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# Using Multi-Objective Value Estimation to Support Predictive Analytics for Human Service Project Management

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USING MULTI-OBJECTIVE VALUE ESTIMATION TO SUPPORT PREDICTIVE
ANALYTICS FOR HUMAN SERVICE PROJECT MANAGEMENT

by

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Human service organizations need outcome measurement approaches that support project management for efficiency and effectiveness.  While, in recent years, human services have increased their capacity to manage data and measure outcomes empirically, several barriers remain.  First, current outcome measurement practices are not designed to effectively support the management of human services programs for maximum efficiency and effectiveness.  Second, human services organizations need a methodology to manage programs to identified outcomes.  This dissertation explored meaningful solutions to both issues.  In Paper 1 (Chapter II), this dissertation assessed strengths and limitations of current outcome evaluation approaches and suggested an innovative application of Multi-Objective Value Estimation as a method that may support predictive analytics for project management.  Predictive analytics are widely utilized project management methods in government and for-profit businesses.  Multi-Objective Value Estimation was field tested for feasibility in Paper 2 (Chapter III). Paper 3 (Chapter IV) took the results of the test conducted in Paper 2 and applied these findings to a project management approach that utilizes predictive analytics.  Due to the high level of uncertainty in human services, Monte Carlo simulations were employed to generate baseline, best case, and actual project performance.  These performance

metrics were graphed in a stochastic S curve.  The potential of this approach to provide

an elegant and highly intuitive methodology to enhance project management in human

services is discussed in the conclusion.

ACKNOWLEDGMENTS

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# CHAPTER I

## INTRODUCTION

### Background and Significance

In today's restricted funding environment, it is critical that human service

organizations manage their programs and activities to produce maximum efficiency and

effectiveness. In an influential publication, *Leap of Reason: Managing to Outcomes in an*

*Era of Scarcity*, Mario Morino (2011) makes a clear case for needed improvements in

management at human service organizations. Morino's book suggests that while outcome

research and program evaluation has become widely used, the dissemination of the

findings have had little impact on actual operations and management in human service

organizations. While restricted funding and staff expertise are contributing factors, other

explanations must be considered. A survey and evaluation of existing outcome

measurement approaches suggest that these approaches do not easily translate into

management practice. Reasons for this include the absence in most human service

organizations of expertise necessary to interpret statistical complexity of the research

findings. Even if these findings can be explained, regardless of method, existing outcome

measurement tells managers how programs and services performed in the past. Evidence

based Practice (EVP) is one attempt to address this issue. EVP's limitations include high

cost to purchase EVP programs and the requirements of fidelity to the EVP, which

eliminates the opportunity for fluid, dynamic program adjustments for increased

efficiency and impact. Human service program managers need outcome research that is accessible, meaningful, and integrated into management decisions based on expected future performance. Advanced business intelligence practices utilized outside of human service professions is a promising solution to address this problem.

Predictive analytics is a management science discipline that has potential benefits for human service organizations. Predictive analytics is a process that uses current and historical information to construct models that forecast future behavior or performance. Development of these models includes an array of statistical methods, including linear and nonlinear regression, curve fitting, and econometric forecasting to develop models that forecast future events or activities (Nyce, 2007). Predictive analytic methods commonly employed in large for-profit business and government organizations (e.g., CDC, NASA, and Department of Defense) such as earned value management (EVM) and risk management exist for this purpose. A common example of predictive analytics is the use of credit scores. Based on previous bill payment history, a credit score predicts the risk that a future loan will be repaid. A high credit score indicates a low risk, while a low credit score indicates a higher probability that borrowed money will not be repaid. In health care, clinical decision support systems have the potential to determine which patients are at risk for developing conditions such as diabetes and heart disease. Pharmaceutical companies, toxicologists, and environmental epidemiologists use a form of predictive analytics that is known as the dose response relationship. Individuals who are exposed to a drug or environmental health condition can be predicted to experience a response based on prior information. Predictive analytics has been used successfully in

these fields. However, human services have not yet made use of advanced management science approaches (Reed & Morariu, 2010).

The use of predictive analytics appears to hold potential for human service applications. Human service interventions can be viewed as investments with expected future returns. Like any investment, the possibility of future returns contains an inherent amount of risk. Programs and interventions never achieve 100% success rates. Predictive analytics provides a method to quantify the risk and predict an expected return. Human service interventions also occur at various intensity levels. Just as exposure to a drug can be ineffective at low doses, effective at moderate doses, and toxic at high doses, programs and services need to identify optimal "dosage" levels to be provided efficiently. A caseworker providing a service to alleviate poverty conditions might visit a family once a month, once a week, or every day. It is reasonable to speculate that once a month is too little to be effective, once a day might be invasive and counterproductive (as well as costly), while once a week might be highly effective. Using prior research, expert opinion and raw data should allow the construction of models that can predict what the expected performance should be for a human service program. This expected performance model can then be plotted against actual performance. Providing this information to program managers may allow for significant improvement in human services, just as it has in for-profit industry and large government organizations.

Predictive analytics, supported by data and outcome research, can empower project managers at human service organizations to use limited resources efficiently and fine-tune projects and programs for increased effectiveness. The nature of human service

in identifying an outcome measurement method that supports this and adopting a project management approach based on predictive analytics is a potential solution to help meet the need for human service programs to operate with efficiency and effectiveness. Increasing the efficiency and effectiveness of human service organization is attractive for economic and ethical reasons.

## Related Purpose of the Three Papers

This dissertation proposal outlines a tri-part dissertation structure to identify an innovative and replicable approach to project management that can be used to manage to outcomes in human service programs. The first paper of the dissertation will use meta-evaluation methods to survey and assess the strengths and limitations of current outcome measurement approaches. Meta-evaluation is a systematic process of examining and evaluating for their credibility and usefulness. Meta-evaluation should not be confused with meta-analysis. Meta-analysis is a statistical method to combine findings from several independent studies. The second paper of the dissertation will implement a cost utility study using secondary source data from a juvenile delinquency program. Multi-Objective Value Estimation (MOVE) (an approach based on health economics and decision-making science) offers an innovative solution. This study will explore the capacity of MOVE methods and their capacity to support project management. While the MOVE method provides some support for project management, limitations were discovered that prevented it from providing an entirely satisfactory solution. In the final paper of the dissertation, data from the MOVE analysis conducted in paper two will be utilized in support of a project management demonstration. The demonstration will use

predictive analytic methods including Monte Carlo simulations, sensitivity analysis, and stochastic S-curves to identify projected performance levels for human service programs. Paper three will also include a discussion of the potential of this approach for human service project management.

The objective of this study is to explore an innovative, practical solution for human service organizations to measure their outcomes using an approach that translates well into predictive analytics for project management. If successful, this approach can support the mandate to manage human service programs for maximum effectiveness and efficiency. The beneficiaries of this effort include public and private funders, community stakeholders, and the organizations themselves. Most importantly, maximizing the efficiency and effectiveness of human service organizations will benefit the vulnerable populations who need the programs and services provided in order to maintain a high quality of health and well-being in our society.

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# CHAPTER II

## MULTI-OBJECTIVE VALUE ESTIMATION: THE ADVANTAGES OF COST UTILITY APPROACHES FOR HUMAN SERVICE PROGRAM MANAGEMENT

### Background and Significance

Human service organizations play an important role in our society. Human services in the U.S. have been growing steadily, both in size and as an important financial sector of the economy. In the last 10 years (2001 to 2011), the number of health and human service nonprofits has increased 25%, from 1,259,764 to 1,574,674 today (Roeger, Blackwood, & Pettijohn, 2011). This growth rate has surpassed the rate of both the for-profit business and government sectors. In 2010, nonprofits contributed products and services that added $779 billion to the nation's gross domestic product, 5.4% of GDP (Roeger et al., 2011). Nonprofits are also a major employer, accounting for 9% of the economy's wages, and over 10% of jobs in 2009 (Roeger et al., 2011). In Michigan alone, the Department of Human Services (DHS) has a 2012 budget of approximately 4 billion dollars (DHS Pub-64, 2011). The Michigan Medicaid caseload at DHS for May 2010 was 1,065,575. The May 2012 food assistance caseload, like most recent months, set a new record high with 884,072 households, representing 1,805,981 individuals. Since January 2000, the caseload (then 258,287) has increased 242% (DHS Pub-64, 2011). These indicators suggest that human service organizations play a significant role in the national economy and provide vital services to vulnerable populations. While they

occupy an important place in the economy and society, human services have not rapidly adopted outcome measurement or project management.

Human service organizations need to measure outcomes and use that information to operate their business in a way that maximizes the efficiency and effectiveness of their services. The National Organization for Human Services (www.nationalhumanservices.org) defines human services as professional or paraprofessional activities using a unique approach to meeting human needs through the following:

- An interdisciplinary knowledge base

- Focus on prevention and remediation of problematic human conditions

- Improving the quality of life for service populations

Expanding this interdisciplinary knowledge base is important to improve the efficiency and effectiveness of human service organizations. The scope of this paper is focused on nonprofit social service organizations. While the analysis is broadly applicable, medical organizations and larger corporate entities are, in many cases, already heavily engaged in advanced management practices. The discipline of project management science includes predictive analytic methodology, which could be a valuable innovation in human services. Measuring and managing these human services for maximum efficiency and effectiveness helps in efforts to provide vulnerable persons with the best possible care.

Today's human service organizations evolved from private charities and tax exempt corporations. Key contrasting characteristics or evolutionary stages are highlighted in Table 2.1. Private charities received support as a gift that provided care for

needy individuals and families. Outcome reporting consisted of anecdotal stories that highlighted the emotional benefits of service (W.K. Kellogg Foundation, 2004). Charities evolved into nonprofit 501(c)(3) tax exempt organizations in the 1970s. 501(c)(3) organizations relied on public funding through grants that paid for services. While outcomes were not commonly measured, human service organizations at this time did commit to improving financial practices, gathering data, and measuring outputs (Hogan, 2007). In the past decade, rapid progress has occurred in human service outcome measurement. This progress has been driven by several factors, including decreasing resources, increased need, and the demand from public and private funders to measure the value of their financial investments. Nonprofit organizations are just beginning the process of developing into mission-based businesses that can manage to outcomes (Morino, 2011). Mission-based businesses are human service organizations defined by the following:

- Data are collected and managed

- Outcome evaluation occurs continuously

- Outcomes and data drive quality improvements

- Business practices are in place to manage organizational success

- At least occasional measured outcomes

- At times, data measurement is translated into policy and advocacy efforts

Table 2.1

*Evolution of Human Service Business Practices and Outcome Application*

| Business Model | View of Funding/Input | Measures of Value | Project Management Integration with Outcome Measures |
|---|---|---|---|
| Charity | Funding is a gift | Good deeds, anecdotal success stories | No |
| Not for Profit Service Organization | Funding pays for a program | Outputs, observational studies of effects, evidence based practices | No |
| Mission Driven Business | Funding is an investment in a project | Monetary and social impact/utility to the community | Yes |

In an annual national survey of nonprofit organizations, the Innovation Networks has collected data on nonprofit strategy and application of outcome measurement practices (Morariu, Athanasiades, & Emery, 2012). *The State of Evaluation* study is based on data obtained through a survey sent out to a representative sample of nonprofits across the country. The survey responses systematically document the nonprofit sector's evaluation capacities and experiences. Findings from the 2010 survey provided a baseline that can be compared and contrasted to the 2012 findings, thereby capturing the evolution of evaluation in the sector. The statistics and findings of the report were based on a national sample of 1,072 501(c)(3) public charities. *N* values (the number of responses

for specific statistics and findings) are given throughout the report. For the majority of statistics and findings, there is a margin of error of plus or minus 4%. The report makes a key distinction for small organizations (annual budget less than $500,000) and large organizations (annual budget greater than $5 million). The 2010 and 2012 surveys represent the best information available that describes nonprofit research and evaluation activity.

Findings of the surveys indicate that several approaches are commonly used for human service outcome evaluation. First, clinical research studies use empirical methods to measure changes in a variable or variables over time. Randomized controlled trials and observational studies are important in measuring the inference of causality for programs and services. Return on investment (ROI) approaches evaluate the monetized benefit of services. Similar in method to financial investment returns, this approach is valuable for identifying the monetary value of benefits produced by programs. For every dollar invested (i.e., cost) in a service, a quantified dollar value return is calculated. Finally, health economic approaches such as cost benefit and cost effectiveness are common in evaluation literature. Cost benefit approaches are comparisons of dollar benefit per dollar cost. The difference between cost and benefit is the net monetary benefit. Cost effectiveness is a measure of cost per utility measure or effect gained or averted. While these approaches all have strengths, there remains a need for additional innovation in the field of human service outcome evaluation.

The field of human service outcome evaluation has not matured to the point where standardization of approaches, methods, or best practices has been identified. Even

terminology such as *outcomes, impact, results, effects,* and *efficacy* are used loosely and interchangeably. Additional general barriers to conducting and utilizing outcome measures for management purposes were identified in the survey. These barriers and limitations are common to existing approaches and include lack of time to conduct evaluation, and staff expertise in conducting and interpreting evaluation. The organizations reported widespread use of evaluation and outcome measurement. However, these organizations also reported significant barriers to the use of existing outcome measurement approaches. Limited staff time (noted by 96% of respondents) and expertise (noted by 81% of respondents) were two of the most notable barriers. Lacking in-depth training as researchers or evaluators, human service organizations, leaders, and funders are challenged to interpret findings and apply them to enhance business practices. However, only 27% of respondents reported working with an external evaluator; this external approach would seem a logical tactic to address staff time and expertise. Lack of funding was noted as another barrier, which may explain the low levels of external evaluation. The same study indicated that the most frequently reported (79%) use of evaluation was to plan and revise programs, i.e., project management. Strategic planning and revision or modification of programming was reported by 68% of the organizations as a use for outcome measures.

The Innovation Network Survey of nonprofit human service organizations outcome measurement approaches identified the following primary categories. Experimental or quasi-experimental pre and post studies were used by 71% of the responding organizations, but only 6% reported conducting studies with control groups.

Return on investment impact evaluations that measure a monetary benefit from services were used by 48% of respondents. Economic evaluation, such as cost benefit or cost effectiveness, was used by 25% of respondents. These approaches—clinical/experimental research, return on investment, and health economic—are used in this study due to their prominent use as reported by organizations in the survey. The target audience for these studies was reported as management and executive leadership by 74% of respondents. Strengthening future work was the most important reason for evaluation, with 79% of respondents identifying this as very important and 18% reporting somewhat important. While the survey provides valuable information describing current outcome research and evaluation, there is no indication that these approaches have been evaluated for their capacity to support day-to-day management in nonprofit organizations.

There is a need for a meta-evaluation standard that could be accessed by human service professionals not trained in empirical research. Having a measure or standard for outcome evaluation would advance the discipline by providing a universal standard of qualities and characteristics that are attractive and meaningful to professionals using them for project and strategic management. While some organizations may be willing and able to operate as charities or traditional nonprofits, funding sources, a competitive market for services, and stakeholders are driving the sector toward advanced management. In order to continue the development of nonprofits into mission-based businesses, meaningful outcome evaluation that translates easily into business management is required.

Meta-evaluation can be defined as the assessment of the merit of an evaluation (Stufflebeam, 1978). Stufflebeam suggested an operational definition of meta-evaluation

as "the process of delineating, obtaining, and using descriptive and judgmental information about the technical ethics, and practicality of an evaluation in order to guide the evaluation and publicly report its strengths and weaknesses" (Stufflebeam, 1978). Meta-evaluation, in general, is used by professional evaluators to systematically assess the extent that an evaluation meets accepted standards in several areas, including empirical methodology, meaningful to consumers, ethical and practical (Scriven, 2009). An example of meta-evaluation in health economics is the study *Meta-Evaluation of Worksite Health Promotion Economic Return Studies* (Chapman, 2003). This meta-evaluation reviewed and scored 42 evaluations of worksite health promotion for their validity and adherence to best practice standards. Findings of the study identified a standardized set of evaluation qualities that can be used to strengthen the validity of future evaluations.

Meta-evaluation is used for primarily two purposes. First, formative evaluation is a meta-evaluation that is conducted during the process of an on-going evaluation. Formative meta-evaluation can be used during the evaluation process to make improvements, and that ensures the quality of the evaluation. The second purpose, summative evaluation, is conducted on previous completed evaluations. Summative meta-evaluation assesses and reports strengths and weaknesses of existing evaluation (Stufflebeam, 2001). Existing evaluations are surveyed and rated for their utility, quality, and other attractive characteristics. This information can be used to identify strengths and limitations of evaluation approaches while suggesting future directions and opportunities for innovation.

# Methods

The study conducted a summative meta-evaluation of the primary categories of evaluation research currently applied to human services. According to Stufflebeam (1978), meta-evaluation is the systematic process of obtaining and using descriptive and judgmental information about the extent to which an evaluation is

1. Technically adequate in revealing the merit of some object;

2. Useful in guiding decisions;

3. Ethical in dealing with people and organizations; and

4. Practical in using resources.

The question most relevant to answer the research question of this paper is number 2. Assuming that all studies are technically adequate, ethical, and make practical use of resources, how useful are evaluations for guiding program decisions? The main concern relates to the capacity of several predominant evaluation approaches to translate to professionals who are not trained in research and statistics and to provide meaningful, timely information to drive service management toward a positive outcome.

The meta-evaluation was structured around prominent, commonly used outcome measurement approaches and a rubric of descriptive dimensions that assess the approaches for their utilization relative to project management. Following a systematic review of the literature, categories of outcome research and evaluation identified as the most frequently utilized was used in the meta-evaluation. Of 12 categories, 65% reported pre and post measures, 48% reported using SROI, and 25% reported using economic evaluations (Morariu et al., 2012). Each identified category was assessed using a rubric

based on qualities that are desirable in human service evaluation. These qualities were identified subjectively but are based on the common needs of information for project management. Rubrics are commonly used in meta-evaluation as they provide an efficient way to share information. The scoring rubric included several dimensions on which the approaches performance were rated using a rating scale for each dimension. Dimensions are generally referred to as criteria, the rating scale as levels, and definitions as descriptors. The scoring rubric was presented in a graphic format, as a grid. Dimensions identified for the meta-evaluation were determined by subjective judgment and experience attempting to utilize data and outcome research to guide program management decisions. The dimensions for the meta-evaluation can be summarized in two categories.

