper	37 Mid, 34 Low	(\$507,003) -63%	\$594,654 112%	\$2,966,732 1702%
4-5	30 Upper	48 Mid, 56 Low	(\$1,405,348) -118%	\$788,456 146%	\$3,959,653 1772%
		Cumulative RODI after 5 years	(\$2,489,293) -360%	\$1,702,405 337%	\$13,215,617 7143%

Note. Intervention and its cost of 30 upper-level leaders only occurred in the first year.

The cumulative gain for the whole five-year time frame equated to an average gain of 337%, or \$1,702,405, with an average investment in intervention cost of only approximately \$690,000 in year one. This is evidence that the continued, and exponential effects of leadership diffusion have a significant impact on RODI of leadership development intervention. See Figure 4.7.1 for a distribution of 10,000 cumulative RODI values over 5 years from intervention of 30 upper-level leaders in the first year, and then leadership diffusion to mid- and low-level leaders.

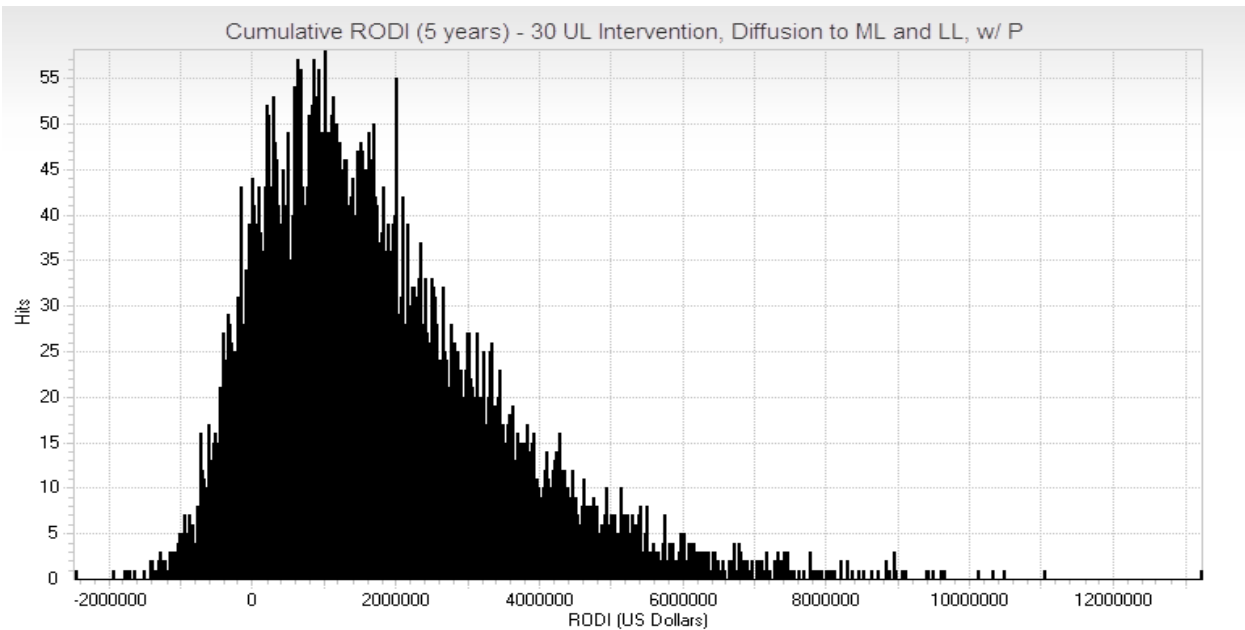


Figure 4.7.1

Distribution of 10,000 cumulative RODI values over 5 years from intervention of 30 upper-level leaders in the first year, and leadership diffusion to mid- and low-level leaders, with adjustments for P .

One of the greatest benefits is the one-time investment for a continuous, revenue generating result. Not considering the additional return gained from the diffusion of leadership development can cause great misinterpretation of the actual RODI of leadership development intervention and its value to the organizations bottom-line. However, although these results are promising, investing in the development of more leader levels can produce even greater returns from the effects of leadership diffusion.

Table 4.7b illustrated the intervention of 30 upper-level leaders and 100 mid-level leaders, who diffused leadership to 26 additional new low-level leaders. Row one demonstrated an average loss of 19% in the first year; yet again in the second year there was an amazing recovery, resulting in an 82% gain. Gains continued to progress leading

to the third year producing a 95% gain, fourth year a 133% gain and the fifth year, a 155% gain.

Table 4.7b

Computer Simulation of intervention and diffusion over five years, including P for 30 upper-, 100 mid-level leaders and diffusion to low-level leaders.

<i>Year</i>	<i>Intervention Level</i>	<i>Diffusion #, Level</i>	<i>Return on Development Investment (RODI)</i>		
			<i>Low Return</i>	<i>Average Return</i>	<i>High Return</i>
0-1	30 Upper, 100 Mid	26 Low	(\$4,031,220) -298%	(\$315,951) -19%	\$7,334,565 1966%
1-2	30 Upper, 100 Mid (In 1 st Year)	32 Low	(\$1,927,353) -190%	\$989,926 82%	\$5,689,152 1072%
2-3	30 Upper, 100 Mid (In 1 st Year)	58 Low	(\$1,308,365) -132%	\$1,134,195 95%	\$7,120,598 1144%
3-4	30 Upper, 100 Mid	142 Low	(\$2,213,545) -135%	\$1,573,358 133%	\$8,757,505 1452%
4-5	30 Upper, 100 Mid	196 Low	(\$9,480,483) -359%	\$3,381,528 155%	\$16,092,070 1409%
		Cumulative RODI after 5 years	(\$8,489,242) -702%	\$5,262,812 443%	\$43,363,640 4822%

Note. Intervention and its cost of 30 upper- and 100 mid-level leaders only occurred in the first year.

The cumulative gain for the whole five-year time frame equated to an average gain of 443%, or \$5,262,812, with an average investment in intervention cost of only approximately \$1,455,000 in year one. See Figure 4.7.2 for a distribution of 10,000 cumulative RODI values over 5 years from intervention of 30 upper-level leaders and 100 mid-level leaders in the first year, and then leadership diffusion to low-level leaders.

Again, these results are evidence that the continued, and exponential effects of leadership diffusion have a significant impact on RODI of leadership development intervention. However,

although these results are promising, investing in the development of all leader levels produce even higher five-year gains.

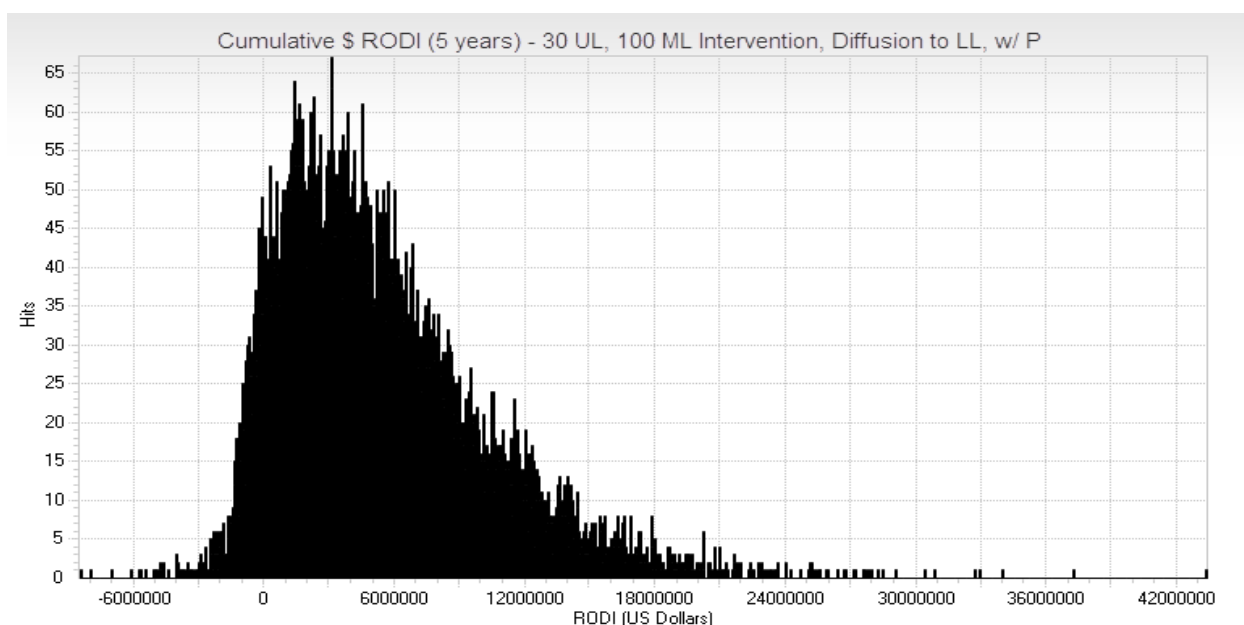


Figure 4.7.2

Distribution of 10,000 cumulative RODI values over 5 years from intervention of 30 upper- and 100 mid-level leaders in the first year, and then leadership diffusion to low-level leaders, with adjustments for P .

