"Saving Lives" is Priceless: Pinpointing ROI for Medical Training

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ABSTRACT

The Department of Defense (DoD) Medical Modeling and Simulation (MMS) acquisition and training communities are challenged in showing a return on investment (ROI) for training. In a for-profit world, investments in training may result in increased productivity or improved quality but tying these advances directly to the use of MMS training in the DoD is difficult at best. In the DoD, where military readiness and cost reduction replace profit as the driving objective, training may increase readiness in exchange for increased cost. In the realm of medical training, increases in training generally save lives and improve patient outcomes. In for-profit medical care, it may be possible to show how improvements made through training resulted in monetary benefits, such as increased profitability. However, in DoD healthcare it is preferable to show how improved training resulted in non-monetary benefits, such as improved patient outcomes. This paper considers the non-monetary benefits of training by exploring how improvements in patient outcomes can be measured and used to calculate ROI for MMS.

Drawing from traditional ROI calculations and alternative ROI models, this paper quantifies ROI for MMS within the Defense Health Agency (DHA) using real-life scenarios and outcomes from the medical training community. We explore the challenges of pulling historical benefit data and provide recommendations for gathering benefits and measuring changes over time based on real medical training experiences.

ABOUT THE AUTHORS

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INTRODUCTION

Program Manager for Medical Simulation and Training (PM MST), a part of Defense Health Agency (DHA), supports the acquisition of simulation for training military medical activities across all services. A significant challenge within the Department of Defense (DoD) and DHA, which PM MST is attempting to mitigate, is the justification and defense of investments into medical simulation training. Some significant contributors to this challenge are the increasing costs of healthcare, budget priorities, the resources required to conduct simulation, and the competing priorities for healthcare provider time. To address this issue, MITRE and PM MST have collaborated to develop a return on investment (ROI) tool with the potential to justify investment into modeling and simulation (M&S) products for medical training.

To effectively justify investment into medical modeling and simulation (MMS) technologies within the DoD, it is critical to develop and implement an assessment framework for evaluating the merit of M&S applications. This is increasingly true in environments where budgets are reduced, test opportunities are limited, and acquisition timelines are short (Oswalt, 2011). Generally, the DoD lacks effective processes and metrics for routine generation of ROI for M&S investments, causing decisions to be made in a less rigorous manner than preferred (AEgis Technologies Group, 2008). Where such processes or metrics exist, it is often the case that the metrics are uneven in scope, are case-specific, or are not well-structured. Furthermore, measures of ROI are often missing or defined incorrectly (Oswalt, 2011).

Calculating the value of an investment is a common task in the information technology (IT) industry. A common method used to quantify the value of an IT investment is ROI. In a for-profit world, ROI is often used as a metric to quantify financial gains from an initial investment: the tangible financial gains and benefits from a project are quantified and weighed against the costs for implementing the solution. However, in the DoD and other government entities, the intangible, non-monetary benefits must be considered (Oswalt, 2011). In the DoD MMS acquisition and training communities, it is difficult to place a monetary value on intangible benefits such as lives saved, improved readiness, or improved patient outcomes. Thus, the traditional method of calculating ROI – only considering monetary gains – is likely not the appropriate method to assess the true value of an MMS capability. Instead, alternative methods incorporating both monetary and non-monetary benefits are required to adequately assess the ROI of DoD MMS investments.

A method used to evaluate an IT investment which can be leveraged in the DoD is the Cost Benefit Analysis (CBA), which takes into consideration the intangible costs and benefits of investing in a project as well as its financial costs and benefits. While this method aligns better with the interests of the DoD MMS communities, the greatest challenge with CBA in the IT community is adequately measuring the project costs and benefits (Murphy & Simon, 2001). This challenge extends into the DoD MMS communities, where quantifying non-monetary benefits can be a challenge stemming from the lack of existing structures to measure such quantities. Due to measurement difficulty, assessing the merit of an investment is often done in a more informal manner. Unfortunately, informal assessments of the cost and value of an investment can lead to the encouragement of goals which are unattainable; fueled by over-optimism and expectations instead of measured value and impact (United States Government Accountability Office, 2020).