The first category of dimensions for the rubric involves the degree to which the outcome research and evaluation can interface with the service delivery management structure and operation. The first dimension identified is heterogeneity. Heterogeneity refers to the diversity and fluidity of the evaluation approach. This dimension deserves consideration due to the reality that human service programs are not homogeneous. For instance, programs designed to address juvenile delinquency can, will, and should have very different strategies to achieve outcomes. Local communities provide contextually different environments (e.g., rural and urban) that make fluid service delivery advantageous. While the outcome measurement approach may not be universal, it needs to be fluid enough to fit diverse social service programs and their evaluation needs. The second dimension in this category is integration. Integration is the degree to which an

outcome measurement approach can be integrated into existing management structures and processes. This dimension is important due to the advantages of cost savings through shared data management systems and the accessibility of the process to professionals actually managing programs. Outcome research and evaluation that separate regular program activities may be valuable for its own sake, but it will not easily support project management. Ideally, the evaluation activity should seamlessly be directed toward regular management activity.

The final dimension for meta-evaluation is the heuristic capacity of the approach. A heuristic approach encourages the discovery of new management solutions to program performance issues above and beyond the scientific and statistical findings of the research itself. Heuristic approaches allow for a trial-and-error process rather than a rigid formula or set rules that guide how a service is provided. Highly heuristic approaches should accommodate human judgment, common sense, and further additional questioning and investigation. Frequently, evaluations of complex human social phenomena are nonlinear; the model needs to welcome and absorb new knowledge as it is discovered.

The second category of dimensions for the rubric involves the desired qualities of the outcome study itself. The first dimension is the empirical rigor of the study itself. Empirical rigor includes research design, sample size, and statistical analysis methods. Empirical methods are important for project management. Desirable approaches should support project management with high standards for data collection and management, sound and appropriate research designs, and statistical analysis. High levels of validity, standardization, and the ability to make strong causal inferences should all be considered.

The second dimension in this category is the capacity to be conducted through ongoing iterations. Because project management is a daily occurrence, outcome evaluation approach need to be easily conducted through multiple iterations. The approach should lend itself to be applied in systematic cycles or repeated, regular intervals. This contrasts with single point-in-time approaches. The need for an iterative model is driven by the necessity to monitor programs for the diminishing marginal returns that can occur from outcomes/impacts over time. Concluding that a program is effective or not effective at a single point in time may be valid but does not support project management by consideration of changes that can occur around the duration of service delivery. Finally, the dimension of translational capacity needs consideration. Translational capacity is the potential for the study to be understood and interpreted by practitioners and professionals making management decisions. This translation includes explanations of findings so that advanced expertise in statistics and research is not necessary. Findings from outcome evaluation studies need to be reported in a meaningful way to the end user, not just the evaluator or researcher. Statistically complex reporting is valuable for scientific purposes but has little value for project management if the audience for the information cannot translate the results. Most human service project managers have little, if any, training and background in statistics and scientific research. Approaches that can translate their results into actionable information are preferred for project management purposes. These two categories with the identified seven dimensions formed the structure for the meta-evaluation.

A self-anchoring, subjective global assessment ordinal scale was used to score a rubric for the meta-evaluation. Self -anchoring scales are instruments that contain upper and lower anchors defined by the rater (Van Acker & Theuns, 2008). A common example is the pain scale used in medical settings. Patients report their subjective experience of pain on a scale of 1-10, where 1 is the absence of pain and 10 is the worst pain imaginable. Self-anchoring scales are based on the rater's subjective experiences, values, perceptions, and assumptions (Van Acker & Theuns, 2008). A self-anchored scale is an appropriate method for the meta-evaluation in this study due to the subjective and experiential nature of utility. A global assessment ordinal scale is a method of rating based on subjective observations. When items are classified according to whether they have more or less of a characteristic, the scale used is referred to as an ordinal scale (Field, 2005). The main characteristic of the ordinal scale is that the categories have a logical or ordered relationship to each other. These types of scales permit the measurement of degrees of difference, but not the specific amount of difference (Field, 2005). This scale is very common in marketing, satisfaction surveys, and attitudinal research.

The rubric used for this meta-evaluation scored each category based on the ordinal rating scale provided below Table 2.2. The scale rated the approaches on a grid displayed in this table.

Table 2.2

*Meta-Evaluation Rubric*

| Dimension | Clinical Studies | ROI | Health Economics |
|---|---|---|---|
| Heterogeneity | | | |
| Integrated | | | |
| Heuristic | | | |
| Empirical | | | |
| Iterative | | | |
| Translational | | | |
| Supports PM | | | |
| TOTALS | | | |

*Note. Rating 1:* The evaluation approach performs very well on this element. Little if any modification is needed to meet the needed elements qualities. *Rating 2:* The evaluation approach is marginal on this element. A partial fit or significant effort is required to meet the desired elements needs. *Rating 3:* The evaluation approach does not meet the elements requirements.

**Results**

Human service outcome evaluation approaches have evolved in three types primarily used by nonprofits. The first category includes experimental research such as observational studies and randomized, controlled trials (RCT). A second approach has been the application of health economic models such as cost benefit analysis (CBA) and cost effectiveness analysis (CEA). The most recent and currently popular trend is the measurement of social impact, which is typically conducted by measuring return on investment (ROI). This trend, favoring outcome measurement and rigorous evaluation, is

a positive development. Each of these three approaches has strengths; however, they also have limitations that suggest the need for additional innovation. These findings are summarized in Table 2.3.

Table 2.3

*Summary of Evaluation Approaches*

| Approach | Examples | Application | Measures | Strengths | Limitations |
|---|---|---|---|---|---|
| Clinical Trials | Randomized controlled trials | Evidence based practices | Causal relationships | Can address threats to validity | Ethical barriers to randomization |
| | Quasi experimental research | Model programs | Interventions impact on samples | Standardized effect sizes | Costs are excluded |
| | | Promising programs | Effect sizes | Translated across disciplines | Difficult to implement |
| | | | | | Single point in time measure |
| Health Economics | Cost benefit, cost effectiveness | Cost comparisons | Comparative costs | Supports comparison of options | Multiple objectives not included |
| | | Single effect comparisons | Singular effects | Cost is measured in relation to effects | Single point in time measure |
| Social Impact Assessments | Return on investment | Philanthropy, | Monetized investments | Investment perspective is meaningful to providers and funders | Heterogeneity of methods |
| | Cost per investment | External reporting of program impacts to funders | Monetized adjusted returns | | Complex |
| | Expected return | | | Monetized outcomes show standardized value | Requires monetization |
| | | Marketing | | | Single point in time measure |

**Clinical Trials and Evidence-Based Practices**

To the extent that there is a universally recognized standard for human service

program effectiveness, RCTs (and observational studies leading to RCT) are established

best practices (Solomon, Cavanaugh, & Drane, 2009). RCTs have strengths that

contribute to the search for effective human service programs. RCTs are attractive

because they have methodology advantages that strengthen the inference of causality

with regard to a program or services. As a rigorous empirical design, RCTs are effective

at controlling for confounding variables that could negatively influence the validity of the

research findings. Confounding influences are especially critical in human service

research because the complexity of human phenomena makes it difficult to measure

isolated intervention effects. RCTs minimize threats to validity and strengthen the causal

inference that funders and providers seek. A database search of Scopus conducted from

2010 to 2012 using the terms *randomized controlled trials* and *human service outcomes*

returned 2,162 results. This suggests an ongoing interest in RCT for human services with

good reasons to support this approach. Funders and service providers want to make

causal inferences about their programs; knowing "what works" has been the gold

standard of human service evidence-based practices.

Another advantage of RCT and observational studies is the contribution to

identifying evidence-based practice (EBP). EBP involves the use of systematic processes

to identify programs and services that empirically demonstrate replicable improvements

in outcomes (Nay & Fetherstonhaugh, 2007). Instead of tradition, gut reaction, or single

observations as the basis for making decisions, EBP relies on data collected through

experimental research and accounts for individual client characteristics and clinician

expertise (Solomon et al., 2009). Human services using EBP methodology can be

identified on a continuum based on the quantity and quality of supporting research. The

continuum can range from services with no evidence to support their use to services that

have been extensively researched with RCT. RCT and evidence-based practice can

support the effectiveness of human service programs. Ratings on the rubric are available

in Table 2.4.

Table 2.4

*Meta-Evaluation Ratings Clinical Studies*

| Element | Clinical Studies | ROI | Health Economics |
|---|---|---|---|
| Heterogeneity | 1 | | |
| Integrated | 2 | | |
| Heuristic | 2 | | |
| Empirical | 1 | | |
| Iterative | 2 | | |
| Translational | 3 | | |
| Supports PM | 3 | | |
| TOTALS | 14 | | |

*Note. Rating 1:* The evaluation approach performs very well on this element. Little if any modification is needed to meet the needed elements qualities. *Rating 2:* The evaluation approach is marginal on this element. A partial fit or significant effort is required to meet the desired elements needs. *Rating 3:* The evaluation approach does not meet the elements requirements.

While the identification of evidence-based practices and RCT research is valuable, there are several significant limitations. The first and foremost barrier to RCT is ethics; in nearly all cases, human services are provided because of their anticipated positive impact on vulnerable populations (Nay & Fetherstonhaugh, 2007). Denial of the service for the sake of a control condition is ethically questionable. Second, establishing evidence-based practices through RCT methodology requires complex research, iterative studies and high levels of expertise in research. Due to the need to eliminate bias in the design, external, independent evaluation is typically necessary. These characteristics of RCT go beyond the capacity of human service organizations in most cases (Reed & Morariu, 2010).

Finally, RCTs do not support project management. As retrospective studies, RCTs can tell organizations and funders about their program's outcome *after the fact.* The three possible findings of an RCT are (1) no statistically significant finding, (2) a statistically significant finding but no effect, and (3) a statistically significant effect with an effect size of .0 to .99. This information has academic value and might be used to leverage future funding, but it cannot be used to modify programs and services, as they occur to optimize service delivery. In fact, the critical issue of fidelity makes evidence-based practices established by RCTs rigid. This is antithetical to the premise of project management. Project management is based on the principle that services can and should be continuously adjusted, modified, and altered for maximum efficiency and effectiveness.

RCTs have served as the historic standard for human services programs. Their strengths have been to establish strong inferences of causality that suggest the effectiveness of human services. Their rigorous empirical approach has given credibility to human service programs and established a collection of evidence-based practices that can be replicated. However, the ethical barriers, complexity, limited translatability, inability to integrate cost per outcome, and retrospective view make their value for project management limited.

**Social Impact Measures/Social Return on Investment**

Social return on investment (SROI) is an approach that measures the social and economic impact of an investment, which is given monetized values. SROI calculates a ratio of financial inputs to financial outputs. The findings are typically stated in the fashion: program *x* provides a "return on investment" of 3:1; for every dollar of funding, three dollars of value are returned. SROI is currently popular in human services due to the apparent simplicity of reporting an outcome that supports requests for additional funding.

SROI was pioneered by the Roberts Enterprise Development Fund (REDF), a U.S. venture philanthropy fund, and the concept has since evolved into a widely used, global framework (Emerson, Wachowicz, & Chun, 2001). SROI includes a careful examination of a human service over an extended period of time, often as long as 10 years. This examination leads to a monetized measure of the amount of investment or capital input that is required to provide the service. Following this measurement, positive social benefits are identified and a monetized value is estimated for those outcomes.

Since benefits accrue over time, the measure of cost benefit must be adjusted back to the date of the original investment using methodology known as net present value (Nicholls, Lawlor, & Neizert, 2009). The findings can then be expressed as a cost-to-benefit ratio that speaks to the value of the social impact (i.e., product) of a human service.

SROI has a number of strengths as a human service outcome evaluation method. First, human service managers can easily understand the results of an SROI analysis. It is relatively easy to explain or translate results to policy makers and the public. With even a superficial knowledge of finance or accounting, an individual can understand that investing one dollar today in order to return three dollars tomorrow is a good decision. Additionally, human service organizations are attracted to this method because the claim of a large SROI can more easily justify requests for additional funding. SROI has given human services a meaningful way to share the financial value of their services with funders and the public. While these advantages are important, SROI also has limitations that must be considered. ROI ratings are listed in Table 2.5.

SROI, in general, has some important limitations. First, there is no single or standardized methodology for SROI. A Gates Foundation study conducted in 2008 attempted to identify a common SROI method. Eight distinct methods were identified and the study concluded that no one superior approach could be supported (Tuan, 2008). Second, a rigorous SROI evaluation requires the review of a lengthy but limited retrospective period. Findings from previous years may not be accurately generalized to the future (Steele, 2009). Due to the need to monetize outcomes, SROI does not directly measure service effectiveness or the change in the state of a measure from pre- to

Table 2.5

*Meta-Evaluation Ratings ROI*

| Element | Clinical Studies | ROI | Health Economics |
|---|---|---|---|
| Heterogeneity | | 2 | |
| Integrated | | 3 | |
| Heuristic | | 2 | |
| Empirical | | 2 | |
| Iterative | | 2 | |
| Translational | | 1 | |
| Supports PM | | 3 | |
| TOTALS | | 15 | |

*Note. Rating 1:* The evaluation approach performs very well on this element. Little if any modification is needed to meet the needed elements qualities. *Rating 2:* The evaluation approach is marginal on this element. A partial fit or significant effort is required to meet the desired elements needs. *Rating 3:* The evaluation approach does not meet the elements requirements.

posttest. A program or service could, in theory, produce an SROI that gives the

impression of a benefit without producing a very large effect. For example, retaining

delinquent youth in the community will undoubtedly produce a large monetary return. A

youth in placement may cost as much as $500 per day, while community services may be

only $50 per day. While there is a monetary savings, if the youth continues to represent a

danger to public safety, the program has not been effective, even though it was

monetarily beneficial. Decision makers choosing between two competing programs might

select a program with a larger SROI but less impact on desirable outcomes than its

alternative. Finally, many outcomes of human services are difficult to monetize. Placing a dollar amount on the benefits of services that reduce poverty, obesity, crime, etc., is challenging even for highly trained economists.

As a method to support human service project management, SROI is problematic. While the findings of SROI methods are relatively easy to report and understand, rigorous studies to determine SROI are very complex. SROI gives one measure of service performance at one point in time and/or one level of investment. The level of investment is seldom static in human service activities; fluid service delivery needs impact organizational capacity related to personnel or infrastructure. While SROI can lend itself to effective communication and advocacy for human service organizations, its utility for advanced project management is limited.

**Cost Effectiveness/Health Economics Approaches**

Cost effectiveness analysis (CEA) is a type of economic evaluation that examines both the costs and effects of human service activities. CEA compares the cost of an intervention to its effectiveness as measured in a ratio, which expresses cost per effect (Honeycutt, 2006). CEA in human service outcome evaluations has been used to compare alternative programs targeted at the same outcomes, as well as to measure the value of a single service.

CEA has much strength that relates to human service outcome evaluation. CEA can be used to identify the most cost-effective strategies from a set of service options that have similar results. For example, institutional placement of juvenile delinquents might be compared to community services as an option to maintain public safety. These options

have a common outcome, but the cost of institutional care is far more expensive when compared to community services. However, the effect "public safety" should (in theory) be achieved more effectively by placing a juvenile in an institutions. CEA can be used to determine how effective community services are at maintaining public safety. Policy and decision makers can use the findings of this analysis to determine if the cost savings provided by the community service is justified if public safety is compromised by retaining the youth in the community. CEA strengths include the following. It can incorporate measures of cost in light of service effectiveness. Effectiveness can be measured using rigorous empirical methods up to and including RCT. CEA is well suited to human services that have single effects and can be used to make meaningful comparisons of alternative interventions with a single population. CEA ratings are listed in Table 2.6.

Because CEA uses a particular outcome measure that must be common among the programs being considered, its value is limited when the programs have different outcomes. CEA results might not be generalizable to all populations. CEA is a useful approach to measuring value of human services. However, its limitations suggest the need to consider other options for human services. Combined ratings are listed in Table 2.7.

Table 2.6

*Meta-Evaluation Ratings Health Economics*

| Element | Clinical Studies | ROI | Health Economics |
|---|---|---|---|
| Heterogeneity | | | 1 |
| Integrated | | | 2 |
| Heuristic | | | 2 |
| Empirical | | | 1 |
| Iterative | | | 2 |
| Translational | | | 2 |
| Supports PM | | | 2 |
| TOTALS | | | 12 |

*Note. Rating 1:* The evaluation approach performs very well on this element. Little if any modification is needed to meet the needed elements qualities. *Rating 2:* The evaluation approach is marginal on this element. A partial fit or significant effort is required to meet the desired elements needs. *Rating 3:* The evaluation approach does not meet the elements requirements.

Table 2.7

*Meta-Evaluation Ratings Combined*

| Element | Clinical Studies | ROI | Health Economics |
|:---:|:---:|:---:|:---:|
| Heterogeneity | 1 | 2 | 1 |
| Integrated | 2 | 3 | 2 |
| Heuristic | 2 | 2 | 2 |
| Empirical | 1 | 2 | 1 |
| Iterative | 2 | 2 | 2 |
| Translational | 3 | 1 | 2 |
| Supports PM | 3 | 3 | 2 |
| TOTALS | 14 | 15 | 12 |

*Note. Rating 1:* The evaluation approach performs very well on this element. Little if any modification is needed to meet the needed elements qualities. *Rating 2:* The evaluation approach is marginal on this element. A partial fit or significant effort is required to meet the desired elements needs. *Rating 3:* The evaluation approach does not meet the elements requirements.

## Discussion and Future Directions

This study suggests that nonprofit organizations are conducting outcome evaluations, and they are attempting to use evaluations for project management purposes. However, limitations of staff time, expertise, and funding to externally purchase this time and expertise are significant barriers in the sector.