Table 4.7c illustrated the intervention of all leader levels with no diffusion: 30 upper-level leaders, 100 mid-level leaders, and 1000 low-level leaders. There were not average losses in these results. On the contrary, row one demonstrated an average gain of 13% in the first year, whereas gains continued to progress leading to the second year producing a 122% gain, the third year producing a 123% gain, fourth year a 126% gain and the fifth year, a 123% gain. Although gains were consistently high, after the second year, this intervention level did not produce the highest gains; and, gains were basically remained at stable from year two on.

The cumulative gain for the whole five-year time frame equated to an average gain of 534%, or \$25,081,004, with an average investment in intervention cost of only approximately \$5,700,000 in year one.

Table 4.7c

Computer simulation of intervention for all leader levels over five years with no diffusion, and adjustments for *P*.

			Return on Development Investment (RODI)		
Year	Intervention Level	Diffusion #, Level	Low Return	Average Return	High Return
0-1	30 Upper, 100	None	(\$19,501,642)	\$734,247	\$47,540,915
	Mid, 1000 Low		-415%	24%	1052%
1-2	30 Upper, 100	None	(\$20,990,260)	\$6,171,923	\$50,560,874
	Mid, 1000 Low		-289%	122%	1785%
2-3	30 Upper, 100	None	(\$18,355,235)	\$6,088,853	\$44,699,627
	Mid, 1000 Low		-455%	123%	1294%
3-4	30 Upper, 100	None	(\$16,331,915)	\$6,091,001	\$45,194,009
	Mid, 1000 Low		-368%	126%	1515%
4-5	30 Upper, 100	None	(\$20,895,057)	\$6,188,490	\$47,177,210
	Mid, 1000 Low		-305%	123%	1108%
Cumulative RODI after 5 years			(\$98,586858) -2065%	\$25,081,004 534%	\$218,952,567 7313%

Note. Intervention and its cost of 30 upper-, 100 mid-, and 1000 low-level leaders only occurred in the first year.

Again, this is evidence that the continued, and exponential effects of leadership diffusion have a significant impact on RODI of leadership development intervention. Although the average, and mostly low and high, returns remained stable and consistent, the continuous positive impact of the all of these developed leaders also remained steady, with an average return after year two hovering around 124% gain. This steady return after year two is likely due to the carrying capacity reaching its limit of 1130 leaders. Further, developing all leader levels not only provides the possibility of the highest possible gains (7,313%), but it also places the organization in a situation whereas they could also experience the greatest possible loss (-2,065%). See Figure 4.7.3 for a distribution of 10,000 cumulative RODI values over 5 years from intervention of all leader levels in year one: 30 upper-level leaders, 100 mid-level leaders and 1000 low-level leaders, with adjustments for *P*.

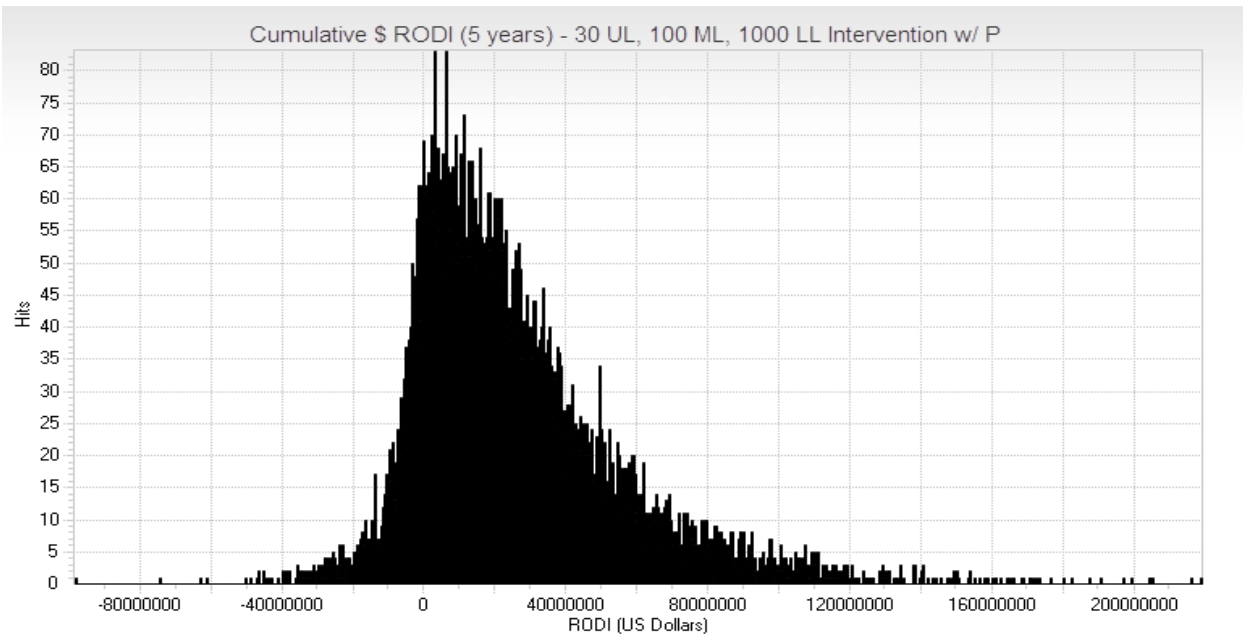


Figure 4.7.3

Distribution of 10,000 cumulative RODI values over 5 years from intervention of all leader levels in the first year: 30 upper-level leaders, 100 mid-level leaders and 1000 low-level leaders, with adjustments for P .

Over time, one could speculate that the level of leadership exhibited from these leaders may decline. However, this study did not include any research to support a type of “half-life” of leadership development intervention. Nonetheless, these results do implicate that those organizational leaders who want near immediate benefits from leadership development intervention must invest in all leader levels, unless they could be sure that the leadership development intervention was of very high quality.

Summary

Results of this study indicated that using non-simulated techniques to estimate RODI could significantly overestimate or underestimate results. Further, these results demonstrate that computer simulation or utility analysis formulas alone cannot accurately estimate RODI without

certain adjustments made that account for the diffusion effects of leadership as well as the leadership development intervention quality.

Once adjustments are made to account for leadership development intervention quality as well as the diffusion effects of leadership development, results indicated that in order to produce near immediate (within one year) benefits or gains from leadership development intervention, organizational leaders still must invest in all leader levels. However, should they have the patience to wait for the second year or thereafter, results at each intervention level indicated organizational leaders could benefit from positive, and often substantial, gains.

Although waiting may not seem practical, investments typically do require some lapse of time before benefits begin to materialize. Yet, these results demonstrated unique findings in that they identified another way to expedite, and one could say further ensure, positive returns on investments. Another, more reasonable approach for organizations to use in order to more quickly benefit from leadership development intervention, is to ensure that the leadership development intervention meets 100%, or near 100%, of the behavioral outcomes that are relevant to individual performance. An even greater assurance for high gains is to both ensure the leadership development intervention's quality as well as allow time for the investment to mature.

Overestimations of losses for low returns across all intervention scenarios were roughly comparable but still considerably high, an average overestimation of loss near 29% RODI when failing to adequately design and implement a quality leadership development program.

Overestimations for high returns when developing upper- and mid-level leaders then diffusing to low-level leaders and when developing all leader levels, averaged approximately 37%. When including the overestimation of high returns from developing only upper-level leaders then

diffusing to mid- and low-level leaders (184% overestimation), the average overestimation for all intervention scenarios increased to 84%.

Overall, the greatest overestimations or underestimations of the computer simulation model between adjustments and no adjustments for P were for average returns. The average underestimation when not adjusting for P was nearly 200%, which included underestimations from intervention of only upper-level leader then diffusing to mid- and low-level leaders (-85%) and underestimations from intervention of only upper- and mid-level leaders then diffusing to low-level leaders (-310%). These results suggested that on average, when estimating RODI for the development only upper-level leaders or both upper- and mid-level leaders without adjusting for P , this can deflate, or underestimate the negative effects of RODI as much as 200% by assuming that leadership development interventions include 100% of behavioral objectives relevant to an employee's performance (Cascio & Boudreau, 2011).

The only overestimation when not adjusting for P was for average returns at 720% overestimation, which was the overestimation of RODI from intervention of all leader levels with no diffusion. These results suggested that on average, when estimating RODI for the development of all leader levels without adjusting for P , this can potentially inflate, or overestimate, RODI as much as 720% by assuming that training programs include 100% of behavioral objectives relevant to an employee's performance (Cascio & Boudreau, 2011).

Returns in Table 4.6 appear to have suggested that leadership development interventions are not worth the investment, except for potential high returns. However, although this assumption has some validity within the first year of leadership development, this table does not take into account the diffusion effect of leadership past one year. Therefore, Table 4.7 illustrated effects of leadership development intervention and diffusion effects from one to five years to

demonstrate these effects. Further, it is very reasonable to assume that leadership development intervention and diffusion of leadership will become exponentially more valuable until reaching its carrying capacity. However, even in the case of reaching its carrying capacity, the effects of leadership may well be re-generative.