To adequately quantify benefits of DoD MMS investments using ROI methods, it is important to establish key metrics so that analysis of alternative approaches or investments can be analyzed in a systematic, fair, and impactful way. In the context of medical training, metrics which describe non-monetary benefits might include: the number of training programs available or provided to personnel at various levels (users, developers, senior executives, etc.), or the percent of knowledge required by each personnel currently achieved (AEgis Technologies Group, 2008). The sample metrics

describing monetary benefits might include: cost effective M&S decisions, or savings from decisions made more effectively (at the right time, done right the first time, etc.). Recognizing the relative value of metrics is equally important. For example, while the number of provided training opportunities for medical personnel is an important metric, measuring improvements in knowledge gained by medical personnel or improvements in patient outcomes are metrics which may have more value and impact, as they directly relate to quality of care. Recognizing the critical monetary and non-monetary metrics is key to quantifying ROI of an MMS investment, and for establishing a structured process within an organization for evaluation of M&S investments.

METHODS

Development of ROI Tool

Through collaboration between MITRE and PM MST, an ROI Tool was developed to support quantifying benefits for MMS products. The tool is designed to calculate the ROI of one or more alternative solutions against the status quo solution. The tool presents different approaches to calculating ROI, all of which can be potentially useful for evaluating future military medical training acquisitions. Given that medical training is focused on saving lives, the tool leverages ROI approaches which consider both non-monetary benefits and monetary benefits.

Inputs to the ROI Tool

The ROI Tool is a simple-to-use excel-based tool that takes costs and benefits of the status quo and alternative solution(s) as inputs, and produces ROI values for the status quo and alternative solution(s) as outputs. Inputs to the tool can be categorized as costs, financial benefits, or non-financial benefits; the user is able to enter as many costs and benefits as desired. For each cost and financial benefit, the user is required to enter the dollars per unit, number of units, and whether the cost or financial benefit is recurring. If recurring, the user must enter the times per year and the length of time for which the cost and financial benefit occurs. For non-financial benefits, a Likert scale is used to rank the non-financial benefit on a scale from a minimum value to maximum value defined by the user. The minimum and maximum values for the Likert scale can vary for each non-financial benefit: for some it may make more sense to scale from 1 to 5, whereas for other benefits a scale from 1 to 9, or 1 to 100 may be more sensible. Alternatively, non-financial benefits may be measured on a traditional numeric scale such as number of treatments provided. For increased flexibility, the user also has the option to define whether the scale for scoring a non-financial benefit is ascending (where the scale's maximum value indicates the best score possible) or descending (where the scale's minimum value indicates the best score possible).

A normalized score is then calculated for each non-financial benefit to transform all non-financial benefit scoring scales to a scale from 0 to 1. Normalization is done first by linearly shifting (if necessary) the benefit score, minimum score, and maximum score so that the minimum score is equal to zero. If an ascending scale is chosen, the normalized score is equal to new (after the linear shift) benefit score divided by the new maximum score. If a descending scale is chosen, the normalized score is equal to the new maximum score minus the new benefit score, divided by the new maximum score (Table 1). Here, we see that a benefit score of 3 on a scale from 1 to 9 results in a higher normalized score when a descending scale is chosen; this is expected since the benefit score of 3 is closer to best score possible when a descending scale is selected (since the best score is equal to 1, and a score of 3 is closer to 1 than it is to 9).

Table 1. Normalization of Non-financial Benefit Scores on an Ascending and Descending Benefit Score Scale

Benefit Name	Minimum score	Maximum score	Score	Minimum score, shifted	Maximum score, shifted	Score, shifted	Normalized Score
Benefit (ascending scale)	1	9	3	0	8	2	0.250
Benefit (descending scale)	1	9	3	0	8	2	0.750

A weight is then attributed to each benefit indicating its relative importance, where the total weight across all non-financial benefits must combine to 100%. To maintain a consistent comparison, the non-financial benefits and their scales and weighting must remain consistent between the status quo solution and all other alternative solutions.