**Multi-Objective Value Estimation**

Multi-Objective Value Estimation (MOVE) is based on well-established methods from health economics and Multi Attribute Utility Theory. MOVE uses costs and multiple weighted measures of value to determine an aggregate measure of value. Multi Attribute Utility Theory (MAUT) is commonly applied in decision-making science (Keeney & Raiffa, 1993). MAUT allows for the subjective identification of desired outcomes and the application of weights to a formula that indicate stakeholder priorities (Edwards, 1982). This method is preferred for stakeholders due to its intuitive nature. Informally, this method is commonly used when consumers comparison shop for major purchases. Cost is viewed in relation to desired attributes of a product. For instance, when purchasing an automobile, a customer frequently compares two or more models. Each model is compared not only on cost but on factors of utility such as gas mileage, appearance, cargo capacity, horsepower, etc. Different customers might prioritize or "weight" these factors of utility differently. One customer might care primarily about gas mileage and another about appearance. This method is formalized and used systematically in MAUT. Stakeholder priorities are determined directly through interviews or focus groups. MAUT formula with three weighted factors of utility appears as follows, where $U(x)$ is the utility of one factor of value and $w$ is the assigned weight for that factor (Levin & McEwan, 2001):

$$U(x_1, x_2, x_3) = w_1 U(x_1) + w_2 U(x_2) + w_3 U(x_3)$$

Cost effectiveness evaluation uses empirical methods and includes a cost measure, but is typically limited to include only one factor of value (Levin & McEwan,

2001). In order to make accurate comparisons between programs, costs must be measured and adjusted using the same method in all cases. Effects are typically measured by quasi experimental or experimental research designs that observe an effect size based on pre- to post-intervention changes in the mean of a sample or population. A cost-effectiveness formula is fairly straightforward (Levin & McEwan, 2001):

$$Costs \div Effects$$

However, Levin and McEwan propose an additional evaluation model that combines the strengths of MAUT and cost effectiveness. He refers to this approach as "cost utility analysis" (Levin & McEwan, 2001). The combined cost utility analysis method defined by Levin and McEwan is:

$$\frac{Cost}{w\ x1\ +w\ x2\ +w(x3)}$$

Multi-Objective Value Estimation (MOVE) is an approach to measure costs and weighted factors of value as outcomes of human service programs. Factors of value are program outcome objectives identified by stakeholders (Keeney & Raiffa, 1993). Each factor of value can receive additional stakeholder input in the form of weights; weights allow prioritization of multiple objectives (Edwards, 1982). Input from stakeholders can be gathered in in a variety of methods. The direct method, which is used in this paper, involves simply asking stakeholders to list their top two or three objectives and rank these objectives in order of priority (Levin & McEwan, 2001, p. 201). The researcher, in the form of formal interviews, focus groups, or surveys, can conduct this process. The MOVE model is a very flexible approach. Staff turnover, funding shifts, and changes in the political landscape are all possible in the human service environment. The MOVE

model can be modified, while services are provided without interruption. Weights on the same objectives can be altered to reflect different stakeholder priorities (Keeney & Raiffa, 1993, p. 34). The objectives themselves can be changed, although this may require the implementation of different measures. This fluidity can be further accounted for by the addition of a sensitivity analysis to explore the impact that shifts may have on the overall measure.

This approach is attractive to human service evaluations for many reasons. First, it allows the inclusion of costs as a factor of value. Secondly, the model allows for meaningful input from stakeholders who identify desired outcomes and prioritize outcomes through the identification of weights. Finally, the model has a high degree of empiricism by measuring effects using scientific methodology and appropriate statistical analysis. While attractive, a review of the literature indicates that a multi-attribute utility approach such as the one suggested by Levin and McEwan has very limited use in the evaluation of human service programs (Selameab & Yeh, 2008). A search of the SCOPUS database using the search terms *multi attribute utility* and *human service program evaluation* returned four documents; only one of these was an evaluation of a program. A review of the ProQuest database with the same terms produced no results. The potential of a Multi Attribute Utility Theory to address many of the limitations of existing human service evaluation approaches supports the need for testing this innovation to determine its applicability. Additionally, the data gathered by this approach can be applied to an innovative use of Monte Carlo simulations to determine optimal input (cost and time) levels for program impacts.

This study has suggested several new findings. First, while there is a positive increase in the quantity of outcome research and evaluation being conducted by human service organizations, these studies need to be subjected to meta-evaluation to assess their merits. Second, when evaluated for their capacity to support meaningful project management, the most widely utilized existing approaches have important limitations. Finally, cost-utility approaches that estimate the value of multiple program objectives are promising. These cost-utility approaches need to be field tested to determine their feasibility as a unique approach and their capacity to support project management.

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# CHAPTER III

## A MULTI-OBJECTIVE VALUE ESTIMATION OUTCOME EVALUATION OF THE YOUTH TRANSITIONS PROGRAM

### Background and Significance

The United States retains approximately 90,000 young people annually in juvenile justice facilities (Justice Policy Institute, 2009). These facilities include public and private institutions that confine youth in settings outside their community. Confinement is a costly approach to juvenile delinquency; the average cost in 2009 of juvenile confinement in the U.S. was $240.99 per day per youth (Justice Policy Institute, 2009). Evaluations of confinement for delinquent youth suggest that outcomes (e.g., education, community functionality) from this approach are poor (Greenwood, 2008). With states facing serious budgetary constraints, evaluation of less costly, and potentially more effective, community-based alternatives for juvenile delinquency is needed.

### Description and History of Juvenile Justice Funding in Michigan

In the state of Michigan, one mechanism for the financial support of county-level juvenile courts occurs through the Child Care Fund (CCF). The CCF originated in Michigan in 1955 with the inception of foster care legislation and policy (Michigan.gov, n.d.). The CCF is a joint effort between state and county governments to fund programs that serve neglected, abused, and delinquent youth (Wishka, 2006). Counties propose an annual CCF Plan for the Family Division of the Circuit. The plans are reviewed and

approved by the Bureau of Juvenile Justice – CCF Division of the Department of Human

Services (Evans, 2010). Expenditures are made locally and then submitted monthly for

reimbursement (Michigan.gov, n.d.). Programs that qualify for CCF must fall under one

of the following categories: (a) wards of the court as subjects of neglect or abuse cases,

(b) delinquent youth who are at risk of out-of-home placement, or (c) delinquent youth

who have a treatment goal of early return from confinement (Evans, 2010).

   During most of its history in Michigan, the CCF was primarily for youth in

confinement (Evans, 2010). In recent years, the Michigan CCF has been adjusted to

include the capacity to fund in-home care (IHC) programs. The IHC funding is intended

to fund community-based interventions to address problems of delinquency or to promote

a child's early return home from family foster care or institutional care (Michigan.gov,

n.d.). However, IHC programs and services are reimbursed by the state at the same rate

(50%) as confinement (Evans, 2010). The CCF may also provide funding of placements

when the safety of the youth, family, or the community is an issue (Michigan.gov, n.d.).

While in-home care is allowed under the existing funding structure, previous years'

expenditures show only about one third of the money being used for community

interventions; the remaining two thirds is spent on confining delinquent youth in

detention or residential facilities (Evans, 2010).

   Reducing the amount of CCF support for confinement and encouraging the use of

in-home care is an attractive opportunity for policy reform. The CCF, as it is currently

structured, provides reimbursement from the state to the counties without any incentive

for effective practice. The Michigan governor's proposed budget for fiscal 2011 allocates

$206.3 million in state reimbursements to the counties (Emerson, 2010, p. B-30). At the reimbursement rate of 50%, this would represent a total CCF expenditure of $412.6 million. In 2006-2007, the State of Michigan reported 2,011 youth in residential placement at an average daily cost of $391.00 per youth. The State of Michigan spent $827,451.45 *per day* on the juvenile residential placements in that year (Sickmund, Sladky, Kang, & Puzzanchera, 2008). In the current financial environment, policy needs to maximize the impact of funding. State-level funding structures that encourage Michigan counties to use CCF to purchase effective in-home care services have the potential to reduce costs and provide more effective service delivery strategies.

**History of the CCF in Muskegon County, Michigan**

The State CCF policy directly impacts Michigan counties. The Muskegon County Family Court struggles with the cost of placing high-risk delinquent youth in residential placements (Wishka, 2006). In October of 2006, the costs of confining Muskegon youth exceeded $250,000 a year and were expected to increase (Wishka, 2006). Residential placement facilities used by Muskegon County can range in price from $125 to $350 per child daily (Wishka, 2006). Also contributing to the cost of confinement are data showing that community-based services in Muskegon typically last 6-12 months (Wishka, 2006), while 18 months is common for residential placements (Greenwood, 2008). Additionally, Muskegon was experiencing some of the challenges inherent in residential placement, which includes reentry and reintegrating youth as they return to the community (Greenwood, 2008). To relieve some of these costs and inherent challenges without compromising public safety or quality service delivery to a high needs population, the

court began to seek creative community-based programming alternatives. Youth

Transitions was developed to meet this need; since implementation in 2006, Youth

Transitions has served 223 youth (Wishka, 2006). The evaluation of costs and effects was

sought by the court administration to determine if public funding could be used more

effectively through community-based services without negatively impacting public safety

(Wishka, 2006).

**History of Existing Studies**

Existing evaluations of juvenile justice programs employ primarily three

methodologies. First, meta-analysis has provided a review of existing single program

studies (Aos, Miller, & Drake, 2006). Second, studies have evaluated cost savings and

public safety community-based services at an ecological level (Greenwood, 2008).

Finally, evidence-based practice studies have established 11 specific programs that have

proven to be effective to provide services to juvenile delinquents in the community; these

11 programs have attained evidence-based standards due to a demonstrated reduction in

either violence or adolescent substance abuse (*Blueprints*, 2011). Meta-analysis and

ecological studies suggest that employing community-based strategies can reduce costs

without sacrificing public safety. Clinical trials suggest that individual community

programs can reduce negative behaviors. However, studies that measure costs, public

safety, and effects of improved general community functionality have not occurred.

A 2011 report found that "the vast majority of juvenile justice services have little

empirical support" (Henggeler & Schoenwald, 2011, p. 1). The report also recommended

that researchers needed to generate more data supporting the cost effectiveness of

interventions and translate this research into support for juvenile justice policy reform; translational research is needed to evaluate both the costs and outcomes of specific community-based programs.

The Washington State Institute for Public Policy (WSIPP) has conducted a cost-benefit analysis of juvenile justice programs. This meta-analysis that included 571 adult and juvenile programs was conducted to evaluate the costs versus benefits of programs aimed at reducing crime (Aos, Phipps, Barnoski, & Lieb, 2001). The findings of this meta-analysis suggest that programs using community-based practices had the largest positive effect on youth while also producing a cost benefit (Aos et al., 2006). Of the five most cost-effective juvenile services identified by the WSIPP study, all were community-based. The most cost-effective service, Multidimensional Treatment Foster Care, reduced crime recidivism rates by 22% and achieved a benefit minus cost of $77,798 (Aos et al., 2006, p. 9). The findings of the study suggest there are immediate financial advantages to adopting an array of evidence-based practices in the community. It should be noted that the findings of the study were based on standardized estimates and not on actual costs or results from specific programs.

A second meta-analysis conducted for the Campbell Collaboration (Petrosino, Turpin-Petrosino, & Guckenburg, 2010) addressed whether any involvement in the juvenile justice system reduces delinquency. The meta-analysis identified 29 studies that used random or quasi-experimental designs, included only juveniles, and assigned juveniles to either the juvenile justice system or an alternative program. The 29 studies included 7,304 juveniles over a 35-year period. The results indicated that juvenile

processing did not have greater impact on the decrease of juvenile crime than programs and services outside the public juvenile justice system. The authors reported that almost all the findings—as measured by prevalence, incidence, severity, and self-report— suggested the crime statistics were lower with alternative programming (Petrosino et al., 2010, p. 6). This meta-analysis suggested a positive association between any involvement in the juvenile system and recidivism but did not look at individual program outcomes or costs. The findings of the meta-analysis methods are complemented by ecological studies measuring recidivism, costs, and public safety.

The rate at which youth reoffend or recidivate is another important measure of the effectiveness of a delinquency intervention. Recidivism rates and related research have indicated that youth who are confined reoffend at an accelerated rate. Approximately 60% of youth in the United States who were in residential placement were rearrested within two years of their release (Justice Policy Institute, 2009). Measuring recidivism of juveniles in adulthood, Gatti, Trembly, and Vitaro (2009) used data from a sample of 779 males under the age of 17 to investigate whether intervention by the juvenile justice system during adolescence correlated to an increased involvement in adult crime. The findings of this study suggest that any intervention by the juvenile court increases the likelihood of involvement with the judicial system in adulthood. Although the study did not control for the severity of the offense, the results also suggested the various measures recommended by the juvenile court contribute unequally to the effect. Those delinquent youth who experienced placement had the highest rate of involvement with the legal system as adults.

Studies using cost-benefit analysis methods suggest there are benefits to community-based interventions for juvenile delinquents. These benefits include the lower costs of community-based services compared with confinement (Aos et al., 2001). Additionally, the studies support the enhanced cost savings that occur from reduction in the rates of future confinement; youth with history of placement are more likely to experience additional juvenile confinement and incarceration as an adult (Gatti et al., 2009).

In addition to cost savings and reduced recidivism, existing literature suggests a public safety benefit as well. In a 2009 public safety study of all 50 states, the Justice Policy Institute (2009) found no correlation between the number of youth in juvenile facilities and crime rates (p. 10). In a separate study, Sickmund et al. (2008) found 6 of 10 states that increased rates of confinement experienced an *increase* in violent offenses reported to law enforcement. The findings of these studies suggest that public safety is not at risk by retaining delinquent youth in the community. Higher rates of confinement do not correlate with improved measures of short-term public safety.

Meta-analysis and broad, population level ecological studies on delinquency outcomes, and narrowly focused clinical trials, have all been used to establish evidence-based practices. The U.S. Department of Health and Human Services has identified The Blueprints Initiative as the "gold standard" for evaluation of delinquency programs designed to reduce violence and drug abuse (SAMHSA, 2012). This initiative sets rigorous standards that approach or reach the levels of clinical trials (Blueprints, 2011). Randomization and control conditions as well as large sample sizes support studies that

have thus far identified 11 programs as meeting the evidence-based standards prescribed in the initiative. Although outcome evaluation research established that Blueprints programs were effective in reducing violence, delinquency, and drug use, very few data were available regarding the costs associated with replicating these programs in local communities; Blueprints notes that only two studies have been done to measure the cost effectiveness of programs that have met the standards of evidence-based practice (Blueprints, 2011). Furthermore, the program-related clinical research demonstrates effectiveness at reducing very tightly targeted negative behaviors such as violence or drug use. These studies, however, have not typically measured impact of community-based services, such as community functionality (Blueprints, 2011).

The research literature on juvenile delinquency to date suggests the application of community-based interventions as an alternative to confinement can result in cost savings and improved results for juvenile delinquents without increased risk to public safety. However, these studies are either meta-analysis, broad ecological measures of estimated cost and effects, or very targeted clinical studies that suggest approaches to reducing specific delinquent behaviors, but have not addressed costs in the consideration of value. A secondary research question involves the potential capacity that this approach has to support project management processes. The data and findings of this study were utilized by the managers at the court and by the service providers to drive a quality improvement process that made program adjustments designed to achieve the specified outcomes. That process and the findings related to this research question are contained in Appendix A.

Based on this literature, reducing the number of confined delinquent youth in Michigan is an attractive strategy to reduce CCF expenditures. What is not known is if this strategy can be translated to local communities, while producing similar outcomes to those observed in previous research. If programming like Youth Transitions in Michigan can demonstrate similar results, it would serve to support a restructuring of the CCF to incentivize the use of in-home care services. This policy change could reduce overall expenditures and produce better outcomes for a vulnerable population of youth without reducing public safety. In order to evaluate this possibility, this study addressed the following outcomes from implementation of a community-based juvenile justice program: cost benefit to the county, functionality of delinquent youth in the community, and impact on public safety.

## Methodology

### Program and Participants

The Youth Transitions program is designed to work with delinquent youth who are at imminent risk of placement in secure out-of-county residential treatment facilities (Wishka, 2006). Youth are selected through an interdisciplinary screening process known as the Placement Review Committee. The disciplines represented on the committee include clinical psychology, social work, child protective services, juvenile probation, and education. Youth at risk for placement in residential facilities are reviewed thoroughly and a decision is made regarding appropriateness for placement. If the committee believes the case is eligible for Youth Transitions services, a referral is made

(Wishka, 2006). The sample for this study was limited to youth who had received 90 days of service or more. Based on a systematic review of the literature, 90 days of service allows for a sufficient quantity of service to occur to achieve minimum effectiveness. In 2010, 28 of 41 youth met these criteria. Nineteen of the 28 youth had been discharged 180 days or more; this subsample provided the data for the recidivism measure.

**Research Design**

A secondary, retrospective analysis was conducted of de-identified records from the court and the Youth Transitions program from 2009 to 2010. The Muskegon Family Court retains records on financial expenditures including purchased services, contracts, and billing records (Wishka, 2006). Data on youth performance are gathered by Youth Transitions staff that has been trained in the collection and confidential retention of evaluation records. Felony arrest data are also collected by the court and are available as public information. Youth selected for the program were assessed at the beginning of the intervention and every 6 months following the initial measures. Felony conviction data were also accessed at three times: 6 months prior to intervention, during the intervention period, and at 6 months following termination of services. Felony convictions were used to determine if any improvement in public safety was retained and to suggest program effects to reduce recidivism.

**Measures**

Costs were compared on an average unit-of-service basis. Costs per unit for Youth Transitions are equal for all youth receiving service. Direct unadjusted costs for

Muskegon County youth were averaged as a daily unit of service for comparison to the

daily unit-of-service cost for Youth Transitions. All youth in the Youth Transitions

program were assessed using the 2010 version of the Child and Adolescent Functional

Assessment Scale (CAFAS), which has high levels of validity and reliability (Hodges,

2002). This instrument rates youth (ages 7-17) performance in eight different life

domains and provides a scaled score of overall functionality. The eight life domains

include School, Home, Community (delinquent-like behavior), and Behavior toward

Others, Mood and Emotions, Self-Harmful Behavior, Substance Use, and Thinking

Problems. A maximum score of 30 in each domain is possible with a range of 0–240. The

scores are gathered at intake and at discharge by master's-level clinicians who have been

trained to administer the instrument.

Public safety was measured by felony convictions. Felony conviction public

record data were gathered for a 6-month period in the community prior to Youth

Transitions services and 6 months post-service termination. The total number of felony

convictions was divided by the total number of days of service delivery to calculate the

per day rate of felony convictions. Public safety data were analyzed by a review of

county delinquency records that indicated the number and type of felony conviction by
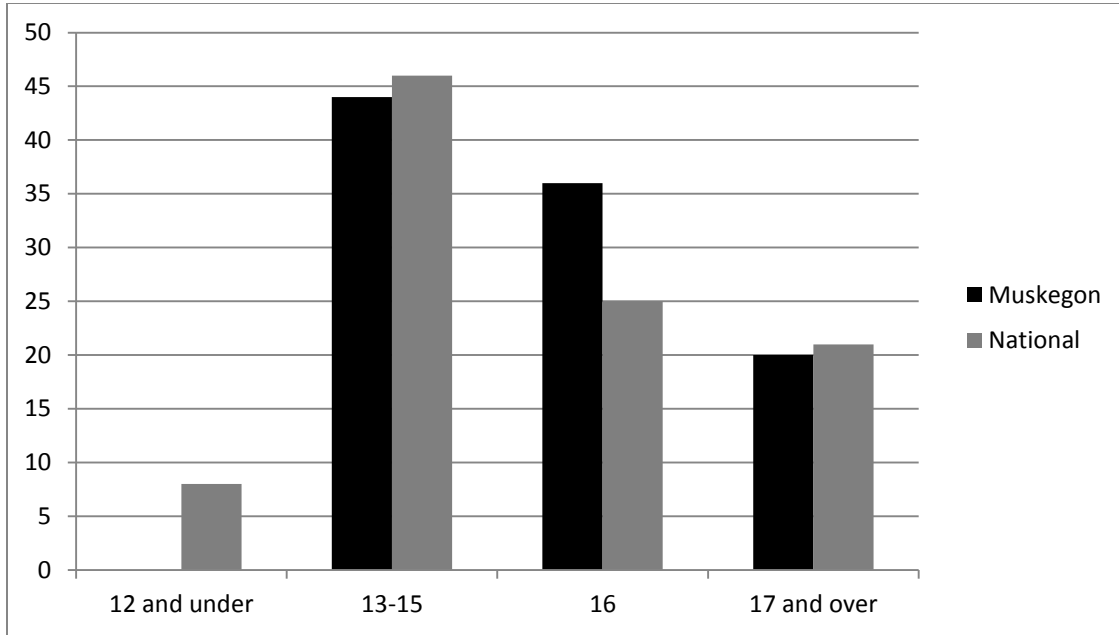
study participant.