CHAPTER 5: DISCUSSION AND CONCLUSION

The method used to estimate return on development investment (RODI) can significantly affect monetary outcomes. The use of computer simulation modeling to estimate RODI provides a more accurate and practical method than non-simulated arithmetical calculations of RODI, such as traditional hand calculations using algebraic equations. The main objectives of this study were: (1) Replicate the Avolio et al. (2010) RODI analysis using discrete-event computer simulation modeling; (2) Determine if better estimates of RODI could be obtained using discrete-event computer simulation modeling after relaxing RODI variables compared to estimates in the Avolio et al. (2010) RODI analysis; and, (3) Determine which intervention method allowed for better estimates of RODI using discrete-event computer simulation modeling: (a) Developing only upper-level leaders and diffusing to mid- and lower-level leaders, (b) Developing upper- and mid-level leaders and diffusing only to lower-level leaders, or, (c) Developing all three levels; upper-, mid- and lower-level leaders.

However, two other very important analyses were added to the study. The first analysis was an incorporation of the effects of a new variable, P , which adjusted for the percentage of behavioral outcomes that a leadership development intervention used relevant to individual performance (Cascio & Boudreau, 2011; Holton, 2011). This analysis demonstrated that without adjusting for P , RODI outcomes were significantly inflated. The second comparative analysis was a yearly estimation of RODI and its diffusion effects over the course of five years. The results of this analysis provided a much greater positive effect than expected, demonstrating that leadership development interventions can produce a cumulative return as high as 465% RODI in just five short years. Surprisingly, even the lowest average returns from investments in

leadership development interventions were quite significant, providing as much as a 244% RODI.

Computer Simulation Replicates Non-Simulation RODI Methods

Not only was the Avolio et al. (2010) RODI analysis able to be replicated using computer simulation modeling, but the simulation method used in this study was also very robust in its ability to create random distributions of values for the RODI variable. This study suggests that computer simulation modeling is a useful and powerful approach to simulate mathematical RODI calculations, allowing stochastic estimations of the return on leadership development intervention. It also suggests that computer simulation modeling is a capable means of studying complex situations that traditional research cannot support (Kelton, Sadowski, & Swets, 2010; Kendrick et al., 2003; Kirman & Zimmerman, 2001; Kohler & Gumerman, 2002; Latane & Bourgeois, 2000; Law & Kelton, 1982; Macy & Willer, 2002; Srbljinovic & Skunca, 2003).

Further, this study indicates that computer simulation modeling is an effective means to understand and mimic leadership behavior regarding the study of RODI (Forrester, 1999; Kelton, Sadowski, & Swets, 2010). Therefore, organizational leaders can be confident that RODI from leadership development interventions can be accurately predicted and assist them in making more informed decisions about whether to invest in a leadership development intervention or not; and, help identify the most appropriate intervention with the highest RODI.

Computer Simulation as a Better Estimator of RODI

Returns on development intervention are better estimated by using computer simulation modeling to relax RODI assumptions, providing a more accurate estimation of RODI than using traditional, non-simulated, arithmetical means. The current study indicated that RODI computer simulation modeling provides significantly more credible and accurate RODI outcomes than

non-simulated means such as those used in the Avolio et al. (2010) study. This is a reasonable outcome considering the ability of the computer simulation model to statistically generate distributions for each variable in the RODI equation, and then randomly sample 10,000 values from the distribution to calculate RODI. This would be a near impossible task if done using traditional hand calculation methods.

After comparing 3-day intervention results for each leader level in the Avolio et al. (2010) study to computer simulation results, in all cases but one, the Avolio et al. (2010) study significantly overestimated or underestimated RODI. The only leader level where the Avolio et al. (2010) study marginally underestimated RODI when was the average return of developing 100 mid-level leaders.

However, these RODI results did not provide the most adequate comparisons considering the large difference in costs used for simulated versus non-simulated methods. For example, the current study used much more representative salary data sets to estimate costs (ASTD, 2009, 2010; U.S. Department of Labor, 2010). This greatly increased the average daily cost of leadership development intervention of upper-level leaders from \$720 per leader as reported in Avolio et al. (2010) to \$6,040 per leader. These higher costs for leadership development intervention produced a much greater potential for monetary losses. Although these low, and mostly negative, returns are possible, they only happen if all of these newly developed leaders do not effectively transfer greater leadership in the workplace. The same explanation can be used for both mid- and low-level leaders and their low returns. Considering that only 10 to 30% of learning is transferred into the workplace (Baldwin & Ford, 1988), these low returns are possible and unfortunately, more likely to occur than high returns provided the quality of the leadership development intervention is less than excellent.

Average and high returns for each leader level were positive, except for average returns for upper-level leaders. For those leader levels that reported positive RODI, ranges spanned from 64% to 1508% gains. However, although intervention of upper-level leaders produced a negative RODI for the average return, this is likely due to the higher intervention costs associated with developing this level of leadership.

Overall, this illustrates that using computer simulation modeling to estimate RODI provides substantially greater accuracy than using non-simulated means of estimating RODI, both in better estimating positive, average and negative returns. Further, although these results are very informative, they do not take into account the diffusion effects of leadership development after the intervention, which can greatly affect RODI outcomes.

Diffusion Comparisons Between RODI Methodologies

Leadership diffusion is well supported in leadership literature and research (Avolio et al., 2010; Avolio et al., 2009; Bass et al., 1987; Bowers & Seashore, 1966; Hannah et al., 2008; Jansen, Vera, & Crossan, 2009; Mayer et al., 2009; Misumi, 1985; Ouchi & Maguire, 1975; Stogdill, 1955), but it has yet to be studied across multiple leadership levels from an RODI perspective. Combining leadership research with concepts of Diffusion of Innovations theory as popularized by Everett Rogers (2003), this study demonstrated an RODI method that by using computer simulation modeling, exponential effects of leadership diffusion can be estimated and calculated into monetary returns.

For example, the development of 30 upper-level leaders would diffuse leadership to approximately eight additional new mid-level leaders, and 100 mid-level leaders would diffuse leadership to approximately 26 additional new low-level leaders. In other words, in the first year the diffusion rate for upper-level leaders to mid-level leaders is approximately 27%, and for mid-

level leaders to low-level leaders it is approximately 25%. Thus, organizational leaders can be confident that on average, for every four upper- or mid-level leaders developed, they can expect one additional new leader. However, the actual monetary value cannot be determined simply by looking at the ratio without considering the return on leadership development investment.

These diffusion effects created significant differences compared to the Avolio et al. (2010) RODI results. In all cases except one, the Avolio et al. (2010) RODI results overestimated the positive RODI, suggesting that using non-simulated means of estimating RODI cannot accurately predict RODI without a more robust methodology or more representative data. There are a couple of explanations for this overestimation.

First, most all RODI returns reported by Avolio et al. (2010) were positive. On the contrary, all low returns using computer simulation modeling in comparison to the Avolio et al. (2010) study reported significantly greater losses; average returns reported both a small loss and a small gain, and were both significantly less than the Avolio et al. study (2010); and, high returns were marginally less for intervention of upper-level leaders but greater for intervention of both upper- and mid-level leaders. Interestingly, low returns in particular, regarding the simulated study, reported significantly greater losses in RODI. Although this may seem odd, there are a few reasonable explanations.

When Avolio et al. (2010) calculated their diffusion effects, they only used one standard deviation above and below the mean. This created a high and low “cut-off” that limited both potentially greater losses and higher gains. The computer simulation model had the ability to use distributions, which greatly exceeded one standard deviation above and below the mean and included most all possibilities.

Another possible explanation for the greater losses reported using the computer

simulation is that there could be costs associated with leadership diffusion. Although this study did not model any leadership diffusion costs, it is reasonable to assume that when leaders diffuse leadership to the next lower level that certain costs may be involved which could further enhance losses in RODI. Although these costs would be a type of “soft” cost, they would be a cost nonetheless. For example, these leadership diffusion cost could be (1) time spent away from work whereas the higher-level leader is not able to carry-out his-her duties, or (2) the potential negative RODI from leadership diffusion that may occur and then the new leader leaves employment or has some negative response. With leadership diffusion cost in mind, this could explain some of the greater loss of RODI as seen in the low returns for the computer simulation estimates when comparing with Avolio et al. (2010) results. Should this be the case, as the number of new leaders would grow, so would the potential leadership diffusion costs. However, future research is needed to further substantiate potential cost of leadership diffusion.

A third explanation for the overestimation of RODI using non-simulated methods was that Avolio et al. (2010) assumed that all 100 mid-level leaders would be impacted by diffusion within one year. Although researchers did attempt to negate the effects by dividing the effect size in half (Avolio et al., 2010), the chances of all 30 upper-level leaders diffusing leadership to all 100 mid-level leaders, in one year, is highly unlikely. Thus, by using the logistic differential growth formula to estimate the possible leadership diffusion effects in the first year, this study provided a much more accurate expectation of new leaders from leadership diffusion. Therefore, one could argue that the comparison between the actual RODI results with diffusion to the Avolio et al. (2010) results is technically not an adequate comparison. Therefore, comparisons between simulated results with diffusion and without diffusion were used to illustrate a more adequate impact of leadership intervention and diffusion.