ROI Calculation Methods

Based on the defined costs and benefits, the tool computes ROI using four different approaches: Traditional ROI, Cost Benefit Index (CBI), Multi-Attribute Decision Model (MADM), and a Hybrid Approach. Each of these methods

considers the return on an investment differently. In the more commonly used ROI approaches, referred to as Traditional ROI, the numerator of the ROI ratio (i.e., the "return") relies on the ability to estimate savings or benefits in a manner that can be incorporated into the ROI formula. In many cases, particularly in an M&S environment, the dollar value of "returns" are difficult to determine. Thus, this tool has incorporated non-traditional ROI approaches – CBI, MADM, and the Hybrid Approach – that utilize quantitative measures to determine "return" where the dollar value of benefits is challenging to quantify. A brief summary of each of these ROI methods is provided below.

Traditional ROI

Traditional ROI methods take the net benefits resulting from a project, divide them by the total costs of the project, and multiply by 100 to generate a percent.

$$ROI = \frac{Net\ Benefits}{Total\ Costs} \times 100 \qquad (1)$$

Relative to this tool, the Net Benefits are equal the sum of the financial benefits, while the total costs are the sum of the entered costs. While this is a straightforward calculation, there are many subtle challenges in measuring the costs and the benefits for a training project. The ROI Institute has workshops on calculating ROI in many situations, including one specifically targeting Training, Simulation, and Education Programs (ROI Institute, 2021). While this method is well understood and often used by businesses to determine profitability of investments, it is designed specifically for cash flow operations and does not translate well to military or other non-profit communities focused on readiness and health (Applied Geographics, Inc., 2009).

Cost Benefit Index (CBI)

In training, projects may include benefits that are not easily measured in dollar amounts but can be measured on a scale of satisfaction; for example, Extremely dissatisfied, Dissatisfied, Neutral, Satisfied, and Extremely satisfied. This type of scale can easily be converted to a numeric scale by assigning numbers to each option. The CBI allows for the incorporation of this type of measure into decision analysis by dividing the net costs by the total benefits.

To apply the CBI, benefits which cannot be expressed by a dollar amount – the non-financial benefits introduced earlier – must exist in a quantitative scale. The normalized scores of the individual benefits are multiplied by their respective weights and are then summed to provide a total benefit score. The net cost for that alternative – the difference in dollar amount between the costs and financial benefits – is divided by its total non-financial benefit score to get the CBI for that alternative. The alternative solution with the lowest CBI is the preferred solution.

It should be noted that the decision to use an ascending or descending scale to score a non-financial benefit only affects the method by which the scores are normalized and converted to a weighted non-financial benefit score. It does not change how the final ROI results should be interpreted when comparing alternative solutions. Regardless of whether metrics are scored on an ascending or descending scale, the alternative solution with the lowest CBI will be the preferred solution. Also, for the MADM and Hybrid ROI methods, which are discussed hereafter, the ascending or descending scale affects only the normalization.

Multi-Attribute Decision Model (MADM)

Designated as MADM, this methodology was developed to address some of the DoD-unique aspects of measuring value with respect to M&S investments (Oswalt, 2011). The model is designed to avoid the need to place a monetary value on items such as lives saved, training improvment, or warfighter readiness levels. It is designed to apply to large systems acquisitions with impacts across multiple areas of DoD operations. However, it can be scaled down to evaluate smaller systems provided stakeholders across the entire scope of system impact are included. The attributes to be measured and evaluated, as well as their relative weight to one another, are decided upon by the stakeholders.

A total utility score is computed for each system using normalized attribute values and the relative weight for each attribute. The attributes consider both the Traditional ROI calculation and the non-financial benefit scores. The utility can generally be defined as:

$$Utility\ Score = \%Weight_{ROI} \times \left(\frac{ROI_i}{\max\left(ROI_{i=1}, ROI_{i=2} \ldots ROI_{i=n}\right)}\right) + (100\% - \%Weight_{ROI}) \times Benefit\ score_{non-financial,i} \qquad (2)$$

where *i* indicates a particular alternative solution ranging from 1 to *n*, and *n* is equal the total number of solutions being investigated (including the status quo solution). Here, the utility score for a solution is the sum of two terms.

The first term is the percentage weight applied to the Traditional ROI calculation ($\%Weight_{ROI}$), defined by the user, multiplied by the ratio of the solution's Traditional ROI value over the maximum Traditional ROI value realized across all potential solutions. The second term is the percentage weight of the non-financial attributes ($100\% - \%Weight_{ROI}$) multiplied by the solution's non-financial benefit score.