Cost benefit was calculated using unadjusted 2010 dollars. Cost analysis was

limited to direct expenditures from the county CCF. Community functionality analysis

was based on data from pre and post CAFAS scores; these scores were entered into SPSS

(Version 16, IBM) and analyzed using paired samples *t* tests. Confidence intervals (95%)

and error bars were included to indicate a statistically significant change in the pre and post scores. Effect size was calculated using Cohen's *d*.

## Findings

The evaluation of the Youth Transitions program explored three research questions. In a sample of delinquent youth at high risk for confinement, CCF expenditures for youth retained in the community were measured to determine if costs for community services were less than the alternative estimated costs of residential placement. Second, the study evaluated the change in community functionality of the youth receiving specialized services. Finally, public safety pre- and post-program was measured to determine if the rate of felony convictions would increase, decrease, or remain consistent with community retention.

The sample consisted of 28 Muskegon County youth on intensive probation in 2010 who received Youth Transitions services. Twenty males and eight females participated in the study. The mean age of the sample was 16.1. Descriptive data analysis of the sample indicated that the age distribution of the Muskegon sample (Figure 3.1) was similar to national samples of delinquent youth (Justice Policy Institute, 2009), although the study sample had no youth in the youngest category and a greater percentage in the 16-year-old group.

*Figure 3.1.* Juvenile delinquency percentages by age: Study participants versus U.S.

The findings suggest that retaining delinquent juveniles in the community with Youth Transitions services provides a cost benefit to the Muskegon County Family Court; as noted in Table 3.1, average per day, per child cost was reduced from $187 to $50. The county experienced a cost benefit for each child, significantly reducing its annual CCF budget. If the same sample of youth had been placed in appropriate residential confinement, the county would have absorbed approximately $728,018 in additional costs.

Table 3.1

*Cost Comparison Youth Transitions and Residential Treatment*

|  | Youth Transitions | Residential Placement |
|---|---|---|
| Average cost per day per child | 50.00 | 187.00 |
| Average cost of 6 months of service per child | 9,000.00 | 33,650.00 |

Delinquent youth retained in the community with Youth Transitions services improved their community functionality as measured by CAFAS (see Figure 3.2). CAFAS scores decrease with increased community functionality. A statistically significant improvement in community functionality was observed in the sample population from pretest ($M = 81.07$, $SE = 2.78$) to posttest ($M = 75.71$, $SE = 2.32$, $t(28) = 2.2$, $p < .05$, $r = .58$) with a mean difference in CAFAS scores from pre- to posttest of 5.36 points.

**Improvements in CAFAS Scores Following Six Months of Intervention**
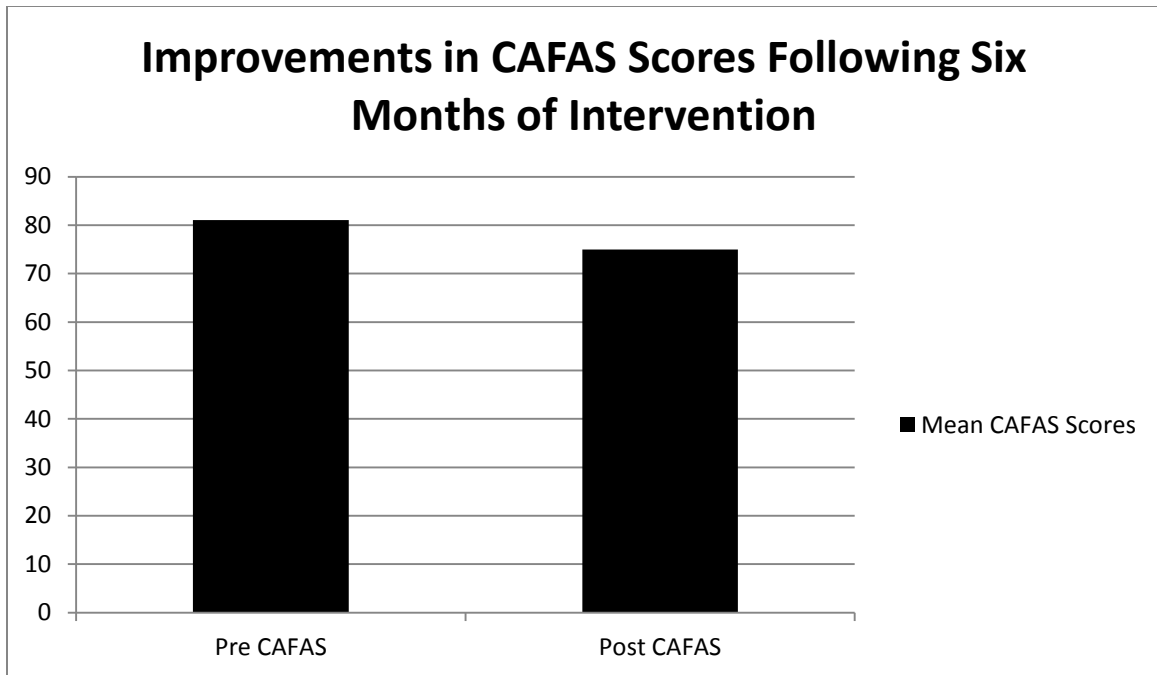
*Note.* Repeated measures *t* test results pretest ($M = 81.07$, $SE = 2.78$) to posttest ($M = 75.71$, $SE = 2.32$, $t(28) = 2.2$, $p < .05$, $r = .58$).

*Figure 3.2.* Improvements in CAFAS scores.

Public safety, as indicated by felony convictions, decreased in the 6 months following the beginning of Youth Transitions services (Table 3.2). This improvement was sustained during 6 months following the termination of services. While receiving services, youth felony convictions occurred at the rate of 3 per 1,000 days. In comparison to the pre-intervention rate of 10 per 1,000 days, this represents a statistically significant ($p < .05$) decrease of 64% in the daily rate of felony convictions. During intervention, 16 felony convictions occurred by 6 different youth. In the sample population, 18 of 41 youth had no felony convictions. Six months following discharge from the Youth Transitions program, data were available on 19 youth. Those 19 youth maintained a low

felony conviction rate of 4 per 1,000 days. In the post-intervention group, 13 of the 19

youth had no felony convictions.

Table 3.2

*Felony Conviction Rates During Three 6-Month Intervals*

|  | 6 Months Pre-Intervention | During Intervention | 6 months Post-Intervention |
|---|---|---|---|
| Total days | 3420 | 5314 | 3420 |
| Total felony convictions | 33 | 16 | 12 |
| Average number of felony convictions per day | .0096 | .0030 | .0035 |

**Discussion**

Many juvenile justice policies in states like Michigan remain unaligned with

research findings that have not translated into meaningful reform. This situation presents

barriers to local courts that must make difficult decisions balancing fiscal pressure, public

safety, and a sincere desire to provide the best possible care for vulnerable youth. The

CCF funding structure, which is not aligned to encourage effectiveness, is an example of

policy that could be reformed. Driven in part by decreasing budgets, the current

opportunity to translate research findings into meaningful policy reform exists in

Michigan.

The results of this study have value for Michigan policymakers at several levels.

First, this study confirmed that the practice of retaining delinquent youth in the

Muskegon community produced financial benefits to both Muskegon County and the

State of Michigan. The dollar amount was meaningful and important in relation to the CCF total budget in Muskegon. The State reimbursement to Muskegon was reduced as a result of the successful use of CCF dollars in Muskegon. In addition to the cost savings, the study observed positive changes in community functionality. This finding is important because it suggests that not only can youth reduce negative behaviors, as previous research suggests, but they can also improve their role performance in various life domains. Finally, and perhaps most importantly to policymakers, public safety was improved with the addition of services in the community; the delinquent youth decreased their rate of felony convictions and sustained this improvement following termination of the program.

While the findings of the study are promising, the research has limitations. The sample size was relatively small; only 3% of delinquent youth in Muskegon were included. Furthermore, the sample was nonrandom and purposefully selected. The PRC team in Muskegon carefully and deliberately selects youth for the very reason that they are highly likely to benefit from the Youth Transitions service. Therefore, caution should be taken with any attempt to generalize the findings to broader populations of delinquent youth in Muskegon or elsewhere. Additionally, small nonrandom samples of delinquency outcomes measured by observational designs are subject to selection regression artifact bias (Maltz, Gordon, McDowall, & McCleary, 1980). This bias occurs due to the nonlinear frequency of offending behavior; delinquent behavior tends to peak and decline over time. Youth tend to receive court attention and high levels of service at peak times in their offending behavior. Therefore, a decline in delinquent behavior without any

intervention is a statistical probability due to the nature of the sample selection process (Butts, 2011). The preferred way to counter this bias is the addition of a control group for comparison. Continuing the research with the addition of data from observation of a comparable sample is a direction for future research.

Additional limitations include the challenge of program replication in environments where the perception of risk is strongly present. In spite of statistical evidence indicating that the risk of retaining delinquent youth in the community is small, any preventable victimization is understandably difficult to accept. Additionally, implementation of service delivery approaches like Youth Transitions requires a strong partnership between public funders, court officials, and service providers. Such a partnership is challenging to facilitate and sustain. This translational study helps address these barriers and encourage the continuing evolution of juvenile justice services in Michigan.

While the study had limitations, its findings are consistent with a limited number of studies on effective programs throughout the United States. This study added to the literature by including costs, functionality of the youth, and public safety in a single program-specific evaluation. Meta-analyses have suggested that a cost saving and positive impacts can occur when delinquent youth receive services in the community. The findings of state-level studies that delinquent youth do not continue to commit high rates of felonies when they remain in the community are consistent with the findings in Muskegon. This study adds to the field of evidence-based clinical trials, which have measured a reduction in negative behaviors such as violence or substance abuse. This

evaluation additionally examined the community functionality of the program

participants because, along with reducing negative behaviors, positive gains in

community functionality are also a desirable outcome of community-based services.

Determining that the participants not only reduce criminal behavior, but improve their

function in the community and do so at a lowered cost, is an important finding.

In the existing structure of the CCF, Michigan makes significant expenditures that

are not associated with outcomes. This presents an attractive opportunity to the State to

save money through policy changes. Restructuring the CCF in a way that incentivizes

strategies that retain delinquent youth in their local community with effective services is

an attractive option. The findings are also meaningful to county-level family courts that

need to identify locally effective interventions at the least cost. This is an unusual but

promising policy situation; the more effective practices actually are less expensive than

the alternatives.

**Future Directions**

The research in Muskegon County with delinquent youth is ongoing. The

opportunity to strengthen the inference of causality when measuring effects of the Youth

Transitions program through the application of a more rigorous research design is being

explored. Selection of delinquent youth for community-based services or residential

treatment is a deliberate process; randomly selecting delinquent youth to apply a true

control or experimental design presents a risk to public safety and would, therefore, be

unethical. While barriers to randomized methods exist, additional research efforts to

support future studies will include data on comparison groups including youth in residential treatment and youth only receiving intensive probation services.

Expanding and enhancing this research will provide valuable information for Michigan courts, legislators, and policymakers. The results of this study and ongoing research measuring the effectiveness of services to juvenile delinquents support cost-effective decision making and demonstrate how research can be meaningful and helpful to the challenging process of service provision to a vulnerable population.

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**CHAPTER IV**

**USING PREDICTIVE ANALYTICS FOR HUMAN SERVICE
PROJECT MANAGEMENT**

**Background and Significance**

In his influential 2011 publication *Leap of Reason: Managing to Outcomes in an
Era of Scarcity*, Mario Marino identified the critical need for human service
organizations to improve the efficiency and effectiveness of their business activities
(Marino, 2011). Human service organizations must operate in an efficient and effective
fashion due to decreasing funding, stakeholder demands for results, and the growing need
for service to vulnerable populations. Marino's observations and suggestions are valuable
and serve as a manifesto for human service management in the 21st century. However,
Marino's work and its popularity in the human service sector are intriguing given the
extensive recent development of human service outcome measurement approaches and
studies. While human service organizations are conducting far more outcome research
and program evaluations than ever, these efforts have not translated into improved
management practices.

There are several possible explanations for the incongruity between outcome
measurement efforts and management practice. Marino identified leadership capacity and
funding as reasons for the current inability of human services to manage to outcomes
(Marino, 2011, p. 3). A survey of nonprofit organizations conducted in 2010 supports
many of Marino's contentions, finding that nonprofit managers lacked both funding and

technical expertise to expand outcome measures and apply findings from the research and evaluation in meaningful ways (Reed & Morariu, 2010). While funding and expertise are certainly factors in the problem, there may be additional reasons for the gap in applying research findings to management practices. First, the common evaluation and research approaches utilized by human services do not translate well into project management. Clinical research such as Randomized Controlled Trials (RCT) have great value in determining relationships between pre and post means in sample populations, but they have little meaning for managing the operations of human service programs. A very popular approach, return on investment (ROI), is also problematic. A variety of methods, complexity in monetizing the value of human service outcomes, and a retrospective focus limit the value of ROI for management activity. These approaches are useful for evaluation of past performance. However, human service managers require current information and projected future performance standards for comparison if they are to successfully utilize the products of research in daily management. Additionally, managers who lack expertise in complex statistical analysis, economics, and research need a highly intuitive method to receive outcome information prior to implementation if they are to make operational adjustments for optimal efficiency and effectiveness in their programs.

Identifying such a method has potential value to funders, stakeholders, service recipients, and the human service organizations themselves. If this method can be identified, funding levels could be adjusted for optimal outcomes. While underfunded human services experience compromise effectiveness, there may also be a diminishing return from overfunding and overserving. The range of cost and time inputs that lies

between "underfunded" and "overfunded" would represent the optimal input range. An innovative method to manage the risk of under- or overfunding human service programs is needed (Tuan, 2008). This paper will (a) review existing approaches to make economic projections regarding project performance, (b) identify an innovative approach with a methodology that fits the needs of human service projects, and (c) test this innovation to assess its utility. The research questions are:

1. Can the results of a cost utility study, Multi-Objective Value Estimation, be used to support the development of a predictive analytic model for project management?

2. Can Monte Carlo simulations be used to reduce the uncertainty in the model and more accurately identify model parameters?

3. Following the simulations, can the refined model be translated and presented in a graphic that requires minimal expertise in statistics or management science?

Findings of this study have the potential to influence future human service management practices and provide a mechanism to achieve Marino's direction to "manage to outcomes in an age of scarcity" (Marino, 2011). Most importantly, improving the efficiency and effectiveness of human service organizations will benefit the vulnerable populations who deserve the best services we can provide.

**Background: Alternative Methods**

A review of forecasting methods reveals several options for exploring and identifying projected performance expectations for improved management practices.

These methods need to be considered in light of the realities frequently found in research related to human service outcomes. Specific realities include the following:

- Data sets are often small.

- Data are often missing or incomplete.

- Findings from studies are not generalizable.

- Human behavior/phenomena are complex.

- Single disciplinary methods have not proven definitive.

A brief review of major methods will suggest a preferred method for identifying forecasts that can translate to project management.

**Method 1: Qualitative predictions.** Qualitative methods of identifying expected future performance are available. Structured interviews, panel discussions, and expert testimony can yield valuable information about future occurrences (Mun, 2010). This method may be considered as a prediction, as opposed to a forecast. A prediction is based on opinion, not on statistics. Forecasting is a method involving statistical analysis of data to project future probabilities. A prediction, however, can be based on expertise grounded in direct experience and past observance. An example of qualitative predictions would include using a structured interview conducted with several experts (Okoli & Powlowski, 2004). For instance, experts in political science might be interviewed to investigate the possibility that the next president will be a woman. Quantitative historical data (since all previous presidents have been men) analysis might not be the preferred method to investigate this question. Qualitative methods can also be used to guide business decisions or make choices when quantitative approaches have proven unsuccessful.

This qualitative method has strengths and limitations. It is valuable when quantitative data are lacking or minimally available. When some data are available, qualitative approaches can also support mixed methods. This is commonly the case with human services. However, basing future project performance on strictly qualitative methods is highly subjective and difficult to replicate, and assumes that experts can come to some consensus about likely outcomes.

**Method 2: Time series data analysis.** Quantitative research offers a method to determine projected optimal input range and reduce risk. Time series approaches use past data and observational studies in which various stratified cost and time inputs are measured in relation to outcomes (Mun, 2010). A comparison of sample means and standard deviations taken at set intervals using time series designs would provide information about the relationship among inputs, time, and outcomes. Once a valid retrospective relationship among cost, time, and outcomes has been identified, this can be used to forecast future performance (Bisgaard, 2011). A common application of this method is Auto Regressive Integrated Moving Averages or ARIMA (Mun, 2010). ARIMA is an econometric approach that investigates the relationship between variables over time. Applications of time series analysis include seasonally adjusted forecasts for unemployment, gasoline prices, etc. Time series analysis relies on access to extensive historical data and regression analysis to identify patterns and trends that forecast future performance.

Although this approach would have a good possibility of identifying optimal funding and time inputs for human service programs, it has important limitations. This

approach is not an attractive option due to the expense and length of time needed to conduct such studies. Additionally, the heterogeneity of human services themselves presents problems. Services and practices are typically not standardized. While programs may address common problems such as homelessness or poverty, the services and programming provided vary vastly from one organization to another. Time series studies can determine forecast performance, but in the absence of extensive historical data, the value of their findings for ongoing management can greatly diminish.