Simulated Comparisons Between Diffusion and No Diffusion

Estimating RODI and considering the diffusion effects of upper-level leaders provides more accurate negative RODI for low returns, suggesting that losses are as much as 11% greater than without considering the effects of diffusion. However, when comparing simulation with diffusion to no diffusion, average and high returns are much more positive. For example, there is a 186% more positive average return considering the diffusion effects of developed upper-level leaders diffusing to mid- and low-level leaders, and gains are 48% higher than when not accounting for the diffusion effects. However, developing only upper-level leaders, even when accounting for the leadership diffusion effects to mid- and low-level leaders, had an average loss of 9%; yet, with the potential for gains as high 554%.

For developed upper- and mid-level leaders diffusing leadership to low-level leaders, when comparing diffusion effects to no diffusion the average gains are 42% higher and high returns report gains that are 36 higher from the effects of leadership diffusion. Actual gains for developing upper- and mid-level leaders, including their leadership diffusion effects, reach as high as 1,675%, with an average gain of 66%.

Although this intervention level had the greatest risk, reporting potential losses as low as 609%, developing all leader levels can produce average gains of 130% and as high as 1,811%.

This demonstrates that by incorporating diffusion effects with leadership development intervention, returns on development investment can be substantial provided the quality of the leadership development is high. Since one of the purposes of developing leaders is to develop others, incorporating diffusion effects provide more accurate intervention benefits associated with leadership development intervention. This suggests that although leadership development

interventions are not without costs, the returns on investment and benefits from leadership development intervention and its diffusion effects outweigh the costs.

Another interesting finding is that incorporating diffusion effects provides potential for greater gains of both average and high returns, even when diffusion only produces a minimal number of new leaders. For example, a 21% increase in the number of leaders produces between -9 and 554% RODI (compared to -26% to 290% RODI) when developing only upper-level leaders and diffusing to mid- and low-level leaders. Similarly, a 16% increase in the number of leaders produces between 66 and 1,675% increase in RODI (compared to 39% to 1,820% RODI) when developing only upper- and mid-level leaders and diffusing to low-level leaders. The diffusion of leadership provides a great benefit with no cost, except possible soft cost that may be involved in diffusing leadership. However, this is purely speculative and more research much be conducted to substantiate any cost to the diffusion of leadership. Should there be a diffusion cost, it is highly unlikely that these costs would be more than those incurred from involving leaders in formal leadership development interventions. Therefore, the benefits of leadership diffusion likely far outweigh any potential costs that may be involved.

Another interesting finding is that there are noticeably smaller percentage differences in RODI for low returns (only 11% for upper-level leader intervention and 25% for upper- and mid-level leader intervention) compared to differences in high returns (48% difference for upper-level leader intervention and 36% difference for upper- and mid-level leader intervention). This suggests that although costs may increase due to more leaders involved in intervention, there are much greater benefits or returns. Thus, the more leaders developed, the less chance for a loss and greater chance for moderate or high gains.

However, it is highly unlikely that after leadership development interventions occur, all leaders would fail exercise developed leadership behaviors or diffuse leadership to those at the next leader level. At the same time, learning transfer research does report that 70 to 90% of the learning could be lost and therefore not applied to the workplace (Baldwin & Ford, 1988). While placing too much emphasis on low returns is questionable, they must not be overlooked and the best remedy to negate losses may well be placing more effort into the design and quality of the leadership development intervention. Similarly, placing too much emphasis on higher returns can also cause unbalanced assumptions suggesting that all newly developed leaders will exercise and diffuse the greatest amount of leadership. This too is unlikely. Although the safest approach may seem to be to use average returns to estimate RODI, this is not necessarily the case. Low and high returns must be taken into consideration, yet the greatest safeguard to reduce chances for investment losses is to focus on the quality of the leadership development intervention.

This analyses assisted in addressing the third research question in this study, which asks which method or intervention scenario provides a better estimate of RODI: (1) Developing only upper-level leaders and diffusing to mid- and lower-level leaders? (2) Developing upper- and mid-level leaders and diffusing only to lower-level leaders? or, (3) Developing all three levels; upper-, mid- and lower-level leaders? According to the results of this study, although developing all leader levels has the greatest risk, it also provides the greatest average return of 130% RODI, with gains reaching as high 1,811%. Developing upper- and mid-level leaders provide the next highest gains, with an average return of 66% and high return of 1,675%. Developing only upper-level leaders actually incurs a 9% loss (-9% RODI) for the average return, but with the potential of a 554% gain. Interestingly, although the difference in cost between developing only upper-level leaders and developing upper- and mid-level leaders is minimal, there is a much greater

benefit in developing both upper- and mid-level leaders (-9% RODI (loss) compared to a 66% RODI (gain)).

Regardless of these seemingly high returns, there are still significant risks for each intervention scenario, whether developing only upper-level leaders (-364%), developing both upper- and mid-level leaders (-403%), or developing all leader levels (-609%). For example, there is a potential for loss of investment (-609% RODI) costing as much as \$26 million to develop all leader levels. This is due mostly from the large number of leaders who would participate in a leadership development intervention, creating a huge expense and the greatest cumulative negative RODI.

On the contrary, for a little more risk than only developing upper- and mid-level leaders (-403% RODI compared to -609% RODI), organizations can develop all leader levels for nearly double the average return (66% gain compared to a 130% gain). Therefore, in this analysis, provided that the leadership development intervention was of excellent quality, the best intervention level with the highest average and high returns for RODI is developing all leader levels. In addition, these high returns are evident with no diffusion effects. Therefore, although developing upper-, mid and low-level leaders have the greatest risk (-609%), they also provide the greatest potential for substantial positive returns reaching as high as 1,811%. This suggests that provided an organization has the financial means, developing all leader levels provides nearly double the RODI. It also suggests that should the diffusion effect be considered for those below low-leader levels, gains could be even greater.

The fact that these RODI results are either highly positive or slightly negative with a positive trend, suggests that leadership development intervention is worthy of investment, provided that the leadership development intervention is designed to meet 100% of the

behavioral objectives relevant to individual performance. This further validates the findings in the Avolio et al. (2010) research, which reported a substantial positive return from the effects of leadership development intervention and its effects on performance. However, the problem with the previous method of estimating RODI is the mere assumption that leadership development intervention always covers 100% of the behavioral objectives relevant to individual performance. This is also unlikely. Thus, a further investigation of the RODI of leadership development intervention is provided using an additional variable to account for the percentage of behavioral objectives relevant to individual performance.

Varying Percentages of Behavioral Objectives Met in Training

Holton (2011) and others (Cascio & Boudreau, 2011; Cascio & Ramos, 1986) suggest that the standard utility analysis formula used in this study could inflate RODI estimates if not adjusted. Without the variable P , the standard utility analysis formula assumes that when evaluating RODI of leadership development programs, 100% of the behavioral objectives are completely relevant to the performance of the person being developed (Holton, 2011). According to previous research, although some percentage of these behavioral objectives will be covered, 100% of the objectives will not be covered 100% of the time (Cascio & Boudreau, 2011; Holton, 2011). The percentage of behavioral objectives covered will likely be proportional to the length of the training program. Therefore, this study incorporated an additional variable, P , to represent this effect and confirm that there are inflated estimates of RODI when this inflation is not properly adjusted for using other means. This is an important distinction because relaxing this assumption causes a significant decrease in RODI for all leader levels participating in leadership development intervention.

Simulating RODI using the standard utility formula, without adjusting for the percentage

of behavioral objectives relevant to a person's performance, indicates that gains can be inflated or overestimated as much as 720% on average, and losses can be overestimated 34%. More specifically, by not adjusting for *P*, on average, RODI is overestimated by 86% for the development of upper-level leaders, 310% when developing upper- and mid-level leaders, and as much as 720% underestimation when developing all leader levels. This means that assuming that leadership development interventions cover 100% of behavioral objectives relevant to individual performance, gains are significantly overestimated and losses are underestimated, especially in the first year after the intervention. Reported also were losses for average returns for development of upper-level leaders (-55%) and for upper- and mid-level leader development (-19%), and a moderate gains for developing all leader levels (24%). This addresses the fourth research question, whereas the objective was to determine whether there were over- or underestimated RODI estimates when no adjustments were made from assuming that training programs include 100% of behavioral objectives relevant to an employee's performance (Cascio & Boudreau, 2011).

Interestingly, for both lower and higher returns there is much less difference. Small differences in low returns were only minimal on average. However, looking at results of each intervention level studied, the percentage of overestimating losses without *P* decreased 10% from only upper-level leaders participating in leadership development intervention to that of both upper- and mid-level leaders being developed (from -32% to -22% RODI). However, once low-level leaders were formally developed, RODI without *P* even further overestimated losses by as much as 34% (-34% RODI). Nonetheless, at each intervention level, by not accounting for the variance in the quality of the leadership development intervention meeting behavioral objectives relevant to individual performance, losses for low returns were consistently overestimated.