The utility scores across all solutions (including the status quo) are then compared, where the highest utility score is considered the best. It is also possible to compare utility scores over time to determine an improvement in utility as various investments are made.

Hybrid Approach

This approach combines the Traditional ROI calculation with the benefit score method from MADM. Rather than attempting to interpret the value of any particular benefit, this approach converts the dollar values on to the benefit scale. This conversion is done by using the costs and benefits of the status quo to determine the conversion factor. Once the dollar values are on the same scale, the Traditional ROI formula is used to calculate the return for each alternative. This means a historical comparison is possible. Using the Traditional ROI formula as a baseline, the net benefits in Equation 1 will now incorporate the total costs of the solution:

$$ROI = \frac{Benefits - Total\ Costs}{Total\ Costs} \times 100 \qquad (3)$$

Here, the Benefits are not being converted into dollars; instead, the dollars in cost are being converted into benefits. The formula to quantify ROI for an alternative solution becomes:

$$Hybrid\ ROI_i = \frac{Weighted\ Benefits_{non-financial,i} - (Weighted\ Cost_i * Scaling\ Adjustment)}{(Weighted\ Cost_i * Scaling\ Adjustment)} \times 100 \qquad (4)$$

where *i* indicates a particular alternative solution ranging from 1 to *n*, and *n* is equal the total number of alternative solutions being investigated (including the status quo solution).

The weighted cost is calculated by multiplying the percentage weight of the Traditional ROI calculation defined in MADM ($\%Weight_{ROI}$), by a normalized cost equal to the ratio of the alternative solution's total cost over the maximum total cost realized across all potential solutions. For this calculation, total costs equal the costs minus the financial benefits:

$$Weighted\ Cost_i = (100 \times \%Weight_{ROI}) \times \frac{Total\ Costs_i}{\max(Total\ Costs_{i=1}, Total\ Costs_{i=2} \ldots Total\ Costs_{i=n})} \qquad (5)$$

The weighted non-financial benefits are calculated in an identical fashion as in MADM:

$$Weighted\ Benefits_{non-financial,i} = (100\% - \%Weight_{ROI}) \times Benefit\ score_{non-financial,i} \qquad (6)$$

The scaling adjustment is based on the status quo solution and is described by the ratio of weighted non-financial benefits over the total weighted costs for the status quo.

$$Scaling\ Adjustment = \frac{Weighted\ Benefits_{non-financial,status\ quo}}{Weighted\ Cost_{status\ quo}} \qquad (7)$$

By definition, Equation 4 will return a Hybrid ROI value of 0% for the status quo. The Hybrid ROI value for an alternative solution will be with respect to the status quo, where a positive value indicates a percent improvement in ROI compared to the status quo and a negative value indicates a percent deterioration in ROI compared to the status quo.

Hypothetical Example – SimLEARN

To assess the functionality of the ROI Tool, a hypothetical scenario was developed based on the Simulation, Learning, Education, and Research Network (SimLEARN) – the Veterans Health Administration (VHA) program for simulation in health care training (United States Department of Veterans Affairs, 2021). A central component of SimLEARN is the use of mannequins and standardized patients to enhance clinicians' skills needed to support quality care for Veterans. The hypothetical scenario developed described a situation in which a training department of a large medical facility currently has two mannequins with an advanced simulation system used to train trauma teams. The department

is looking to enhance their training capabilities and is exploring whether the purchase of two additional mannequins, each costing $4,500, would be a good use of their training dollars. A series of questions and responses was generated to approximate the costs and benefits of such an investment. While data from SimLEARN was not available, the hypothetical data used in this scenario was informed through several real conversations with SimLEARN staff. A portion of the questions asked (in cyan text) and their responses (in orange text) are shown below:

What other costs are involved in holding this training?
Cleaning costs associated with each use of the mannequins. An estimated $10 per mannequin per day of use.
Material costs for trauma team practice ($150/practice) and for Advanced Life Saving (ALS) class ($40/attendee).