**Method 3: Structural equation modeling.** Mathematical approaches also offer a mechanism to support project management. Regression models can be applied to make predictions about future performance of identified variables and to identify statistical relationships between variables (coefficients). The findings from the regression models can lead the researcher to inferences that suggest trends (Field, 2005, p. 158). For example, if a business wanted to sell more widgets, it could conduct a multiple regression analysis on radio advertising versus "door-to-door" demonstrations and sales of widgets. The results might suggest a strong relationship between advertising and sales and a weak relationship between door-to-door demonstrations and sales. The rational inference for the widget company would be to spend more money on radio advertising and less on door-to-door demonstrations. Using this method, the manager of widgets could forecast an increase in sales and make appropriate adjustments to increase production. While this is a practical method to project future business events, this approach also has several limitations. First, the expertise necessary to conduct multiple regression analysis and interpret the regression coefficients is not readily available in human service

organizations; obtaining the capacity to conduct this type of study is cost prohibitive in most cases (Wood, 2010). The regression method suggests the strength of relationships between variables, but it does not directly get to the desired range of a forecasted optimal funding range. A similar statistical approach to forecast future economic states is to measure covariance in structural equation modeling.

Structural equation modeling (SEM) is a multivariate method allowing the evaluation of a series of simultaneous hypotheses about the impacts of latent and observed variables on other variables, while taking measurement errors into account (Bacon, 1997). The basic statistic in SEM is covariance. SEM employs regression and factor analysis to determine the relationship between variables. Forecasting is accomplished with hypothesis testing (Andedokun, 2011). Model development makes use of path diagrams and algorithms, such as those in Figure 4.1. The objective of SEM is to identify patterns of covariance (the measure of the strength of the correlation between two random variables) and explain as much of the variance (i.e., error) as possible.
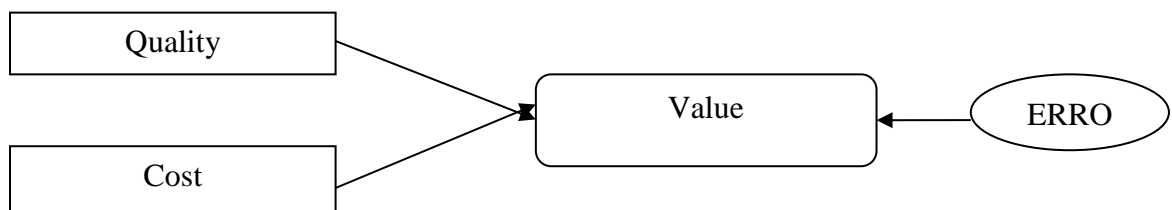


Source: (Adedokun, 2011)

*Figure 4.1.* Example of an SEM perceived value model.

An example of an SEM equation appears as follows:

$$Value = quality + cost + error$$

SEM has been used for economic and demographic forecasts, including population age/gender/ethnicity, income, and employment (Bollen, 1989). Major applications in project management include optimal scale of operations, least cost analysis, inventory control, labor assignment, and least time studies (Bacon, 1997).

As a statistical approach, SEM has several advantages to human service applications. SEM provides researchers with a method to deal with latent variables (Bollen, 1989). These latent variables are common in human services, challenging to measure, and can present a challenge to quantitative methods. Examples of latent variables from the field of economics, which can influence models, include quality of life, business confidence, morale, happiness, and conservatism. SEM allows latent variables in quantitative analysis while taking into account the variability they present (Bacon, 1997). Secondly, SEM accounts for low levels of reliability in latent variables by identifying the impact that a change in the variable has on the model; changes in human attitudes and behavior can be modeled statistically and adjusted (Bollen, 1989). Finally, a statistical advantage of SEM is its capacity to address multi-collinearity, which often occurs in human service studies (Bacon, 1997). In models with multiple variables, collinearity can increase the probability of making a Type II error, causing the finding of no significant relationship between variables when one actually exists (Field, 2005). While SEM presents some strengths, there are barriers to its application in project forecasting for human services.

The limitations of SEM reduce its attractiveness as a human service forecasting approach. First, the SEM statistical model is based on fixed, known parameters that are

not always known (if they exist at all) for human phenomena. As with regression coefficients, covariance is a statistical method that is not widely understood in the human services. Finally, SEM does not directly get to the goal of identifying predicted optimal funding ranges. SEM represents a valuable method for understanding covariation in the relationship of variables that assist in projecting project performance; however, its limitations prevent it from being the preferred option for this study.

**Method 4: An interdisciplinary innovation.** Interdisciplinary science has the potential to extract methods from several areas to identify new knowledge that can address human service project performance forecasts. Interdisciplinary methods are appropriate when problems involve complex human phenomena, occur at the intersection of several disciplines, and single discipline methods have not identified satisfactory solutions (Repko, 2008). Forecasting human service project performance for program management meets these criteria. Problems such as poverty are complex human phenomena. Multiple single disciplines can and should make contributions to human service projects. Finally, no one discipline has been able to definitely address the problem.

Relevant methodology for this investigation can be found in the disciplines of health economics, management science/predictive analytics, and epidemiology. Health economics contributes methods for value estimation. Cost utility, cost effectiveness, and cost benefit methods provide essential sources of data and analysis that can support the construction of predictive models. Predictive analytics is a management science discipline that contributes methods for creating predictive models including risk

management and earned value management. Predictive analytics also contributes a critical statistical method for reducing uncertainty in models through Monte Carlo simulations. Finally, epidemiology contributes exposure–response models. The theory and methods for exposure–response predictive models are similar to expected impacts of human service programs. While literature from epidemiology commonly uses exposure–response to measure harmful circumstances, exposure to human service programs is expected to yield a positive response. Exposure–response models can predict thresholds for initial response, half maximum dosages, and response reduction.

The objective of this study is to identify a method for projecting human service project performance in a way that can translate to managers and be utilized to improve outcomes. An interdisciplinary approach drawing from these three disciplines is the preferred strategy to attain this objective. A brief investigation of the literature from these disciplines will explore the advantages they have for conducting human service project management.

**Literature Review: Methodology Contributions of the Disciplines to the Study**

A review of the literature suggests that options for projecting optimal funding levels can be found in the science of project management using predictive analytics. Project management employs a variety of statistical and non-statistical tools to manage projects (Alshibani & Moselhi, 2012). Project management is widely used in engineering, the Department of Defense, NASA, and the CDC (Czarnigowska, 2011). The science of project management is based on statistical probability determined through predictive analytic methods. In recent years, project management has made important progress in

identifying optimal input levels for desired results (Alshibani & Moselhi, 2012). This progress and the adoption of these methodologically complex approaches have been advanced due to the rapid increase in desktop computing power and software packages that simplify the process of modeling. The potential application of this approach may have the empirical rigor and accessibility to be an innovative solution for identification of optimal funding levels in human services.

This project management approach uses predictive analytics for forecasting. Forecasting for project performance is an intuitive idea. Project managers want to know at what point (or range of points) the "biggest bang for the buck" is observed. The basic model used in project management forecasting contains several common elements. First, models most commonly use three key variables: time, cost, and outcome. Time refers to the cumulative time spent on the project. Cost is the cumulative monetary input, and outcome is the percentage of the measured outcome attained. The outcome variable can be calculated as a ratio of work completed to work not completed or may be measured as a quantitative latent variable. Two predictive analytics methods are used by project management to measure project performance and project future costs, time, and outcomes: earned value management (EVM) and risk management (RM) (Hillson, 2004). The approaches have some important similarities and differences.

Both EVM and RM use a stochastic S-curve differently (Naeini & Heravi, 2011). The S-curve is used in project management as quantity of input (usually monetary input) over the projected time of the project; this provides project managers with a tool to chart the real-time expenditure of resources. These resources might be the cumulative cost of

the project, the number of man-hours required at any given stage in the project, the

expenditure of raw materials for construction or assembly, etc. As Figure 4.2

demonstrates, EVM is an approach that gives access to managers to make data-based

decisions based on actual project performance.
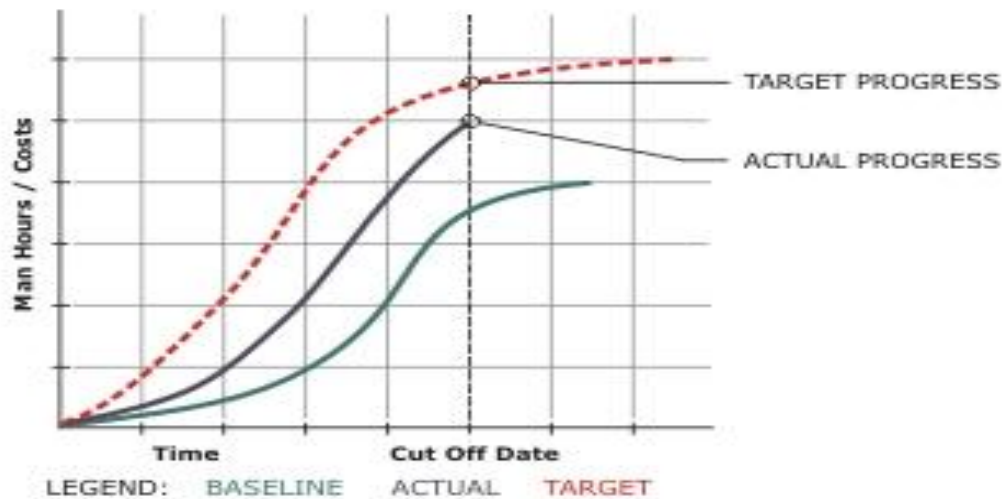


*Figure 4.2.* Example of an EVM S-curve. (Hillson, 2004)

EVM represents a potentially valuable tool to human service program

management. EVM is a valuable tool to monitor projects' past and present performance

based on quantitative empirical metrics (Czarnigowski, 2011). This information is vital to

funders, stakeholders, and managers of human service programs. EVM has the additional

capacity to extrapolate short-term future performance based on past and present

conditions (Association for Project Management, 2008). This forecasting capacity is

limited by the fact that extrapolation is tied closely to past performance. The amount of

error in the EVM model grows exponentially as the forecast is lengthened (Hillson,

2004). This limited forecasting capacity and the necessity of existing data reduce the value of this approach for identifying optimal funding ranges for human service projects.

An alternative predictive analytics use of the stochastic S-curve found in the literature is to indicate a cumulative likelihood distribution. Risk management (RM) makes use of this function (Gardoni, Reinschmidt, & Kumar, 2007). Project managers use RM to determine the possible future dangers of under- or overspending. RM is especially appropriate in situations where projections are made that contain high levels of uncertainty in the model (Naeini & Heravi, 2011). For example, making the decision to invest opportunity costs (time and energy) in furthering education could be modeled with an RM approach. If too little is invested in education, an individual's professional outcomes should be low. This is found in the lower tail of the S-curve and could represent the attainment of a low level of educational achievement. Investing increasing amounts in education shows significant gains as an individual attains advanced degrees such as bachelor's, master's and doctoral education. However, the curve flattens dramatically as more investment is made. This represents the diminishing marginal returns that would occur from getting additional degrees, such as a second, third, or fourth doctoral degree. Cumulative likelihood distributions describe probabilistic returns on investments and support management decision making to optimize those returns at given levels of investment.

The literature also reveals that an especially attractive feature of the predictive analytics approach is the fact that managing uncertainty in the models can be accomplished with simulations. Monte Carlo simulations use statistical sampling to

approximate solutions to quantitative problems (Kwak & Ingall, 2007). Monte Carlo

simulations are valuable due to their capacity to reduce uncertainty in model parameters

(Bilke, Beutels, Brisson, & Jit, 2011). To conduct a Monte Carlo simulation, the

researcher develops a model with quantifiable variables. These variables have a mean and

standard deviation for a range of possible values that can be represented by a probability

distribution function. Monte Carlo simulation performs risk analysis by building models

of possible results by substituting this probability distribution for any factor that has

inherent uncertainty. It then calculates results, each time using a different set of random

values from the probability functions. Depending upon the number of uncertainties and

the ranges specified for them, a Monte Carlo simulation could involve thousands or tens

of thousands of recalculations before it is complete. The resulting product of the

simulation produces distributions of possible outcome values. By using probability

distributions, variables can have different probabilities of different outcomes occurring.

Probability distributions are a way of describing uncertainty in variables.

In a Monte Carlo simulation, values are sampled at random from the input

probability distributions (Kwak & Ingall, 2007). Each set of samples is called iteration.

Monte Carlo simulation does this many times, and the result is a probability distribution

of possible outcomes. In this way, Monte Carlo simulation provides a much more

comprehensive view of what may happen. The simulation provides information about not

only what could happen, but how likely it is to happen, as in Figure 4.3.

Cumulative Probability Distribution Stochastic S-Curve (Single Variable)



Source: http://www.gummy-stuff.org/latin-hypercube.htm
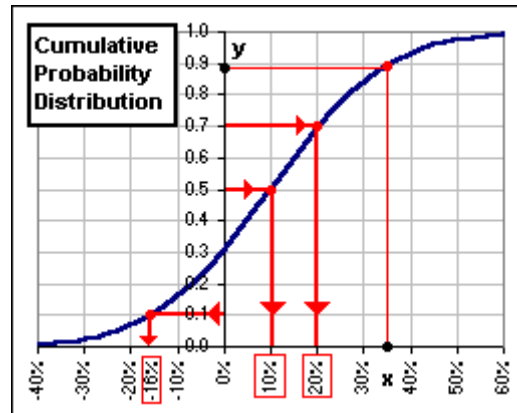
*Figure 4.3.* Results from a Monte Carlo simulation.

The literature suggests that Monte Carlo simulation provides a number of advantages over deterministic, or "single-point estimate," statistical analysis (Risk Assessment Forum, 1997):

- Results show what could happen, and the probability of each outcome.

- Monte Carlo simulation generates graphs of different outcomes and their chances of occurrence. This is important for easily communicating findings to project managers' stakeholders.

- A sensitivity analysis is useful when sample sizes are small; Monte Carlo simulations include this analysis in order to measure the largest effect on results.

- Scenario analysis: In deterministic models, it is very difficult to model different combinations of values for different inputs to see the effects of truly different scenarios. Using Monte Carlo simulation, analysts can see exactly

which inputs had which values together when certain outcomes occurred. This is invaluable for pursuing further analysis.

- In Monte Carlo simulation, it is possible to model interdependent relationships between input variables. It is important for accuracy to represent how, in reality, when some factors go up, others go up or down.

An enhancement to Monte Carlo simulation in the literature is the use of Latin hypercube sampling, which samples more accurately from the entire range of distribution functions. While simple random sampling can be effective, stratified sampling methods such as Latin hypercube sampling have been shown to reduce the impact of outliers on the model, especially when multiple variables are included (Mooney, 1997).

The primary limitation of the Monte Carlo simulations discussed in the literature is that the accuracy of the forecast of future performance is based on the quality of the data for the model (Kwak & Ingall, 2007). Human service programs may be especially vulnerable to complex confounding interactions. This makes the need for high quality data imperative. Conducting an empirical study of costs, duration, and effects from a program will provide high quality data on which to build the simulation model. Data from the literature (Chapter III in the dissertation) will be used to build the model and establish the parameters for the simulations distribution.

While the literature from predictive analytics suggests its applicability to human service project management, this suggestion is strengthened by a review of literature in epidemiology. Exposure or dose response (DR) relationship models are often employed in epidemiology (Greenland, 1995). The DR model is applicable in conditions of

exposure risk and uncertainty (Holcomb et al., 1999). Epidemiology, toxicology,

pharmaceutical science, food safety science, environmental sciences, and other health-

related disciplines are often concerned with the relationship between exposures to a

condition over time (see Figure 4.4). Low levels of dose or exposure are inconsequential.

High levels may be harmful or fatal.
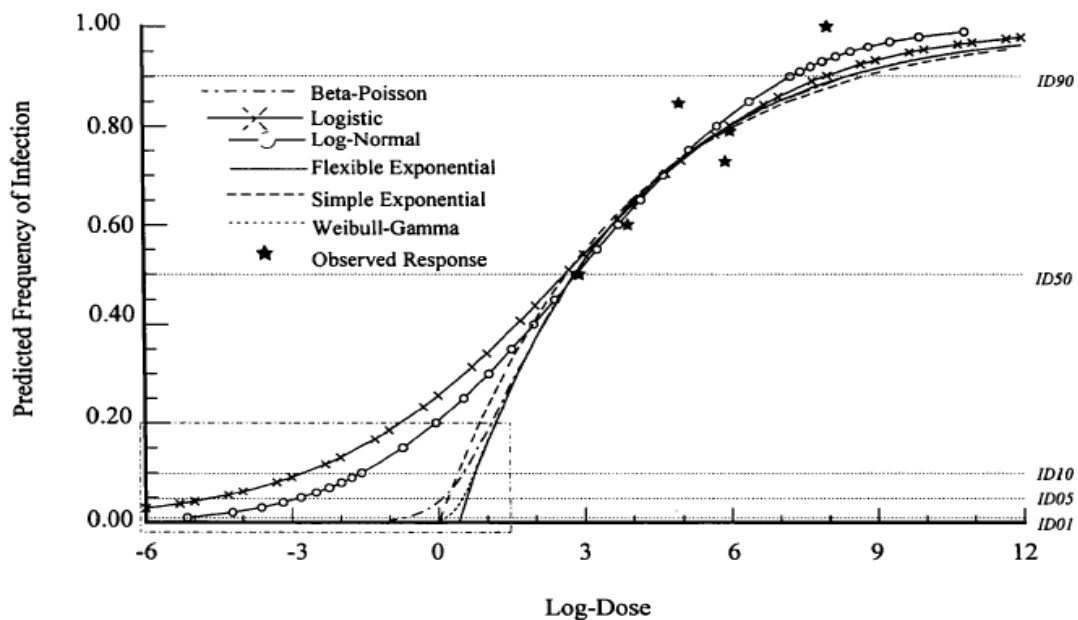


*Figure 4.4.* Example of dose response models for food borne pathogens. (Holcomb et al.,
        1999)

**Literature Review: Specific Studies**

An example of the application of simulation is found in the Thomas Hornbeck

(2011) study, *On Hand Hygiene Compliance and Diminishing Marginal Returns: An*

*Empirically-Driven Agent-Based Simulation Study.* The author observed that failure of

healthcare workers to wash their hands is a leading cause of healthcare associated

infections. Rates of hand washing were below 50% in some settings. Simulations

identified an optimal compliance rate. Findings of the study suggest that there was great

benefit to inputs that increased compliance at low compliance levels. However, those

benefits decreased rapidly as compliance levels increased.

Martin Meltzer's (2001) study, "The Economics of Vaccinating Restaurant

Workers Against Hepatitis A," used Monte Carlo simulation models from the funder

(restaurant owner) and societal perspectives to determine the cost benefit of a vaccination

program. Monte Carlo simulation models were selected for the study due to the absence

of data from observational studies. Based on net present value, the findings suggest that

vaccination programs from either perspective are not economical.