These results suggest that there is a much greater potential for loss with fewer upper-level leaders than compared to mid- or low-level leaders. It also provides another insight with regard to accounting for P . Thus, by accounting for P , there is less potential for loss at all intervention levels. This is likely due to the fact that when P is added, this marginalizes both the benefit side of the utility analysis equation and the cost side. More specifically, it marginalizes both the extreme high values within each variable's distribution as well as the extreme low, and at times negative, values. Therefore, this P effect "trims" both the high and low returns of the simulated distribution. Even further, the effect of P actually creates a negatively skewed distribution range for the development of upper-level leaders, forcing the average return to an even greater negative RODI (-64% with P from a -9% without P). As a matter of fact, adjusting for P even forces the development of upper- and mid-level leaders to a 19% loss (-19% RODI) from a 46% gain without adjusting for P . The only intervention method that produced a positive RODI after adjustments for P , was the development of all leader levels. However, this intervention level reported a moderately positive RODI of only 24% from 106% without adjusting for P .

These are very interesting findings, and quite discouraging on the face of it. However, these low and often negative returns do not mean that RODI is not a worthy investment. One must remember that intervention costs, as with most investments, often require an initial investment (often associated with a cost) in order to receive some benefit. This benefit, as opposed to the cost, does not necessarily come immediately. Often costs come at the onset of the investment and the benefit comes at some time later; hence the idiom, "It takes money to make money." In the case of leadership development and diffusion, the more leaders that participate in leadership development interventions will incur a greater cost. However, the question becomes over time, will the benefits outweigh the costs? It is important to note that RODI distributions

mostly signified a positive skew (greater positive high return than negative low return), indicating that the more leaders developed, the more likely the average return would produce a positive RODI. To test this hypothesis, five-year projections of RODI were illustrated.

The Effects of Leadership Intervention and Diffusion Over Time

Although RODI and ROLD in the first year of leadership development intervention for both all intervention scenarios indicate either negative RODI or minimally positive RODI, these are only projected returns for one year after intervention. Thus, unless an organization has a “get rich quick” attitude, they could clearly see and expect some time lapse before they benefit from the returns on their investment. Much like long-term investments in the stock market, depending on the types of investments one may be making, having some patience can pay off hundred-fold. This is the case in leadership development intervention and its diffusion effects.

Using logistical growth methodology and diffusion concepts to project the number of new leaders developed in a five-year time frame (Pearl & Reed, 1977; Rogers, 2003; Verhulst, 1838, 1977), this study demonstrated that substantial returns on leadership development intervention and diffusion are possible, even with an extra effort to suppress results by adding P to the RODI utility analysis equation. Although in the first year two out of three intervention scenarios have a negative RODI, in the second year, the leader population increases exponentially increasing returns, and again the third year, again the fourth, again the fifth, and so on; thus, this exponential pattern is expected until the carrying capacity begins to taper the effects. Therefore, the true diffusion effect will greatly enhance the effects of leadership intervention through diffusion to next level leaders should it be extended 2, 3, 5 or more years until reaching carrying capacity or a new leadership development intervention occurs.

Developing all leader levels provides a positive average RODI in the first year, as well as the highest average RODI in a five-year investment. Although one may argue that the average and high returns are significantly higher than compared to developing only upper- and mid-level leaders, it is important to note that the risk of developing all leader levels is significantly greater (-2,065% as compared to -702% from development of upper- and mid-level leaders). Therefore, organizational leaders must ask themselves the question of whether they prefer immediate RODI but with the greatest risk of loss and a fairly comparable highest average RODI? Or, whether they prefer less risk and the highest return, but with the expectation that they must wait at least two years to see a positive RODI and five years to reap the highest returns? Clearly, these two intervention scenarios provide the most benefit and the greatest means for organizational leaders to make the best investment decisions depending on their individual circumstances.

As for developing only upper-level leaders, the potential to reach a positive RODI is possible even though the first year produces a negative average RODI (-55%). However, at year two, this intervention level does produce a positive RODI of 60% and by the fifth year it produces a positive RODI of 337% on average. One advantage of developing only upper-level leaders is that this intervention scenario provides the least cumulative risk of investment loss (-360% RODI). However, this intervention scenario also provides the greatest potential loss in the first year (-445% RODI) and has a similar potential for loss in the first year as developing all leader levels (-415% RODI). Thus, developing all leader levels produces a 143% increase in returns with nearly the same risk. Therefore, it is recommended to consider investing in intervention for either upper- and mid-level leaders or all leader levels before investing in only upper-level leaders. Furthermore, with a similar risk of loss in the first year, investing in all

leader levels produces the greatest chance for much higher gains. However, this option can potentially have a greater cost of initial investment.

Although investing in the intervention of upper- and mid-level leaders produces a loss in the first year (-19% RODI), this intervention level may be a viable option for those organizations that want the least chance of loss but a with smaller average loss and potentially high gain (1,966%). However, to arrive at an average positive RODI, the organization would have to be willing to be patient with their investment and provided they are, the second year could produce average returns as high as 82%.

This analysis confirms this effect by demonstrating an actual monetary RODI from investments in leadership development interventions and how they pay off substantially when considering the extended effects of these interventions through the diffusion of leadership to lower leader levels. Although negative RODIs are produced the first year from investing in leadership development intervention for only upper-level leaders (-55%) and only upper- and mid-level leaders (-19%), the diffusion effects of leadership significantly impact the RODI the following year. In year two, RODI increases to positive 60% from the development of only upper-level leaders and their diffusion effects, and a positive 82% from the development of upper- and mid-level leaders and their diffusion effects. From year one to year two for the development of all leader levels, RODI increases from 24 to 122%. Thus, cumulative effects of leadership development intervention and the diffusion of leadership across four additional years results in the following:

1. RODI ranging from an average return of -55% the first year to 337% RODI in the fifth year from the development of only upper-level leaders and diffusion to mid- and low-level leaders in the first year with diffusion spanning across the

next four years.

2. RODI ranging from an average return of -19% the first year to 443% RODI in the fifth year from the development of both upper- and mid-level leaders and diffusion to only low-level leaders in the first year with diffusion spanning across the next four years.
3. RODI ranging from an average return of 24% the first year to 534% RODI in the fifth year from the development of all leader levels in the first year with diffusion spanning across the next four years.

Conclusion

Computer simulation modeling not only validates Avolio et al.'s (2010) research, which suggested leadership development intervention as having a significantly higher monetary return on development investment (RODI) than most organizational leaders are aware, but it also provides a much more accurate estimation of RODI. This is further supported even when the model variables are pushed well beyond previous methods of estimating RODI (Avolio et al., 2010). This includes creating random distributions of variables and including new variables (*P*), which estimate the percentage of behavioral outcomes embedded in the leadership development intervention or diffusion effect that are relevant to individual performance (Cascio & Boudreau, 2011; Cascio & Ramos, 1986).

Although adjusting for the quality of the leadership development intervention substantially lowered RODI, the diffusion effects of leadership development has the potential to regain these losses or minimized gains over time. Investing in the development of all leader levels provides the highest average returns in the first year (24% RODI) and over a five-year period (534% RODI), with returns reaching as high as nearly \$219 million (7,313% RODI).

However, developing only upper-level leaders and diffusing to mid- and low-level leaders provides the lowest returns, and even a loss in average returns (-55% RODI) the first year. However, by the second year, returns are positive (60% RODI) and by the fifth year, organizational leaders could see a 337% average gain on their investment. Investing in upper- and mid-level leaders provides a smaller loss in the first year (-19% RODI) but a second year positive return of 82% and a five-year cumulative return of 443%.

Overall, this research demonstrates that RODI can be estimated much more accurately using computer simulation modeling and that when organizational leaders consider the diffusion effects of leadership, they can reap significant, exponential returns on their investments if they are willing to exercise patience and let time and leadership diffusion do its job.

Other Implications and Future Research

As opposed to more deterministic models of RODI such as found in Avolio et al (2009, 2010), this RODI uses stochastic models that allow one to more accurately estimate variables of interest. However, this technique is underutilized in HRD research and when determining the value of human capital investments.

The ability to answer stakeholder questions of how a program will add value, especially when costs and benefits are deterministic factors, is extremely beneficial. The financial viability of an organization is a real concern – you cannot operate an organization very long without positive finances and investments. Therefore, organizational leaders and their respective investors must be concerned with worthy investments that can demonstrate a straightforward return on their investment. Using simulated RODI methodology provides this straightforward approach and the results are seamlessly matched with common financial jargon comparison that are commonplace for executive interpretation.

One challenging issue facing organizations, organizational leaders, human resource and training and development professionals, and others is valuating human resource programs, training and development programs and other programs and projects. Attempts to justify program or project worthiness merely based on interests or its effectiveness on face value, is unacceptable to stakeholders and decision-makers in current organizational environments. These leaders want to see quantifiable returns on their investments; expected or actual results that they can clearly see the performance benefit.