What benefits has the facility seen from this training?
Prior to the trauma team training, 297 out of 521 trauma patients (57%) survived to discharge.
In the first year of running the training, 314 out of 529 trauma patients (59%) survived to discharge.
In the second year of running the training, 311 out of 509 trauma patients (61%) survived to discharge.
These new mannequins replaced two out-of-date mannequins previously used for Cardiopulmonary Resuscitation (CPR) training.
Previously the ALS attendees had to go to another location at a cost of $96 per attendee.

Are there any additional benefits that could come from purchasing additional mannequins?
Additional CPR classes could be held for nonmedical staff and for part time staff.
An additional 2-day class on Airway Management and Intubation could be added to the curriculum. Currently, attendees for this 2-day class need to go to a different facility at a cost of $123 per attendee. There are currently 25 attendees per year, but more could be trained if the facility held the class internally.
The trauma teams could train more often, once every 4 weeks as opposed to once every 8 weeks.

These conversations helped quantify the costs and benefits – both financial and non-financial – of acquiring two additional advanced simulators (Table 5 – Appendix). In addition to serving as a first test of the ROI Tool's functionality, the hypothetical scenario helped understand the types of questions that needed to be asked and answered for estimating ROI of future real-life projects.

ROI of Complicated Obstetrics Emergency Simulators (COES)

COES is an emergency obstetrics simulation system selected by the DHA to provide a standardized platform for training clinical staff on patient safety during obstetric care (Briscese, 2017; Kalinyak, 2017). The COES simulators were incorporated into the medical training programs at 35 military treatment facilities (MTFs) across the DoD (Air Force, Army, Navy, and DHA). Using the developed ROI Tool, the value of implementing COES simulators was evaluated in comparison to the status quo of utilizing the standardized patient (a person recruited and trained to characterize a real patient for training purposes). First, costs for the status quo and the alternative solution (COES simulators) were estimated. Next, the non-financial benefits of the status quo and the COES simulators were quantified. As previously mentioned, the non-financial benefits measured were identical for each potential solution to ensure consistent evaluation. Scores on patient outcomes, patient safety outcomes, quality of data on participation, and anecdotal feedback were scored on a Likert scale from 1 to 5 or 1 to 9. These scores were informed by expert knowledge within PM MST on the implementation of COES. Data metrics involving COES simulator team drills, accreditation, provider participation, and adherence to The American College of Obstetricians and Gynecologists (ACOG) guidelines, were scored from 0 to 100, making direct use of numeric data collected by the Women and Infant Clinical Community (WICC), primarily through the Simulation Training and Reporting System (STARS) reports. Where medical training data prior to the introduction of the COES simulators was not available, assumptions for status quo metrics were made based on expert knowledge and situational awareness within PM MST on the medical training procedures for obstetric care prior to implementation of COES.

All metrics except post-partum hemorrhage (PPH) patient outcomes were scored on an ascending scale, where the minimum value indicated the worst condition possible, and the maximum value indicated the best condition possible. A descending scale for PPH patient outcomes was chosen as it allowed for the direct incorporation of data on Military Health System pregnancy-related mortality rates; i.e., a low mortality rate would be scored higher (be more preferrable) than a high mortality rate. Based on the above inputs, the ROI Tool calculated the Traditional ROI, CBI, MADM Utility score, and Hybrid ROI for the status quo and the COES simulators.

RESULTS

Cost and benefit metrics were determined for the status quo (standardized patient) and the proposed alternative solution (COES simulators) for obstetric medical training (Tables 2 and 3). For the status quo, the cost of standardized patients was estimated over a two-year period. For COES, the cost of the hardware, supplies, and labor was estimated over the same two-year period. Tables 2 and 3 show these values as they appear in the ROI tool.

Table 2. Snapshot of the ROI Tool: Cost and Benefits for Status Quo (Standardized Patient).