*Monte Carlo Simulation: Quantitative Applications in the Social Sciences*

(Mooney, 1997) discusses applications and methods for Monte Carlo simulations in

social science research that is closely related to human services. Much of this source is

out of date due to the substantial improvements in desktop computing power and the

appearance of new software packages. The work is valuable for its discussion of

applications in social science research. The author stated,

> Monte Carlo simulation offers an alternative to analytical mathematics for
> understanding a statistic's sampling distribution and evaluation of its behavior in
> random samples. Monte Carlo Simulation does this empirically using random
> samples from known populations of simulated data to track the statistic's
> behavior. . . . Because it is usually impractical for social scientists to sample
> actual data multiple times, we use generated data that resemble the real thing in
> relevant ways. (Mooney, 1997, p. 2)

Carl Phillips' (2001) study, "The Economics of 'More Research Is Needed,'" uses

economics and decision theory concepts to calculate the possible payoff from applied

health research. The study methodology used a parameter-based probability distribution model for Monte Carlo simulations. Findings from the study suggest an approach to measure the probabilistic value of future research and assess whether or not it is warranted. When very little is known, almost any research has value; however, the common assertion that "more research is necessary" may lead to high cost, low value products as a body of knowledge grows.

Andrew Quanback's (2010) study, "A Cost Benefit Analysis of Wisconsin's Screening, Brief Intervention, and Referral to Treatment Program**,"** developed a Monte Carlo simulation model to estimate the costs and benefits to employers of a screening and treatment program for problem drinking. The net present value of employer-funded screening and treatment was evaluated in comparison to the cost to the employer of problem drinking without the program. Findings from the simulation estimated that the net present value of the program was $771 for each employee who participated in the program. The findings supported a health policy recommending the adoption of the program by employers across Wisconsin.

In 2011, the Centers for Disease Control updated its data on the number and type of food-borne illnesses in the U.S. These new data made previous cost models obsolete. Robert Scharff's (2011) "Economic Burden from Health Losses Due to Food Borne Illness in the United States" used the new data and enhanced methodology to estimate the cost of food-borne illness using Monte Carlo simulations (@Risk version 5.5). The Monte Carlo simulations accounted for uncertainty in the model and allowed for

revisions in the estimated costs of food-borne illness to $1,068 per case or $77.7 billion in aggregate.

The risk management, dose response curve is an attractive model for human service project management. The model is a straightforward relationship between two variables. The model has an intuitive appeal to practitioners and managers who commonly see a pattern of low-level initial results followed by significant gains and, eventually, diminishing marginal returns as service recipients maximize benefits from services. The S-curve model resonates with a wide variety of professional human service managers who have life experiences that can relate to this pattern. Finally, the S-curve demonstrates a model that the relationship of investment in human services to outcome is not linear (Bugalla, 2012). Low levels of investment do not make much of an impact and therefore have little value. However, increasing investments once the point of diminishing marginal returns is reached is also a poor choice. While S-curve models are attractive, any model reflecting human behavior is challenged by potentially high levels of uncertainty.

## Methods

The need for human service project management that avoids the retrospective limitations of commonly used outcome approaches may be met by utilizing predictive methods. Predictive analytics takes information from a variety of available sources, constructs a model of expected program performance, and uses statistical analysis and simulations to improve the model. While all models and predictive activities have some uncertainty, the nature of human service programs presents a challenge in terms of high

levels of uncertainty. Predictive models that involve human behavior are especially

subject to high levels of uncertainty. This makes probabilistic models the preferred

method for human service project management. Probabilistic models generally include

upper, lower, and most likely scenarios for performance. These methods have the

objective of providing human service projects with a predicted model of expected

performance that can be used by managers to make data-driven decisions that increase

the efficiency and effectiveness of services targeted toward vulnerable populations.

The procedure for conducting the predictive analytic process is presented

graphically in Figure 4.5. Specific steps followed in this study include:

1.  Background research is conducted including a literature review, soliciting

    expert opinion, and data mining from the health economic cost utility study of

    Youth Transitions program for juvenile delinquents.

2.  Assumptions and parameters are identified.

3.  A predictive analytic preliminary model is then developed using estimated

    values for a dose response relationship between variables.

4.  The relationship of the variables is investigated using regression analysis.

5.  Monte Carlo simulations are conducted to reduce the uncertainty in the model.

6.  The revised models suggest best, worst, and most likely forecasts for project

    performance.
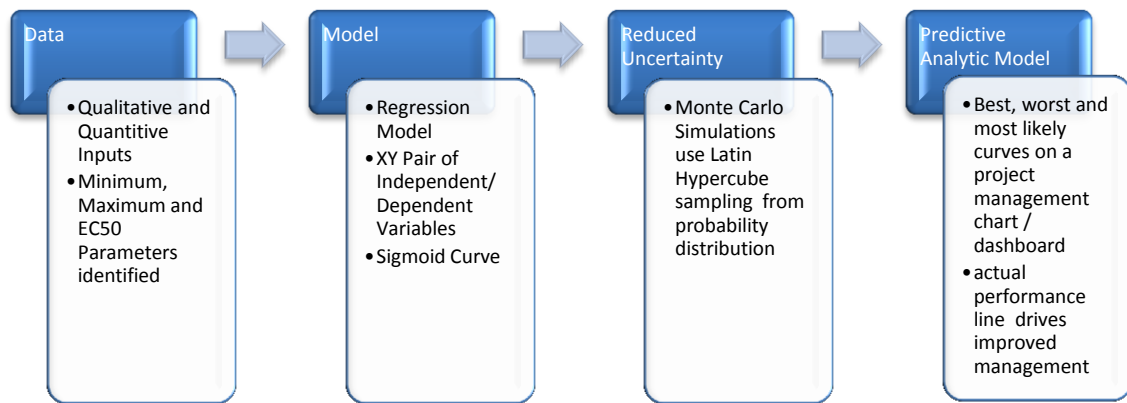
*Figure 4.5.* Study process summary.

The data mining for the Youth Transitions (YT) program model was gathered

from several sources. A cost utility study conducted on the YT program measured

variables of cost, time, units of service, public safety, and community functionality for a

sample of delinquent youth in Muskegon County, Michigan. The findings of this study

identified an average cost utility for the program. These data were used to set the central

parameter for the model. This parameter is known in dose response models as the $EC_{50}$.

The $EC_{50}$ is defined as the half maximal effective concentration. In epidemiology, the

$EC_{50}$ refers to the concentration of a drug, antibody, or toxicant that induces a response

halfway between the baseline and maximum after a specified exposure time. The YT

average cost utility served as the $EC_{50}$ parameter for the model. The YT data also served

as a basis for establishing parameters for length of service delivery (i.e., dose) and

expected outcome trends over time. Literature review of research on treatment effects for

high risk juvenile offenders similar to the population served by YT indicates that a 200-

hour service delivery threshold should be provided before treatment effects should be expected (Lipsey, Wilson, & Cothern, 2000). These data were used to estimate the lower tail parameters. Unfortunately, no similar study is available to inform the expected maximum benefit threshold. This parameter was estimated based on data from the YT study and input from court and YT staff with expertise working with the population. Five parameters—starting cost utility, lower tail threshold, $EC_{50}$, upper tail threshold, and final cost utility—were estimated and served as the dependent variables. Units of service, which is analogous to project time or dose, were measured as the independent variable.

The dependent and independent variables were analyzed using regression. Regression was conducted using Sigmaplot 12 software. The results of the regression analysis were used to provide statistical descriptions of the relationship between the variables. Sigmaplot software was then utilized to fit a 4-parameter sigmoid curve to the data that were calculated as a cumulative probability distribution. Cumulative probability is a measure of the proportion of a population with a value less than $x$ and the probability of having a value less than $x$.

The formula for a 4-parameter logistic equation is:

$$y = min + \frac{max - min}{1 + \left(\frac{x}{EC50}\right)^{-Hillslope}}$$

Where:

min = the minimum value of $y$

max = the maximum value of $y$

$EC_{50}$ = Log $EC_{50}$ value

Hillslope = the slope of the curve at its midpoint. Large values result in a steep curve, whereas small values result in a shallow curve. The 4-parameter logistic curve will increase with $x$ if the Hillslope is positive and decrease if it is negative.

This distribution curve served as the baseline model for the study. The YT data and baseline probability distribution were used to estimate upper and lower limits for expected performance. A range chart was produced based on 95% confidence intervals mined from the YT MOVE study variables.

Assumptions in the creation of the model include the following:

- A exposure/dose response relationship exists between the variables.

- This relationship between variables is best represented in a nonlinear model.

- A 4-parameter sigmoid (S-curve) model is the most accurate representation of the predictive relationship between variables.

Following the estimation of upper and lower limits for the distribution's parameter, Monte Carlo simulations were conducted for the purpose of removing uncertainty from the model. Oracle Crystal Ball software was utilized to conduct 1,000 iterations of the model. Monte Carlo simulations randomly sample variables from the distribution. The sampling method used was Latin hypercube sampling. Latin hypercube sampling is a form of stratified sampling that has advantages for model improvements when compared to simple random sampling. Recognizing that the model contains strata of data that are not equally likely makes a stratified approach preferable to simple random methods. The results of Monte Carlo simulations are models of upper, lower, and most

likely project performance that have reduced uncertainty around the $EC_{50}$, standard deviation, and expected performance parameters.

These three curves can be placed on the same chart or a dashboard to translate the statistical model into understandable and meaningful information for project managers. Actual project performance data can be entered into the system as a project progresses and compared to the projections. This comparison can drive management decisions to manage the project to the desired cost utility value.

## Results

The base model was constructed around four parameters. The core model parameter was identified by applying the average cost utility from the Youth Transitions study as the $EC_{50}$ value of 7267. Literature from the field and a review of the Youth Transitions data suggested remaining response parameters for the initial base model specified in Table 4.1.

Table 4.1

*Base Model Parameters*

| Units of Service | Average Expected Cost Utility |
|---|---|
| 1.0000 | 6267.0000 |
| 50.0000 | 6367.0000 |
| 100.0000 ($EC_{50}$) | 7267.0000 |
| 150.0000 | 8100.0000 |
| 200.0000 | 8267.0000 |

A regression analysis was conducted to better understand the relationship between

the independent variable units of service (i.e., exposure or dose), and the dependent

variable average cost utility (Tables 4.2 and 4.3). $R$ and $R^2$ values close to 1 suggest that

the model is a good representation of the relationship between the variables.

Table 4.2

*Regression Results*

| Variables | Coefficient | $R$ | $R^2$ | Std. Error | $t$ | $p$ |
|---|---|---|---|---|---|---|
| Average Cost Utility | 5533.7 | 0.97 | 0.94 | 281.57 | 19.65 | .001 |
| Units of Service | 573.3 | 0.97 | 0.94 | 84.90 | 6.75 | .007 |

Table 4.3

*Analysis of Variance*

| | $df$ | SS | $F$ | $P$ |
|---|---|---|---|---|
| Regression | 1 | 3286728.9 | 45.59 | .007 |
| Residual | 3 | 216262.3 | 72087.43 | |
| Total | 4 | 3502991.2 | 875747.800 | |

*Note.* Normality Test (Shapiro-Wilk): Passed ($p = 0.938$).
Constant Variance Test: Passed ($p = 0.050$).

Sigmaplot 12.0 uses the Marquardt-Levenberg algorithm to find the parameters

that give the best fit betwseen the curve/line regression equation and the data. Line and

scatter plots were selected and a simple spline curve was created representing the best fit
to the data for the base model as shown in Figure 4.6.

**Youth Transitions Cost Utility Performance Model**
**Three Parameter Sigmoid Curve**
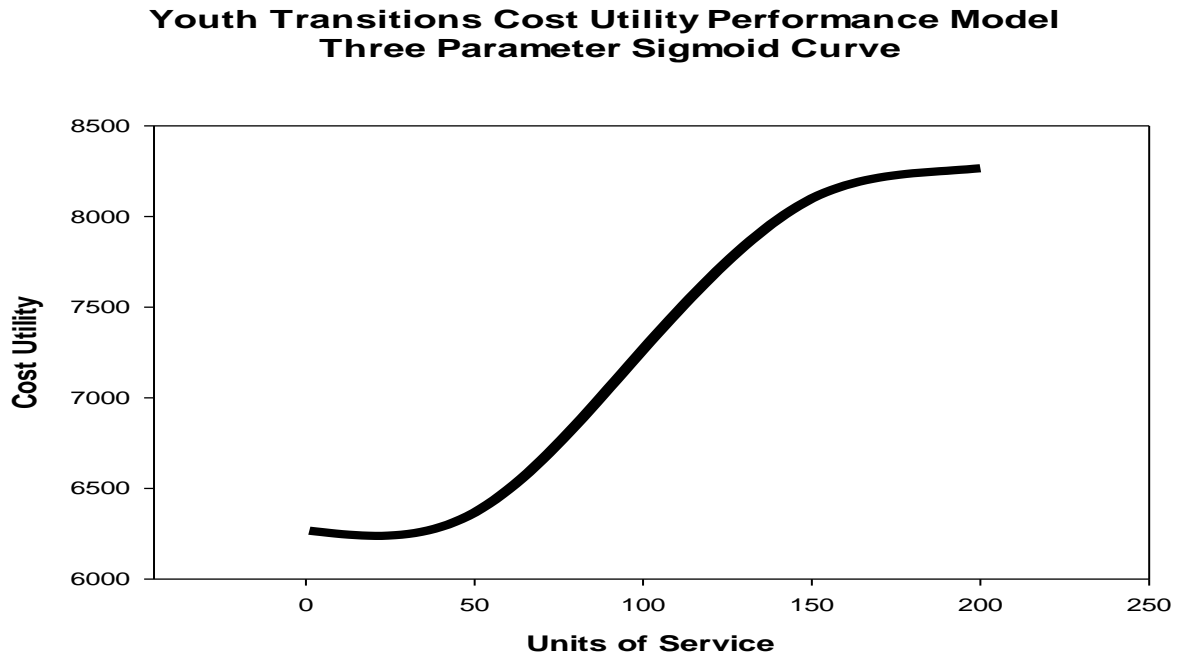


*Figure 4.6.* Base model.

Once these parameters were estimated for each case (see Table 4.4), confidence
intervals produced in the Youth Transitions study were the basis for upper and lower
range estimates for each of parameters as displayed in Figure 4.7.

Table 4.4

*Three Case Model Parameter*

| Units of Service | Most Likely Parameter Estimates | Best Case Parameter Estimates | Worst Case Parameter Estimates |
|---|---|---|---|
| 1.0000 | 6267.00 | 6467.00 | 5867.00 |
| 50.0000 | 6367.00 | 6767.00 | 5967.00 |
| 100.0000 ($EC_{50}$) | 7267.00 | 7667.00 | 7067.00 |
| 150.0000 | 8100.00 | 8500.00 | 7900.00 |
| 200.0000 | 8267.00 | 8467.00 | 8067.00 |

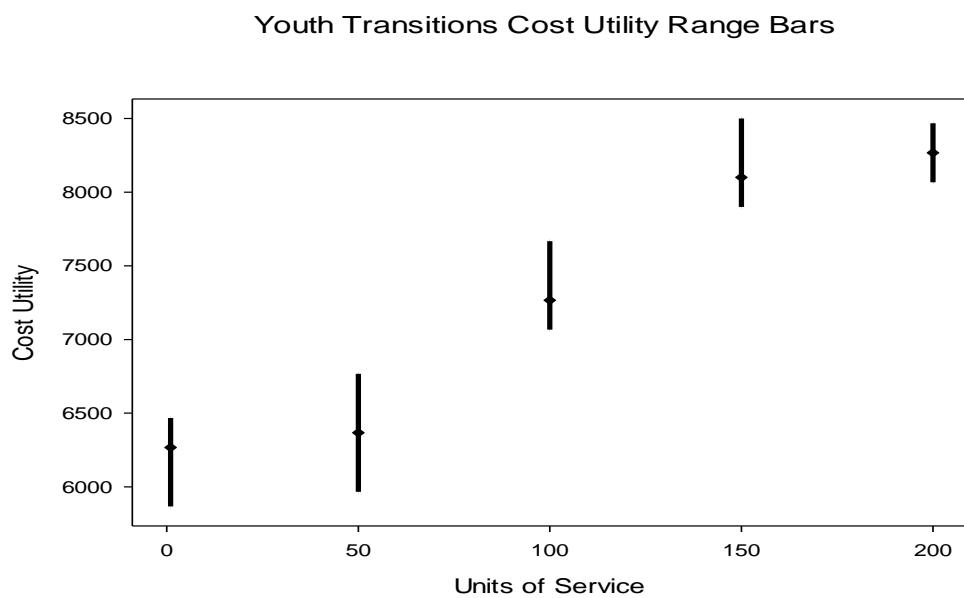Youth Transitions Cost Utility Range Bars



*Figure 4.7.* Range bars for upper and lower parameters of average cost utility.

Following the calculation of range bars, the results of the base model data table were exported to Oracle Crystal Ball software for simulations. Crystal Ball conducted 1,000 iterations (samples) of the data following the assumption of a logistic model and using Latin hypercube sampling.