Thus, another value-added implication of simulated RODI methodology is that it can effectively estimate leadership development intervention value cross-industry, regardless if these interventions are nested within industries or organizations such as healthcare, manufacturing, government, refining, chemical, energy, petroleum, construction, sales, non-profit, religious, banking, communication, hospitality, media, retail, technology, and food. Basically, any industry that has employees and a salary value is a candidate for simulated RODI analysis. In addition, this RODI method can be very useful for specific fields and disciplines to enhance their effectiveness and organizational value. For example, the field of human resources is typically involved in program design, development, implementation and evaluation. Programs that once seemed overtly subjective, too qualitative, and difficult to convey value to stakeholders can now be analyzed objectively and introduced or evaluated much more accurately using these RODI techniques.

This study promotes and supports other researcher positions that encourage organizations that are currently participating in leadership development interventions, or plan to participate (even those who no longer participate), to make an effort conduct RODI analyses (Avolio et al., 2010). A benefit of this research is that it can not only help organizational leaders value current

leadership development interventions and the RODI, but participating in the RODI process can provide greater insight into future development needs and goals. Therefore, simulated RODI can serve as a proactive tool, which in conjunction with other valuation methods can provide a more objective approach toward making investment decisions that impact the bottom-line of the organization.

Knowing the true RODI can promote organizational accountability for performance. Efficient organizations value investments to the point of ensuring that money spent are well accounted or better, money invested is monitored closely awaiting its return and ensuring that obstacles inhibiting those returns are minimized. Providing identifiable, accurate, and even predictive RODI program estimates in common ROI terms have several benefits. It not only increases the probability of RODI to be more universally accepted and understood across the organization, but it can also make RODI more recognized as an important, value-added investment that requires consistent attention. When an investment in dollars is made, and a clear return in dollars is expected, this can naturally enhance prioritization, especially with those whose obligation is to protect the bottom line. Therefore, when individuals who are directly in charge of the financial matters of the organization are clear on the costs and benefits to be had, a great accountability to see the investment through will follow.

Those participating in the intervention can even facilitate increased performance accountability. Making known and understood the cost and potential benefit to those engaged in the leadership development intervention, can very likely increase the probability to further transfer learning to the workplace. All necessary and possible enhancements to increase trainee engagement in, and transfer of, learning is vital, since research reports that only about 10 to 30% of learning transfers back to the workplace (Baldwin & Ford, 1988).

When organizations do not spend appropriate energy and effort properly designing and implementing leadership development programs, they will likely experience low or even negative returns on their investment. Interestingly, this research suggests that even average programs can lead to low or negative RODI. Thus, it is critical that organizational leaders not only invest in initiating leadership development programs but they also invest in their design, implementation and trainee engagement and buy-in. This makes the low return results of this study an even more important factor to consider, and possibility one of the most important factors. It also demonstrates how critical it is to ensure learning transfer and design effective programs that meet the highest percentage of behavioral objectives relevant to individual performance as possible. Meeting only 50% of behavioral objectives with a 10 to 30% transfer of learning (Baldwin & Ford, 1988) could simply be a formula for disastrous loss of leadership development investment. However, organizational efforts providing top-quality leadership development interventions with clear outcomes for participants and stakeholders can be quite rewarding, producing double, triple, quadruple or even multi-fold their investment.

Although most managers deem leadership as critical to organizations, managers previously reported that only 8% of organizations comprise excellent leadership (Csoka, 1997; Kincaid & Gordick, 2003). Thus, this research can help close that leadership gap. It can provide organizational leaders with more insight into the use and benefits of investing in leadership development interventions, using it as tool to make more insightful decisions on whether they should invest in leadership development at all. Further, this RODI research can help the organization better recognize low and high performing areas; thus, capitalizing on high performing areas and further developing low performing areas to increase leadership capital (Kincaid & Gordick, 2003).

With computer simulation modeling, there are a plethora of opportunities to further expand research with regard to further leadership development intervention and RODI. Other modeling techniques may provide additional insight to the impact of leadership development interventions. Further, other modeling techniques such as agent-based modeling, continuous and dynamic could include interactions between agents (agent-based), continuous looping of model behavior (continuous), or a modeling that replicates the changing nature of interactions within systems (dynamic) (Forrester, 1999; Kelton, Sadowski, & Swets, 2010; Sterman, 2000). While these modeling techniques are much more complicated and may require more even research surrounding agents and factors that may affect leadership development outcomes, they very well may have the ability to more effectively model human behavior (Canessa & Riolo, 2003; Srbljinovic & Skunca, 2003). However, research estimating RODI using computer simulation modeling is much too undeveloped to know whether an agent-based, continuous, dynamic, or other modeling techniques would more or less accurately estimate RODI.

A final implication for future research is statistical modeling of the potential cost of leadership diffusion. It does cost time from higher leader levels to diffuse leadership to those at lower leader levels. If certain “soft” costs are associated with leadership diffusion, then this could potentially weaken RODI and ROLD. However, this study did not model any potential costs of leadership diffusion and cannot attribute greater losses to effects of diffusion costs.

REFERENCES

- Alimo-Metcalfe, B. (1998). Professional Forum: 360 degree feedback and leadership development. *International Journal of Selection and Assessment*, 6(1), 35-44.
- Allen, T. T. (2011). *Introduction to Discrete Event Simulation and Agent-based Modeling: Voting Systems, Health Care, Military, and Manufacturing*. London: Springer-Verlag.
- ASTD. (2009). *Executive Development: Strategic and Tactical Approaches*: American Society for Training and Development and Booz Allen Hamilton.
- ASTD. (2010). *ASTD 2010 State of the Industry Report*: American Society for Training and Development.
- Avolio, B. J., Avey, J. B., & Quisenberry, D. (2010). Estimating return on leadership development investment. *The Leadership Quarterly*, 633-644.
- Avolio, B. J., Reichard, R. J., Hannah, S. T., Walumbwa, F. O., & Chan, A. (2009). A meta-analytic review of leadership impact research: Experimental and quasi-experimental studies. *The Leadership Quarterly*, 20, 764-784.
- Axelrod, R. (1997). The Dissemination of Culture: A Model with Local Convergence and Global Polarization. *Journal of Conflict Resolution*, 41, 203-226.
- Bailey, N. T. J. (1975). *The Mathematical Theory of Infectious Diseases and Its Applications*. London: Charles Griffin.
- Baldwin, T. T., & Ford, K. J. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology*, 41(1), 63-105.
- Bass, B. M. (1990). *Bass and Stogdill's handbook of leadership* (3rd ed.). New York: The Free Press.
- Bass, B. M., Waldman, D. A., Avolio, B. J., & Bebb, M. (1987). Transformational Leadership and the Falling Dominoes Effect. *Group & Organization Management*, 12, 73-87.
- Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago: University of Chicago Press.
- Bergon, M., Harper, J. L., & Townsend, C. R. (1996). *Ecology* (3rd ed.). Oxford, UK: Blackwell Scientific.
- Bernstein, A. L. (1966). *A handbook of statistical solutions for the behavioral sciences*. New York: Holt: Rinehart and Winston.
- Berson, Y., & Avolio, B. J. (2004). Linking transformational and strategic leadership: Examining the leadership system of a high-technology organization in a turbulent environment. *The Leadership Quarterly*, 15, 625-646.

- Bobko, P., Karren, R., & Parkington, J. J. (1983). Estimation of standard deviations in utility analysis: An empirical test. *Journal of Applied Psychology*, 68, 170-176.
- Bowers, D. G., & Seashore, S. E. (1966). Predicting Organizational Effectiveness with a Four-Factor Theory of Leadership. *Administrative Science Quarterly*, 11, 238-263.
- Brailsford, S. C., & Hilton, N. A. (2001). A comparison of discrete event simulation and system dynamics for modelling health care systems. In J. Riley (Ed.), *Planning for the Future: Health Service Quality and Emergency Accessibility. Operational Research Applied to Health Services (ORAHs)*: Glasgow Caledonian University.
- Brauer, F., & Castillo-Chavez, C. (2000). *Mathematical Models in Population Biology and Epidemiology*. New York: Springer Verlag.
- Brinkerhoff, R. O. (2003). *The Success Case Method: Find Out Quickly What's Working and What's Not*. San Francisco, CA: Berrett-Koehler.
- Brogden, H. E. (1946). On the Interpretation of the Correlation Coefficient as a Measure of Predictive Efficiency. *Journal of Educational Psychology*, 37, 65-76.
- Brogden, H. E. (1949). When testing pays off. *Personnel Psychology*, 2, 171-183.
- Brogden, H. E., & Taylor, E. K. (1950). The dollar criterion—Applying the cost accounting concept to criterion construction. *Personnel Psychology*, 3, 113-154.
- Burke, M. J., & Day, D. (1986). A cumulative study of the effectiveness of managerial training. *Journal of Applied Psychology*, 71, 232-246.
- Caffarella, R. S. (2002). *Planning programs for adults: A comprehensive guide* (2nd ed.). San Francisco: Jossey-Bass.
- Canessa, E., & Riolo, R. L. (2003). The Effect of Organizational Communication Media on Organizational Culture and Performance: An Agent-Based Simulation Model. *Computational & Mathematical Organization Theory*, 9, 147-176.
- Cartter, A. M. (1959). *Theory of wages and employment*. Homewood, IL: Irwin.
- Cascio, W. F. (1982). *Costing Human Resources: The financial impact of behavior in organizations*. Boston: Kent Publishing.
- Cascio, W. F. (1991). *Costing Human Resources: The financial impact of behavior in organizations* (3rd ed.). Boston: Kent Publishing.
- Cascio, W. F., & Boudreau, J. (2011). *Investing in people: Financial impact of human resource initiatives* (2nd ed.). Upper Saddle River, NJ: FT Press.