Alternative Name: Status Quo - No Simulators

Costs (Status Quo - No Simulators)

Cost Name	$ Per Unit	Units	Reoccurring?	Times per Year	# of Years	Cost
Standardized Patient Costs Yr 1	$ 108,930.14	35	NO	1	1	$ 3,812,554.90
Standardized Patient Costs Yr 2	$ 62,924.16	35	NO	1	1	$ 2,202,345.60
					TOTAL:	$ 6,014,900.50

Non-Financial Benefits (Status Quo - No Simulators)

Benefit Name	Min	Max	Score	Normalized Score	Weight	Weighted Score
PPH (Patient Outcomes)	1	9	7	0.250	20%	5.00
Quality of Data on Participation	1	9	3	0.250	3%	0.75
Anecdotal Feedback	1	5	3	0.500	5%	2.50
Team Drills Performed	0	100	80	0.800	8%	6.40
Drill Frequency	0	100	80	0.800	8%	6.40
ACOG Guidelines Met at Drill	0	100	80	0.800	8%	6.40
Provider Participation	0	100	45	0.450	8%	3.60
Standardized Scenarios Used	0	100	75	0.750	12%	9.00
Met Accreditation	0	100	100	1.000	15%	15.00
Drill Data Transmitted to WICC	0	100	80	0.800	3%	2.40
Patient Safety Outcomes	1	9	5	0.500	10%	5.00
				Total:	100%	62.45

Financial Benefits (Status Quo - No Simulators)

Benefit Name	$ Per Unit	Units	Reoccurring?	Times per Year	# of Years	Savings
N/A	$ -		NO			$ -
					TOTAL:	$ -

Table 3. Snapshot of the ROI Tool: Costs and Benefits for COES.

Alternative Name: COES Simulators

Costs (COES Simulators)

Cost Name	$ Per Unit	Units	Reoccurring?	Times per Year	# of Years	Cost
Hardware	$ 71,968.00	35	NO			$ 2,518,880.00
Supplies	$ 13,455.00	35	YES	1	2	$ 941,850.00
Labor	$ 41,166.72	35	YES	1	2	$ 2,881,670.40
					TOTAL:	$ 6,342,400.40

Non-Financial Benefits (COES Simulators)

Benefit Name	Min	Max	Score	Normalized Score	Weight	Weighted Score
PPH (Patient Outcomes)	1	9	2	0.875	20%	17.50
Quality of Data on Participation	1	9	8	0.875	3%	2.63
Anecdotal Feedback	1	5	3	0.500	5%	2.50
Team Drills Performed	0	100	83	0.830	8%	6.64
Drill Frequency	0	100	95	0.950	8%	7.60
ACOG Guidelines Met at Drill	0	100	83	0.830	8%	6.64
Provider Participation	0	100	90	0.900	8%	7.20
Standardized Scenarios Used	0	100	100	1.000	12%	12.00
Met Accreditation	0	100	100	1.000	15%	15.00
Drill Data Transmitted to WICC	0	100	31	0.310	3%	0.93
Patient Safety Outcomes	1	9	5	0.500	10%	5.00
				Total:	100%	83.64

Financial Benefits (COES Simulators)

Benefit Name	$ Per Unit	Units	Reoccurring?	Times per Year	# of Years	Savings
N/A			NO			$ -
					TOTAL:	$ -

No financial benefits were identified for the status quo or COES. All identified benefits were non-financial and were all applicable to both the status quo and COES alternatives; they measured patient outcomes, quality of participation data, anecdotal feedback, anecdotal feedback on the solution, and metrics related to team drill outcomes and activities gathered from the STARS Data Archive. The score for each alternative solution in each non-financial benefit category

was determined. The relative importance of each non-financial benefit was defined by applying weights to each benefit; these weights were determined after investigation of scholarly articles and background information on the intent of the COES program. Additionally, it was determined that the Traditional ROI calculation would account for 75% of the generated MADM Utility score (Weight of ROI = 75%), reflecting that the costs of the solutions are strongly considered when assessing value.

Using the input costs and benefits, the ROI of the status quo and COES were quantified using the four ROI approaches, appearing in the tool as shown in Table 4. For the Traditional ROI calculation and the MADM Utility score, a higher value indicates a greater ROI, while for the CBI a lower score indicates the preferred alternative. For the Hybrid method, the status quo is equal to zero by definition; a positive percentage for any alternative solution indicates an improvement on the status quo, while a negative percentage indicates a deterioration compared to the status quo.