A logistic distribution for the variable "units of service" (plotted on the $x$ axis) was assumed for the analysis. Logistic distributions are used to describe growth. It is a continuous probability distribution for a non-negative random variable (Figure 4.8). It is used in survival analysis as a parametric model for events such as mortality, whose rate increases initially and decreases later. The logistic distribution is the probability distribution of a random variable whose logarithm has a logistic distribution. It resembles a normal distribution but has heavier tails. Its cumulative distribution function can be written in closed form, unlike that of the log-normal. This is essential for the model due to the necessity of producing a cumulative probability distribution that is the basis for the S-curves (Figure 4.9).
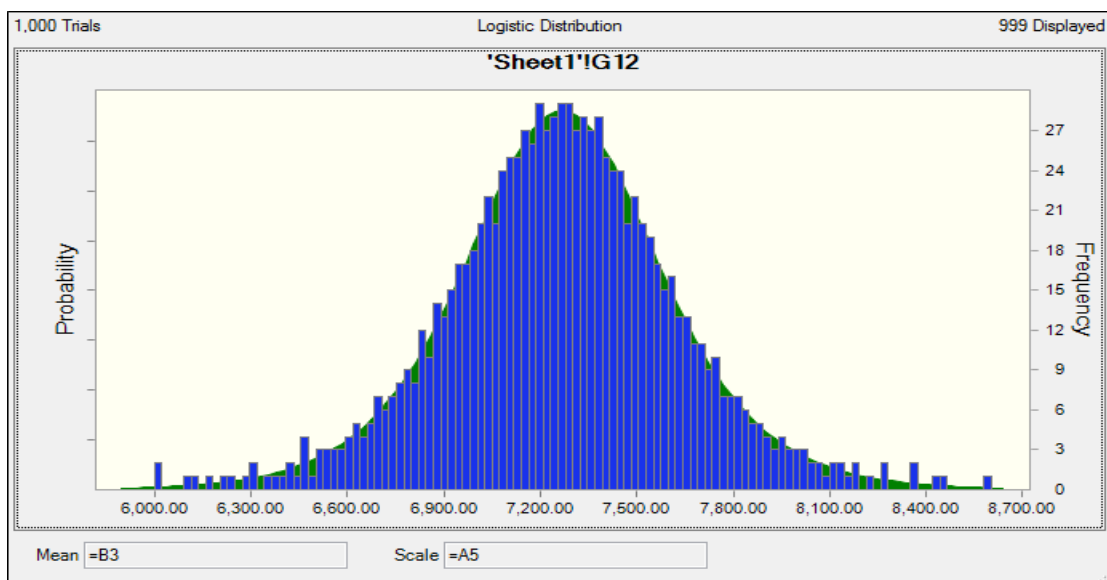
*Figure 4.8.* Logistic distribution of the data.
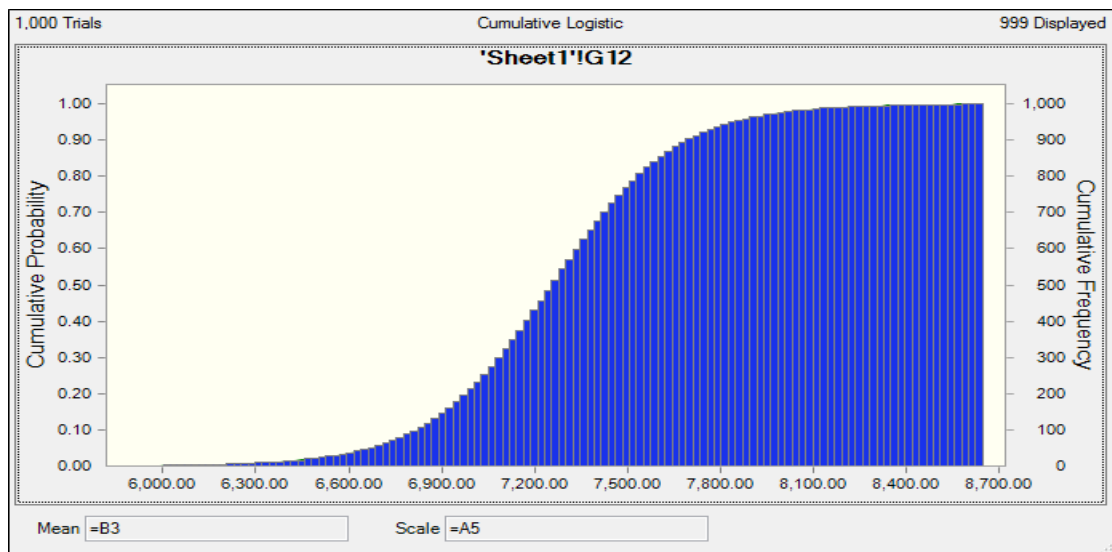
*Figure 4.9.* Cumulative probability of the data.

This method produced an important finding. Following the Monte Carlo simulations, the $EC_{50}$ value estimated in the base model as 7267.00 was more accurately identified to be 7357.85 (Figure 4.10).
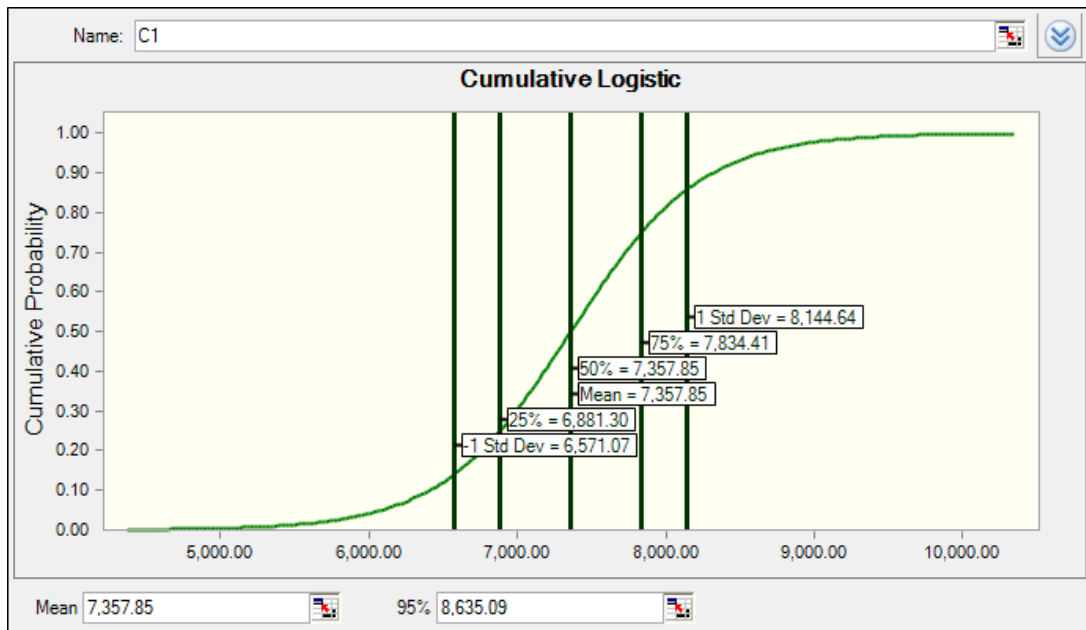


*Note.  x axis = value estimation from the Multi-Objective Value Estimation literature*

*Figure 4.10.* Monte Carlo simulation results most likely model.

The resulting most likely, best case, and worst case models produced by Crystal Ball software are demonstrated in Figures 4.10, 4.11, and 4.12. Utilizing the Monte Carlo simulations reduced uncertainty in the model and produced estimates of the parameters that are more precise and are expected to be more accurate when compared to actual project performance. The best, worst, and most likely models are also displayed in Figure 4.13 as products of Tableau 8.0 Dashboard software.
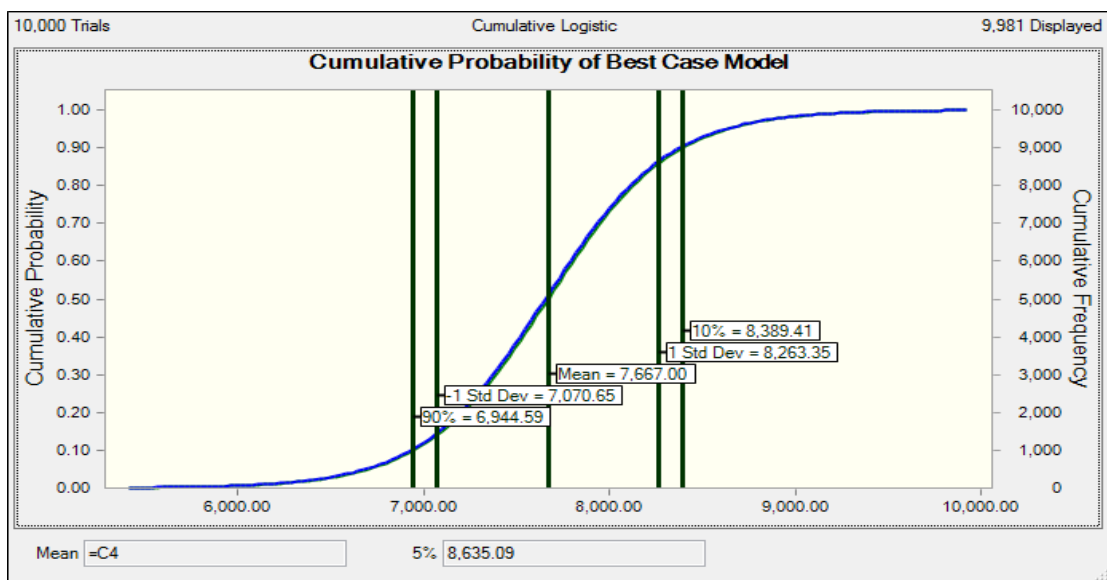
*Note.* *x axis = value estimation from the Multi-Objective Value Estimation literature*

*Figure 4.11.* Monte Carlo simulation results best case model.
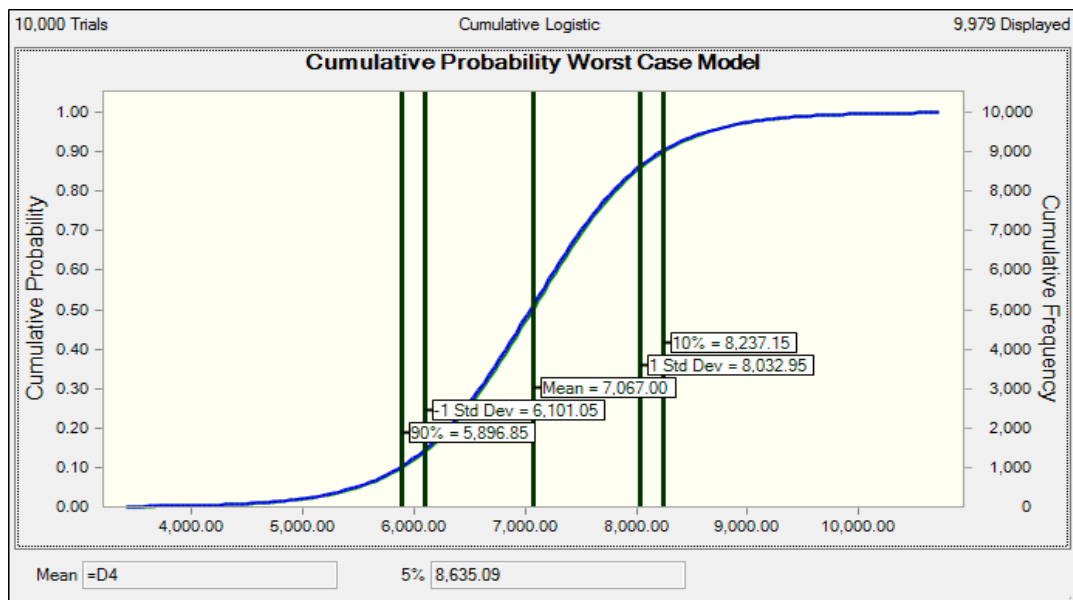


*Note.* x axis = value estimation from the Multi-Objective Value Estimation literature

*Figure 4.12.* Worst case model.

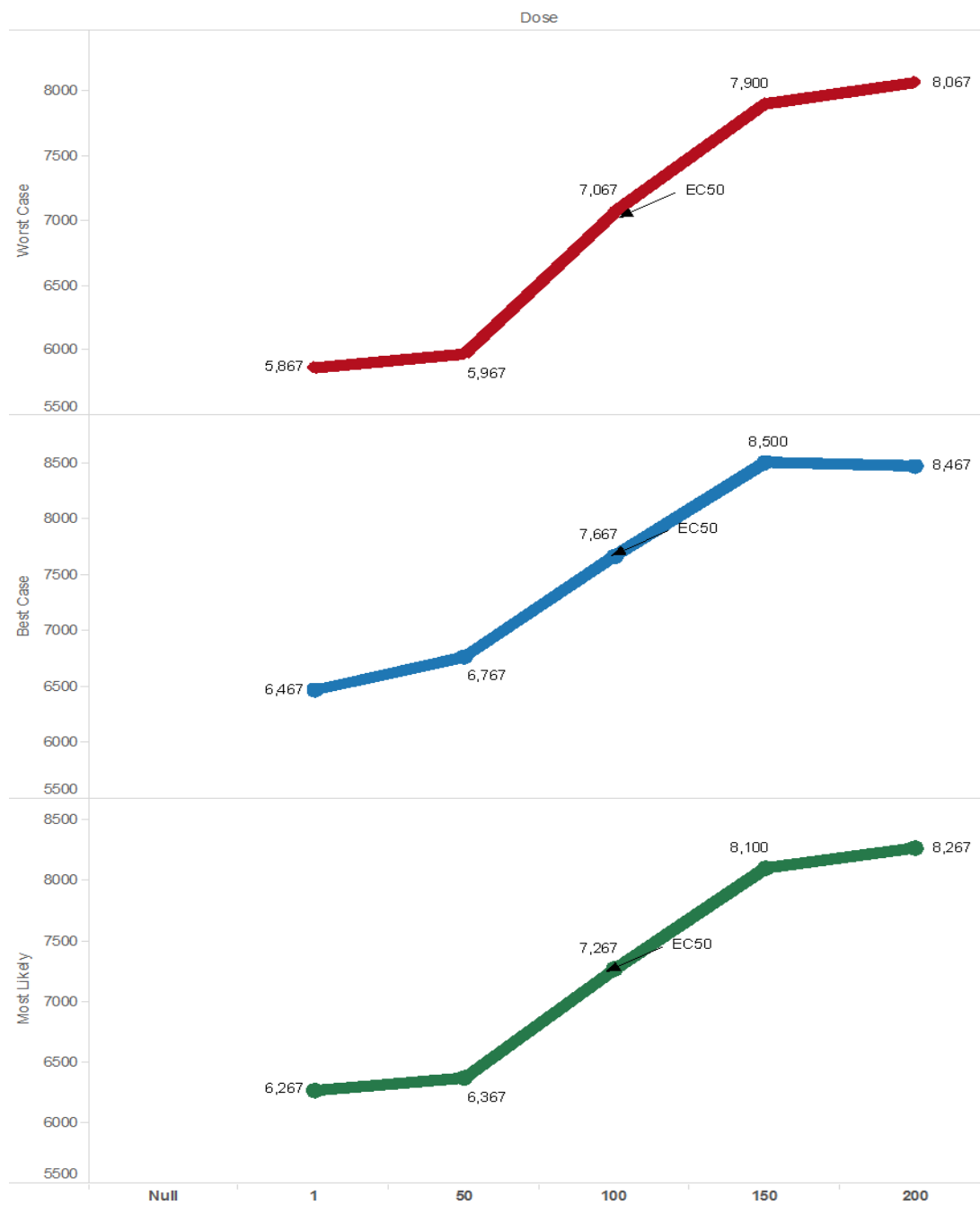*Figure 4.13.* Tableau 8.0 Dashboard screenshot.

The S-curves predicting project performance represent a tool for human service project management. Actual performance can be measured and, following data entry, can be represented as an additional line on the graph. To simplify the graph for managers not familiar with project management, it may be helpful to plot actual project performance against only the most likely curve. Project managers can then graphically see actual performance compared to predicted performance. If actual performance is above the predicted curve, performance is exceeding the prediction. If actual performance is below the predictive curve, quality improvement processes can commence to address deficiencies and make immediate changes to manage the project to the expected values.

The results of the study suggest that predictive analytics can be used to develop accurate models for human service project management. The Multi-Objective Value Estimation conducted on the Youth Transitions program provided essential empirical quantitative findings that supported the identification of a critical measure, the $EC_{50}$ value. This value formed the basis for the models and simulations that followed. This suggests an affirmative answer to the research question related to the capacity of MOVE to support predictive analytics for human service project management. Monte Carlo simulations proved an effective method to reduce uncertainty in the model and, more accurately, identified model parameters by conducting iterative Latin hypercube sampling. Finally, the refined models were translated to excel charts and dashboards that translated the findings into straightforward graphics that could be used to compare actual project cost utility (i.e., performance) to predicted performance. Without any special

expertise in statistics or research, human service managers can use this information to make adjustments and manage their service to desirable outcomes.

There are several important limitations of the study. First, predictive models are inherently inaccurate. These models do a credible job of predicting a range of probabilistic outcomes. However, these findings remain estimates. Data and information used to construct the models and make the projections may be of low quality, anecdotal, or biased. Applying the findings to actual project management should include, at least initially, oversight that questions the accuracy of the model in relation to actual program performance. A second limitation is the nature of human service projects in general. Human behavior is complex and often does not conform to statistical trends. When coupled with small samples and research design limitations, study findings are suggestive at best. Finally, regression artifact bias is an important limitation in many human service research studies. This limitation suggests that human service programs often intervene at a point where vulnerability or problematic behavior is peaking. If no intervention were provided, there is a statistical probability that the crisis might abate on its own. This presents a limitation to the inference of causality that human service projects would like to report. These limitations are important but do not diminish the potential that predictive analytics has to improve the management of human service programs.

Predictive analytics for human service project management appears to be a promising practice. Once produced, the models can be accessed by basic computer software such as Excel and Microsoft Word. Human service project managers without advanced expertise in science, accounting, and business can interpret the S-curve due to

its straightforward and intuitive characteristics. When actual project performance is

plotted on the chart, it can be compared to the best, worst, and most likely curves. Project

performance that is below the most likely curve can trigger a quality improvement

process that makes data-driven decisions to adjust programming for maximum efficiency

and effectiveness. Predictive analytic models based on cost utility measures such as

MOVE have the potential to visually report the value of projects that invest scarce

resources in projects designed to ensure the safety and quality of service delivery for

vulnerable populations.

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# CHAPTER V

## APPLYING INTERDISCIPLINARY HEALTH SCIENCE TO IMPROVE HUMAN SERVICES FOR VULNERABLE POPULATIONS

### Summary of Study Findings

This study investigated the capacity of Multi-Objective Value Estimation to support predictive analytics for human service project management. Strengths and limitations of commonly used methods for research and evaluation were reviewed using a meta-evaluation rubric. Clinical research, return on investment, and health economics all had important limitations with regard to their capacity to support human service project management. An innovative application of cost utility analysis, Multi-Objective Value Estimation (MOVE), explored the capacity for this approach to support performance management processes. While MOVE did have significant strengths when compared to alternatives, important limitations remained. Finally, the study used an interdisciplinary method to develop predictive analytic models using the MOVE data and findings. A sigmoid function or S-curve was identified as a base model and statistical methods were employed to reduce the level of uncertainty in the model. The resulting model has the capacity to address many of the limitations of traditional outcome research and may serve as a useful approach to translate research into meaningful information for human service project managers.

## Paper One Summary

Human service organizations have economic and ethical drivers to manage their programs and services with maximum efficiency and maximum effectiveness. While outcome research and evaluation has been commonly accepted as a best practice, human service organizations have not been able to integrate the findings of this research to support enhanced management practices. The research question for this paper investigated the capacity of three approaches—clinical research, social return on investment, and health economics,—to provide outcome measurement for project management. Meta-evaluation methodology investigated the three approaches. A rubric to identify and assess strengths and limitations of these approaches was developed. The findings of the study suggested that these commonly used outcome measurement and evaluation science methods do not translate well into management practices. An innovative application of a cost utility outcome measurement approach, Multi-Objective Value Estimation (MOVE), was suggested to address the limitations of existing approaches. The potential capacity of cost-utility methods to support human service project management was discussed.