- Cascio, W. F., & Ramos, R. A. (1986). Development and application of a new method for assessing job performance in behavioral/economic terms. *Journal of Applied Psychology*, 71, 20-28.
- Chahal, K., & Eldabi, T. (2010). System Dynamics and Discrete-Event Simulation: A meta-comparison. On *Proceedings of the 2010 Winter Simulation Conference*.
- Cohen, J. (1977). *Statistical power analysis for the behavioral sciences*. New York: Academic Press.
- Collins, D. B., & Holton, E. F. III. (2004). The effectiveness of managerial leadership development programs: A meta-analysis of studies from 1982 to 2001. *Human Resource Development Quarterly*, 15, 217-248.
- Craig, S. B., & Hannum, K. M. (2007). Experimental and Quasi-experimental Leadership Development Evaluation. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 19-47). San Francisco, CA: Jossey-Bass.
- Cronbach, L. J., & Gleser, G. C. (1965). *Psychological tests and personnel decisions*. Urbana: University of Illinois Press.
- Csoka, L. (1997). *Bridging the leadership gap (Report No. 1190-97-ES)*. New York: The Conference Board.
- Cunningham, G., & Kitson, A. (2000). An evaluation of the RCN Clinical Leadership Development Programme: Part 2. *Nurs Stand*, 15(13-15), 34-40.
- Davidson, J. E., & Martineau, J. W. (2007). Strategic Uses of Evaluation. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 48-70). San Francisco, CA: Jossey-Bass.
- Doo, M. Y. (2005). Exploring leadership teaching methods. *Academic Exchange Quarterly*, 9(3), 198-202.
- Edelstein-Keshet, L., & Ermentrout, G. B. (1998). Models for the Length Distributions of Actin Filaments: I. Simple Polymerization and Fragmentation. *Bulletin of Mathematical Biology*, 60, 449-475.
- Fitzpatrick, J. L., Sanders, J. R., & Worthen, B. R. (2004). *Program Evaluation: Alternative approaches and practical guidelines* (3rd ed.). Boston, MA: Pearson Education.
- Forrester, J. W. (1999). *Industrial Dynamics*. Cambridge, MA: MIT Press.
- Glass, G. V. (1976). Primary, secondary and meta-analysis of research. *Educational Researcher*, 5, 3-8.

- Glass, G. V., McGaw, B., & Smith, M. L. (1981). *Meta-analysis in social research*. Beverly Hills, CA: Sage.
- Goldstone, R. L., & Janssen, M. A. (2005). Computational models of collective behavior. *Trends in Cognitive Sciences*, 9(9), 424-430.
- Guerra-Lopez, I. (2008). *Performance evaluation: proven approaches for improving program and Organizational Performance*. San Francisco, CA: Jossey-Bass.
- Gutiérrez, M., & Tasse, T. (2007). Leading With Theory. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 48-70). San Francisco, CA: Jossey-Bass.
- Hannah, S. T., Avolio, B. J., Luthans, F., & Harms, P. D. (2008). Leadership Efficacy: Review and future directions. *The Leadership Quarterly*, 19, 669-692.
- Hannum, K. M., Martineau, J. W., & Reinelt, C. (2007). *The Handbook of Leadership Development Evaluation*. San Francisco, CA: Jossey-Bass.
- Hernez-Broome, G., & Hughes, R. L. (2004). Leadership development: Past, present, and future. *Human Resource Planning*, 27(1), 24-32.
- Holton, E. F. III, & Naquin, S. S. (2000). *Developing high performance leadership competency*. Baton Rouge, LA: Academy of Human Resource Development.
- Holton, E. F. III (2011). Technical Introduction to the TransferLogix™ Approach to Estimating ROI (Level 4/5 Evaluation). Retrieved from http://1stglobal.com/cms_img/Overview of the TransferLogix™ Approach to Estimating ROI Approach to Level 4 Evaluation.pdf
- Huber, S. G. (2004). School Leadership and Leadership Development: Adjusting leadership theories and development programs to values and the core purpose of school. *Journal of Educational Administration*, 42(6), 669-684.
- Hunter, J. E., & Schmidt, F. L. (1982). Fitting people to jobs: The impact of personnel selection on national productivity. In E. A. Fleishman & M. D. Dunnette (Eds.), *Human performance and productivity: Vol. 1. Human capability assessment* (pp. 232-284). Hillsdale, NJ: Erlbaum.
- Hunter, J. E., Schmidt, F. L., & Judiesch, M. K. (1990). Individual differences in output variability as a function of job complexity. *Journal of Applied Psychology*, 75(1).
- Jansen, J., Vera, D., & Crossan, M. (2009). Strategic Leadership for Exploration and Exploitation: The moderating role of environmental dynamics. *The Leadership Quarterly*, 20, 5-18.
- Jansen, J. J. P., Vera, D., & Crossan, M. (2009). Strategic leadership for exploration and exploitation: The moderating role of environmental dynamism. *The Leadership Quarterly*, 20(5), 5-18.

- Kellogg Foundation, W. K. (2002). *Evaluating outcomes and impacts: A scan of 55 leadership development programs*. Battle Creek, MI: W. K. Kellogg Foundation.
- Kelton, D. W., Sadwoski, R. P., & Swets, N. B. (2010). *Simulation with Arena* (5th ed.). New York, NY: McGraw Hill.
- Kenrick, D. T., Li, N. P., & Butner, J. (2003). Dynamical Evolutionary Psychology: Individual decision rules and emergent social norms. *Psychological Review*, 110(1), 3-28.
- Kincaid, S. B., & Gordick, D. (2003). The Return on Investment of Leadership Development Differentiating Our Discipline. *Consulting Psychology Journal: Practice and Research*, 55(1), 47-57.
- Kingsland, S. (1982). The Refractory Model: The logistic curve and the history of population ecology. *The Quarterly Review of Biology*, 57, 29-52.
- Kirkpatrick, D. L. (1979). Techniques for evaluating training programs. *Training and Development Journal*, 33(6), 78-92.
- Kirkpatrick, D. L. (1996). Great ideas revisited. *Training and Development Journal*, 50(1), 54-59.
- Kirman, A., & Zimmerman, J. B. (2001). *Economics with Heterogeneous Interacting Agents*. Paper presented at the Lecture Notes in Economics and Mathematical Systems.
- Kohler, T. A., & Gumerman, G. J. (Eds.). (2000). *Dynamics in Human and Primate Societies: Agent-Based Modeling of Social and Spatial Processes*. Oxford University Press.
- Latane, B., & Bourgeois, M. J. (2000). Dynamic Social Impact and the Consolidation, Clustering, Correlation, and Continuing Diversity of Culture. In R. S. Tindale & M. Hogg (Eds.), *Handbook of Social Psychology Volume 4: Group Processes*. London: Blackwell.
- Law, A., & Kelton, D. (1982). *Simulation Modeling and Analysis*. New York: McGraw-Hill.
- Leiderman, S. (2007). From the Inside Out. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 3-14). San Francisco, CA: Jossey- Bass.
- Lemay, N. V., & Ellis, A. (2007). Evaluating Leadership Development and Organizational Performance. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 3-14). San Francisco, CA: Jossey- Bass.
- Lingham, T., Richley, B. A., & Rezania, D. (2006). An Evaluation System for Training Programs: A case study using a four-phase approach. *Career Development International Journal*, 11, 334-351.
- Lipsey, M. W. (1990). *Design sensitivity: Statistical power for experimental research*. Newbury Park, CA: Sage.