## Paper Two Summary

Paper Two field tested a MOVE study of a human service program to address juvenile delinquency. Family courts typically address the challenge of juvenile delinquency with either confinement or community-based services. A growing body of evidence suggests that confinement is more costly and less effective than community-

based alternatives. Innovative community-based programs have been developed in Michigan; these programs need to be evaluated to determine their effectiveness. A secondary research question investigated the utilization of the study to support an innovative project management process. This translational study evaluated the costs and effects of such a program in Muskegon County, Michigan.  The program provides case management services at a cost to the court that is less than the cost of the confinement alternative. A retrospective secondary analysis of program records explored changes in community functionality, public safety, and direct costs of services in the community. A cost savings of $135 each day was found. An improvement in community functionality was observed as measured using the Child and Adolescent Functional Assessment Scale (CAFAS) ($t(28) = 2.2$, $p < .05$, $r = .58$). The rate of felony convictions was reduced from 10 felony convictions per 1,000 days in the 6-month period before intervention to a rate of 3 per 1,000 days during the 6 months of intervention. This improved rate was sustained during a 6-month posttest observation (4 per 1,000).

The findings of the study suggest that juvenile delinquents in Michigan can receive less costly, community-based services and improve their functionality in the community without an increased threat to public safety. These findings support policy change that creates an incentivized funding structure for effective delinquency interventions in Michigan. A strategic framework to support project management was also implemented. Data and findings from the MOVE study were used to make management decisions, but the process remained complex and retrospective.

**Paper Three Summary**

One important limitation faced by human service managers is the difficulty current commonly used outcome methods have in supporting management of programs and services. The research question for this paper investigated the capacity of an innovative cost utility method, Multi-Objective Value Estimation (MOVE), to support project management methods for human services. Findings from a MOVE study were used for parameter estimation to construct a model for predictive analytics. Monte Carlo simulations and Latin hypercube sampling methods addressed uncertainty inherent in the model of human behavior. The results are used to define a baseline stochastic S-curve and an optimal stochastic S-curve. These S-curves form the basis of a project management model. This model can be constructed and employed using techniques such as dashboarding to support human service management. The potential for these methods to improve the efficiency and effectiveness of human service organizations was discussed.

**Limitations**

There are several limitations to the study that deserve attention. Meta-evaluation methods used in Paper One are subjective and based on high quality but limited numbers of research studies in the literature. While it proved to be a useful support for the predictive analytic model, MOVE methodology remains a retrospective and complex task. Using this method to construct models will still require an investment in research that may not be feasible for some human service organizations. Small sample size in the

MOVE study limits the generalization of these findings to larger populations. Finally, any modeling of future events is based on assumptions and is subject to relatively high levels of uncertainty. There may also be some reluctance to adopt the technology and methodology due to the concern that transparency for deficient projects may result in the loss of funding. While these limitations are important, the findings of the study have significance for human service project management.

## Significance of the Findings

In recent years, economic challenges have led to a record number of individuals in poverty. This situation is acutely felt by populations with enduring vulnerably. Increasing numbers of low-income seniors and disabled consumers on fixed incomes are unable to keep up with the rapidly rising cost of living and are requesting help to meet their basic needs for food, safe shelter, transportation, and education. This increased need has been directly impacted by concurrent reductions in public funding for programs. In this challenging economic climate, the need for capacity building to ensure that health care, social, and educational programs are effective is acute. The capacity to conduct adequate evaluation of these complex and difficult-to-measure human services outcomes is challenging, even for experienced, dedicated researchers. One of the most critical needs nonprofit community-based organizations have is in the area of data collection, analysis, and research. While some improvements have occurred in the last 10 years, the overall situation remains challenging for most organizations due to the cost of research initiatives, and the general lack of capacity to conduct and understand rigorous scientific evaluations. This capacity deficit is important given that grant proposals, evaluations,

fiscal monitoring, resource allocation, and overall project planning are all dependent on accurate research and data.

The lack of focus on nonprofits' research data practice needs has real consequences. These consequences include reduced ability to perform effective advocacy, reduced potential to leverage funds from competitive opportunities, and a pervasive inability to engage in effective quality improvement initiatives. Additionally, the typical nonprofit organization faces significant financial challenges that make traditional solutions to meet this challenge impractical. Funding employed positions that do not directly generate revenue is out of the question for almost all nonprofit organizations given strict limitations on administrative overhead and costs in nonprofits' budgets. Contracting services out is also expensive and, in most cases, cost prohibitive. Addressing this problem requires innovation in thought and practice.

The move to a new outcome measurement approach requires a paradigm shift for human service organizations and the scientific efforts applied to measure their outcomes. Classical empiricism and the process of critical rationalism proposed by Karl Popper are poor fits for human services looking for methodology to manage their programs for greater efficiency and effectiveness. The alternative philosophy of science suggested by Paul Feyerabend is a more attractive foundation. In his books *Against Method* and *Science in a Free Society*, Feyerabend proposed the idea that there are no methodological rules that should always be used by scientists. He proposed that no singular scientific method is appropriate on the grounds that any such method would limit the scientific research and reduce progress in attaining new knowledge. Feyerabend

defended his position as desirable because it was more *humanitarian* than other methods, due to the fact that it did not impose rigid rules on scientists.

> For is it not possible that science as we know it today, or a "search for the truth" in the style of traditional philosophy, will create a monster? Is it not possible that an objective approach that frowns upon personal connections between the entities examined will harm people, turn them into miserable, unfriendly, self-righteous mechanisms without charm or humor? (Feyerabend, 2010, p. 154)

This philosophy is precisely relevant to the construction of predictive analytic models proposed in this dissertation. While high-quality empirical research is preferred, any valid source of information should be considered when constructing models. Feyerabend, at least in relation to predictive analytics for project management, appears to have the preferred epistemology. Classical empiricism and Poppers' falsification methods limit the knowledge available to a narrow field. This narrowness of restrictive methods prohibits the timely acquisition of knowledge and contributes to the irrelevance of science for human services. Feyerabend's innovative thinking allows for a vast array of methods and approaches to knowledge acquisition. This allows human service leaders (who are often not scientists in the classical or Popperian sense) to employ a wide variety of meaningful methods without rejecting science.

Following this paradigm shift, human service project management efforts benefit from interdisciplinary health science methods. Interdisciplinary methods are an appropriate choice for the following reasons:

- Human services outcomes are related to complex human phenomena.

- These outcomes occur at the intersection of multiple single disciplines.

- Traditional disciplinary or multi-disciplinary approaches have not been able to definitively solve the problem.

- Effective human service project management requires the production of new knowledge from integrated health science research.

Disciplines utilized in this dissertation include economics, social work, management science, and epidemiology. It is difficult to imagine a path to the results that could have been accomplished by any one of these disciplines alone. The utility of interdisciplinary health science for addressing this human service need is essential. This shift has impacted some human service organizations in significant ways.

## Application and Future Directions

TrueNorth Community Services is a nonprofit human service organization providing these services to low-income households in a 34-county region. TrueNorth is a large 501(c)(3) organization with an annual budget of over $10 million and over 140 employees. The organization's main office is in Fremont, Michigan. TrueNorth specializes in rural human service delivery. TrueNorth manages 63 separate programs that are primarily designed to ensure the safety of the vulnerable, support the transition of families out of generational poverty, and elevate the impact of crisis. In 2012, TrueNorth housing and energy initiatives served recipients 10,331 times. Food and hunger initiatives served 38,918 individuals with 80,677 meals. Youth services including mentoring, children's camp, education, and the Youth Transitions program served 16,089 children. The data trends for 2013 indicate a sharp increase in these numbers.

Recognizing the need for improvements in management operations and outcome measurement, TrueNorth began a 5-year strategic initiative to improve capacity in these essential areas. The initiative was driven by demands from funding organizations and a sincere desire to be good stewards of revenue while providing the best possible services to vulnerable recipients. The process of capacity enhancement began with improvements in data collection and management for more accurate output reporting. Initial efforts to measure outcomes included observational studies in homeless housing services and Youth Transitions. While these efforts produced valuable outcome measures, they also highlighted the need for up-to-date, "real time" outcome methods that would support project management. In 2010, the use of a new method, Multi-Objective Value Estimation, was implemented with the hope that this would better meet the needs of the organization. While the process did provide utility in measuring program outcomes in relationship to costs, the full promise of a system that supported realistic project management processes was unfulfilled.

To address this need, TrueNorth began the development of a project management system. The system is based around three essential elements: a data management and communication infrastructure backbone, predictive analytic models, and dashboards. A cloud-based Customer Relations Management (CRM) has been developed and implemented for data collection and management. Sigmaplot 12.0 and Oracle Crystal Ball were identified as data analysis tools that would allow the construction of predictive models for project performance. The most important element of the system was the use of Tableau 8.0 for dashboards. In addition to Key Performance Indicators (KPI), the

dashboards can display predictive analytic models for projected project performance. This tool is currently in the implementation phase internally across TrueNorth's services and represents an ongoing application of the research conducted for this dissertation. The system provides a feasible method to satisfy the need for empirical rigor when measuring and reporting outcomes while overcoming the barriers of retrospectivity and translatability. Once constructed, the models automatically feed actual up-to-the-minute project performance data into the project management field of the dashboard. Actual performance is then compared to the model's projected performance. The only necessary expertise for the manager is the ability to read the chart and understand that actual performance above the curve is good and performance below the curve should trigger investigation into the systems functioning and quality improvement actions. While the research presented in this dissertation has been presented primarily as a valuable method to improve organizational capacity and benefit service recipients and stakeholders, it is becoming apparent that other applications are also possible.

In addition to improving their internal operations, human service organizations need innovative methods for improving cooperative efforts and developing integrated service delivery systems. Traditionally, human service organizations interface through an inefficient process of collaboration. Collaboration typically occurs at collaborative meetings held on regular monthly or quarterly schedules. While information is shared at these collaborations, the process is slow and inefficient, with little impact on day-to-day operations as they occur in separate organizations. The capacity of cloud-based data management, predictive analytics, and dashboarding may have potential to move from

the collaborative approach to true service delivery integration. Dashboards displaying key performance indicators and predictive analytic models can easily be shared with stakeholders, funders, and other cooperative organizations to share information at the project and case level to manage services across multiple organizations. This capacity suggests a promising future direction and application of the dissertation's findings.

Several research questions remain unanswered by this study. First, the adoption of the predictive analytic models displayed on dashboards or other media needs to be investigated. Will this approach actually be used by managers in real-world settings to improve their decision-making process? If the models are utilized, the actual impact resulting from their use needs to be measured. Will the use of predictive analytic models actually improve the efficiency and effectiveness of human service programs, services, and projects? The findings of this study are promising and suggest the need for additional research in these areas.

## Summary

This dissertation has been a successful interdisciplinary investigation into improvements in the methods available for human service project management. Existing outcome methods including experimental research, social impact return on investment, and health economic approaches are useful in measuring retrospective outcomes but are limited in utility when applied to project management. Multi-Objective Value Estimation (MOVE) is an approach that can provide some supports to human service programs project management. However, this approach is still limited by retrospective measurement and complex methodology that does not translate well to project managers.

Predictive analytics, supported by MOVE findings, represents a solution for human services organizations. The construction of predictive analytic models based on data and expertise allows managers to make data-based project adjustments for improving performance in real time. The use of stochastic S-curves represents an economical, elegant, and intuitive model to translate statistically complex research findings into meaningful information for managers. Future research, measuring observed increases in organizational efficiency and effectiveness associated with predictive analytics for project management, should be conducted. Until then, MOVE, to support predictive analytics for project management, is a promising method. Most importantly, innovations for improved efficiency and effectiveness of human service projects meet the need for wise stewardship of limited resources and ensure the best possible service for vulnerable recipients.

## Reference

Feyerabend, P. (2010). *Against method* (4th ed.). New York: Verso Books.

**Appendix A**

**Using Multi-Objective Value Estimation (MOVE) for Project Management**

**Using Multi-Objective Value Estimation (MOVE) for Project Management**
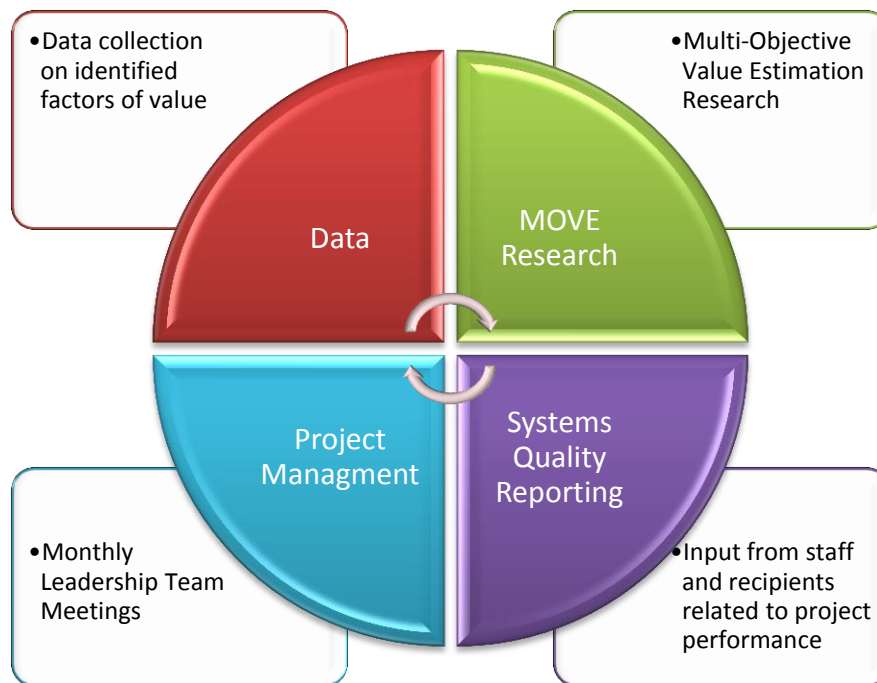
**Background**

A secondary research question for the MOVE study of Youth Transitions outcomes investigated the capacity that this approach would have to support project management through an innovative business model. At the inception of the project, a new business model was developed between the funding organization, The Muskegon County Family Court, and the service provider. This model discarded the traditional contractual program-centric approach. This traditional approach, or purchase of service agreement, directs payment from the funding organization to the service provider upon provision of the service. The focus of this model is on service provision, not outcomes. To replace this model, the court worked with the service provider to develop desired outcomes, preferences, or weights for these outcomes and an agreed-upon method for quality improvement that used the MOVE approach to support project management. Furthermore, both funder and service provider agreed that payment would be for producing outcomes, not services. Using this approach, service delivery could be both fluid and centered on the individual needs of the client. To support this innovative business model, MOVE was integrated into the services from their inception, and a quality management structure was created to manage the service for maximum cost effectiveness.

**Project Management Methods**

        A systematic quality improvement approach was developed as an alternative

method to manage the Youth Transitions program. This systematic approach contained

four key components. Data collection and management, the outcome evaluation, and a

multi-level quality improvement process were created to support project management for

efficiency and effectiveness (see figure below).

**The Youth Transitions Project Management Process**



- Data collection on identified factors of value
- Multi-Objective Value Estimation Research
- Monthly Leadership Team Meetings
- Input from staff and recipients related to project performance

Data    MOVE Research    Project Managment    Systems Quality Reporting

        Identified factors of value included cost of the service compared to institutional

alternatives, public safety, and community functionality. Staff gathered these data, which

were then analyzed in the MOVE study. Outcomes were reported in Excel spreadsheets,

charts, graphs, and written reports. Direct input from staff that provided qualitative

information was also gathered systematically through a reporting process. These inputs were reviewed monthly in face-to-face meetings between the court administration and the program manager from the service provider. Project management decisions were then made based on the data, outcome results, and staff input.

**Findings**

The results of the attempt to use MOVE to support project management led to the discovery of some important successes. The innovative business model was reported to be successful by both the court and the service provider. The client-centered approach saved the funder significant costs while protecting public safety and supporting positive outcomes for the service recipients. The quality management structure and processes were also highly successful and allowed for the fluid and effective provision of service. These successes were important findings for the community and the youth receiving service.

The investigation of the MOVE approach as a superior method for supporting project management led to the discovery of several important limitations. First, the statistical findings of the research were not inherently more translatable than competing approaches. MOVE did have the advantage of engaging the stakeholders in the study as a participant from the beginning of the effort. Funders and service providers were, therefore, more informed of the variables, their measures, weights, and the process of study. However, accurate reporting of the study results remained a complex task that did not translate easily to project managers. A second limitation discovered was that conducting the rapid iterations of the research necessary to provide timely information for

project management was difficult. The quality improvement process occurred on a

monthly cycle. To meet the needs of the process with up-to-date outcome measures

required conducting the monthly repetition of the study. While this was possible in the

short term, the cost of the labor-intensive process when applied on a larger scale is high.

Finally, even with updated data and outcomes, the information remained retrospective.

While looking at the past performance was helpful and superior to traditional

management processes, the MOVE approach remained limited by this characteristic.

**Discussion and Future Directions**

The findings from this study provide several opportunities for future research and

development. The MOVE study and its accompanying project management processes

produced important successes that can form the basis for advancement in future

innovation. An effective business model and an improved (but still limited) method for

the utilization of evaluation outcomes to manage human service programs were key

findings. However, innovation is still needed to address the following:

- A tool or mechanism to translate outcome results into meaningful
  management information needs to be developed.

- A methodology for efficiently projecting future program performance needs to
  be investigated to overcome the barrier of retrospective information.

To meet these needs, future investigation could explore the application of business

intelligence methods for project management. The field of predictive analytics provides a

promising solution that has been successful in for-profit business and government

organizations but has not been explored as a possible project management solution for

human service organizations. Predictive analytics requires the development of a model that forecasts project performance. The MOVE study findings could form the basis for this predictive model. Actual program performance could then be compared to the predicted performance, and this information could be used by project managers. Finding a solution that builds on the successes and addresses the limitations of this study will make better use of limited resources and provide the best possible service to vulnerable populations that are recipients of those services.

**Appendix B**

**Human Subjects Institutional Review Board**
**Letter of Approval**

# WESTERN MICHIGAN UNIVERSITY

Date: February 7, 2013

To: Kieran Fogarty, Principal Investigator
David Wingard, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair *Amy Naugle*

Re: HSIRB Project Number 13-02-16

This letter will serve as confirmation that your research project titled "A Secondary Analysis of Multi-Objective Value Estimation Data to Support Predictive Analytics for Human Service Project Management" has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., *you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study*)." Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

**Reapproval of the project is required if it extends beyond the termination date stated below.**

The Board wishes you success in the pursuit of your research goals.

**Approval Termination:     February 7, 2014**