- Lord, R. G., & Hall, R. J. (1982). Contemporary views of leadership and individual differences. *The Leadership Quarterly*, 3, 137-157.
- Lorenz, T., & Jost, A. (2006). *Towards an orientation framework in multi-paradigm modeling*. Paper presented at the 24th International Conference of the System Dynamics Society.
- Macy, M. W., & Willer, R. (2002). From Factors to Actors: Computational Sociology and Agent-based Modeling. *Annual Review of Sociology*, 28, 143-166.
- Malthus, T. R. (1826). *An essay on the principle of population* (6th ed.). London: John Murray.
- March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science*, 2(1), 71-87.
- Mattson, B. W. (2003). The Effects of Alternative Reports of HRD Results on Managerial Support. *Human Resource Development Quarterly*, 14, 127-151.
- Mayer, D. M., Kuenzi, M., Greenbaum, R., Bardes, M., & Salvador, R. (2009). How low does ethical leadership flow? Test of a trickle-down model. *Organizational Behavior and Human Decision Processes*, 108, 1-13.
- Meehan, D., & Reinelt, C. (2007). Accelerating Learning About Leadership Development: A learning community approach. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 511-535). San Francisco, CA: Jossey- Bass.
- Mintzberg, H. (1975). The Manager's Job: Folklore and Fact. *Harvard Business Review*, 53(4), 49-61.
- Misumi, R. (1985). *Leadership in Japanese organizations*. New York: Harper & Row.
- Morecraft, J., & Robinson, S. (2004). *Explaining Puzzling Dynamics: Comparing the Use of System Dynamics and Discrete-Event Simulation*. Paper presented at the In Proceedings of the 23rd International Conference of the System Dynamics Society.
- O'Reilly, C. A. (1983). The Use of Information in Organizational Decision Making: A Model and Some Propositions. *Research in Organizational Behavior*, 5, 103-139.
- Ouchi, W. G., & Maguire, M. A. (1975). Operational control: Two functions. *Administrative Science Quarterly*, 20, 559-569.
- Packer, M. B. (1983). Measuring the intangible in productivity. *Technology Review*, 86, 48-57.
- Parry, S. B. (1996). *Measuring Training's ROI*. Princeton: Training House Inc.
- Pearl, R., & Reed, J. (1920). *On the rate of growth of the population of the United States since 1770 and its mathematical presentation*. Paper presented at the National Academy of Sciences, Johns Hopkins University.

- Peters, L., & Baum, J. (2007). The Importance of Local Context in Leadership Development and Evaluation. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 261-283). San Francisco, CA: Jossey-Bass.
- Phillips, J. J. (1997). *Return on investment in training and performance improvement systems*. Houston: Gulf Publishing Company.
- Phillips, J. J., & Phillips, P. P. (2007). *Show Me the Money: How to determine ROI in people, projects, and programs*. San Francisco, CA: Berrett-Koehler Publishers.
- Phillips, J. J., & Phillips, P. P. (2008). Distinguishing ROI Myths From Reality. *Performance Improvement*, 47(6), 12-17.
- Phillips, J. J., Stone, R. D., & Phillips, P. P. (2001). *The Human Resource Scorecard: Measuring the Return on Investment*. Woburn, MA: Butterworth-Heinemann.
- Reilly, R. R., & Smither, J. W. (1985). An examination of two alternative techniques to estimate the standard deviation of job performance in dollars. *Journal of Applied Psychology*, 70, 651-661.
- Robinson, S. (2005). Discrete-Event Simulation: From the Pioneers to the Present, What Next? *Journal of the Operational Research Society*, 56(6), 619-629.
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: The Free Press.
- ROI Institute, I. (2009). *Certification in the ROI Methodology: The Complete Impact Measurement Certification System*.
- Rosenthal, R., & Rubin, D. B. (1982). Comparing effect sizes of independent studies. *Psychological Bulletin*, 92, 500-504.
- Rothwell, W. J. (1996). *Beyond training and development: State-of-the-art strategies for enhancing human performance*. New York: Amacom.
- Russ-Eft, D. F. (2007). Communication In Evaluation: A Systems Approach. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 3-14). San Francisco, CA: Jossey-Bass.
- Russon, C., & Reinelt, C. (2004). The Results of an Evaluation Scan of 55 Leadership Development Programs. *Journal of Leadership & Organizational Studies*, 10(3), 71-85.
- Saslow, S. (2006). Measuring Impact and ROI in Executive Development Programs. Retrieved from <http://www.mannaz.com/articles/impact-and-roi-in-executive-development>
- Schmidt, F. L., & Hunter, J. E. (1983). Individual Differences in Productivity: An Empirical Test of Estimates Derived from Studies of Selection Procedure Utility. *Journal of Applied Psychology*, 68, 407-414.

- Schmidt, F. L., Hunter, J. E., McKenzie, R. C., & Muldrow, T. W. (1979). The impact of valid selection procedures on work force productivity. *Journal of Applied Psychology*, 64, 709-626.
- Schmidt, F. L., Hunter, J. E., & Pearlman, K. (1982). Assessing the economic impact of personnel programs on workforce productivity. *Personnel Psychology*, 35, 333-347.
- Scriven, M. (1991). Beyond Formative and Summative Evaluation. In M. W. McLaughlin & D. Phillips (Eds.), *Evaluation and Education: At Quarter Century* (pp. 19-64). Chicago: Univeristy of Chicago Press.
- Srbljinovic, A., & Skunca, O. (2003). An Introduction to Agent Based Modelling and Simulation of Social Sciences. *Interdisciplinary Description of Complex Systems*, 1(1-2), 1-8.
- Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston, MA: Irwin McGraw-Hill.
- Stoel, D. (2004). The Evaluation Heavyweight Match. *Training and Development Journal*, 58(1).
- Stogdill, R. M. (1955). Interactions among superiors and subordinates. *Sociometry*, 18, 552-557.
- Strang, D., & Soule, S. A. (1998). Diffusion in Organizations and Social Movements: From hybrid corn to poison pills. *Annual Reviews of Sociology*, 24, 265-290.
- Stufflebeam, D. L. (1999). *Foundational Models for 21st Century Program Evaluation: The Evaluation Center*.
- Swanson, R. A., & Holton, E. F. (1999). *Results: How to assess performance, learning, and perceptions in organizations*. San Francisco: Berrett-Koehler.
- Symonette, S. (2007). Making Evaluation WORK for the Greater Good: Supporting provocative possibility and responsive praxis in leadership development. In J. W. M. C. R. K. M. Hannum (Ed.), *The Handbook of Leadership Development Evaluation* (pp. 111-136). San Francisco, CA: Jossey-Bass.
- Tarde, G. (1903). *The Laws of Imitation* (E. C. Parsons, Trans.). New York: Henry, Holt and Co.
- Torres, R. T. (2007). Continuous Learning. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 536-557). San Francisco, CA: Jossey-Bass.
- Umble, K. E. (2007). Evaluation For Planning And Improving Leadership Development Programs: A framework based on the Baldrige Education Criteria for Performance Excellence. In K. M. Hannum, J. W. Martineau & C. Reinelt (Eds.), *The Handbook of Leadership Development Evaluation* (pp. 464-486). San Francisco, CA: Jossey-Bass.

- Verhulst, P. F. (1838). Notice sur la loi que la population poursuit dans son accroissement. *Correspondance mathématique et physique*, 10, 113–121.
- Verhulst, P. F. (1977). A note on the law of population growth. In D. Smith & N. Keyfitz (Eds.), *Mathematical demography: Selected papers* (pp. 333- 337). Berlin: Springer-Verlag.
- Waldman, D. A., & Yammarino, F. J. (1999). CEO Charismatic Leadership: Levels of Management and Levels of Analysis Effects. *Academy of Management Review*, 26, 266-285.
- Weiss, C. H. (1995). Nothing as Practical as Good Theory: Exploring theory-based evaluation for comprehensive community-based initiatives for children and families. In J. P. Connell, A. C. Kubisch, L. B. Schorr & C. H. Weiss (Eds.), *New Approaches to Evaluating Community Initiatives: Concepts, Methods and Contexts* (Vol. 1). Washington, DC: Aspen Institute.
- Wielkiewicz, R. M. (2000). The Leadership Attitudes and Beliefs Scale: An Instrument for Evaluating College Students' Thinking About Leadership and Organizations. *Journal of College Student Development*, 41(3), 335.
- Yukl, G. (2002). *Leadership in organizations* (5th ed.). Upper Saddle Creek, NJ: Prentice-Hall.

VITA

Brett Wayne Richard was born in Sulphur, Louisiana, and received his early education in the public school of Calcasieu Parish. He graduated from Sulphur High School in 1992. He was awarded a Master of Science in Industrial-Organizational Psychology degree from Lamar University in 2001, and also holds undergraduate degrees in psychology and process technology.

Currently, he is the Founder and Managing Director of Performyx Consulting, an organizational development consulting firm, and has spent the last 12 years consulting and working within a variety of industries spanning industrial robotics, manufacturing, wealth management, social service, computer technology, education, state and city government, utilities, etc. – all with the purpose of increasing organizational alignment, enhancing human capital and improving bottom line performance. He is also an adjunct professor for the Human Resources and Operations Management Department in the School of Business and Management at Kaplan University.

Beginning his career as an HR Manager/Recruiter for an industrial robotics firm, he has also served in various executive leadership roles from a human resource executive to chief executive officer. For example, as internal OD/HR consultant and Executive Director at a non-profit institution, he worked closely with the Board of Trustees identifying performance needs, establishing a human resource strategy, and closing performance gaps.

Previous to this engagement, he worked directly with top-level executives with the LCTCS and SOWELA Technical Community College in an institutional spin-off to become an independent college as directed by Governor Mike Foster. There he served as Human Resources Director re-designing and re-building the Human Resources function and department throughout the transition.

He has also designed and taught courses for a state-sponsored small business entrepreneurial program and on both college and university levels, has taught courses in psychology, introduction to industrial careers, industrial plant health and safety, and process technology, covering areas of six sigma, process capability, total quality management, and statistical quality and process control.

He has been awarded the “Outstanding Professional Staff Award” from the Louisiana Community and Technical College System and the “Dr. B. Tierney Award,” after helping an institution be recognized for organizational excellence.