Table 4. Snapshot of the ROI Tool: ROI results for the status quo (left) and COES (right)

Traditional ROI (Status Quo - No Simulators)	
Total Benefits:	$ -
Total Costs:	$ 6,014,900.50
ROI:	**0%**
Cost / Benefit Index (Status Quo - No Simulators)	
Total Financial Benefits:	$ -
Total Costs:	$ 6,014,900.50
Net Costs:	$ 6,014,900.50
Total Benefit Score (Weighted):	62.45
CBI (Net Costs / Total Benefit Score):	**96,315.46**
MADM (Status Quo - No Simulators)	
Weight of ROI:	75.00
Utility Score:	**15.61**
Hybrid (Status Quo - No Simulators)	
Weight of Cost:	75.00
Normalized Cost:	0.95
Weighted Cost:	71.13
Total Weighted Benefits:	15.61
Adjustment:	0.22
ROI:	**0.00**

Traditional ROI (COES Simulators)	
Total Benefits:	$ -
Total Costs:	$ 6,342,400.40
ROI:	**0%**
Cost / Benefit Index (COES Simulators)	
Total Financial Benefits:	$ -
Total Costs:	$ 6,342,400.40
Net Costs:	$ 6,342,400.40
Total Benefit Score (Weighted):	83.64
CBI (Net Costs / Total Benefit Score):	**75,834.28**
MADM (COES Simulators)	
Weight of ROI:	75.00
Utility Score:	**20.91**
Hybrid (COES Simulators)	
Weight of Cost:	75.00
Normalized Cost:	1.00
Weighted Cost:	75.00
Total Weighted Benefits:	20.91
Adjustment:	0.22
ROI:	**27.01**

DISCUSSION

Traditional ROI method results reported a 0% ROI for both the status quo and COES solutions. This was due to the lack of any identified financial benefits for either alternative solution. This is likely to be a common occurrence for projects where benefits are intangible, such as improving care or saving lives. However, in some cases there may certainly be a positive financial impact realized other than those associated with those defined in the costs section of

the ROI Tool. For example, a financial benefit such as cost avoidance might exist, and by definition would produce a non-zero ROI. An illustration of this can be seen in the hypothetical example on SimLEARN in the Appendix (Table 6). The CBI value of 75,834.28 for COES was over 20% less than the value for the status quo of 96,315.46, indicating a reduced cost per benefit with implementation of COES. For the MADM method, the COES simulators had a higher utility score compared to the status quo (20.91 to 15.61), also indicating a preference for COES. Finally, the Hybrid model indicated COES to have a 27% increase in benefit compared to the standardized patient. In totality, the results certainly suggest that implementation of the COES simulators provides a greater return on investment compared to the status quo solution of the standardized patient.

Trends seen in the current example may not necessarily apply to all ROI assessments generated from the ROI Tool. While in the current example all non-traditional ROI methods favored the same alternative solution, it is possible for different methods to have conflicting viewpoints. For example, if the non-financial benefit score for COES was determined to be lower than that of the status quo, the MADM method would likely return a lower utility score for the COES simulators compared to the status quo. However, if in this same scenario the costs of the simulators were significantly reduced compared to the costs of the standardized patient, the results could still report a lower (more preferrable) CBI score for the COES simulators. One may also notice that the ratio of the COES MADM utility score to the status quo MADM utility score is identical to the Hybrid score returned for COES. This is due to the lack of financial benefits (a Traditional ROI of 0%) for either alternative; in any case where a non-zero Traditional ROI is realized, even if just for one alternative solution, this trend will not persist.

As evident by the ROI results, traditional methods for calculating ROI may not be appropriate for estimating the benefits or return on investment of a particular alternative solution. Traditional ROI methods rely on financial benefits and do not consider the non-financial benefits of an investment which a government program may value significantly. For programs concerned with non-financial benefits, CBI, MADM, and the Hybrid ROI method are three options that can be utilized to assess the ROI of a project or investment. Before running an analysis of the ROI Tool it is important to understand the core principles and values of a program, as well as its financial limitations. The importance of financial and non-financial benefits to a program, as well as the relative importance of non-financial benefits to one another should be carefully considered. While one program may apply more weight to non-financial benefits, another program under stricter financial limitations may place a greater importance on the financial benefits.

In addition to estimating ROI for COES, iterative development and refinement of the ROI Tool brought to light challenges that PM MST and DHA face when attempting to estimate the impact of M&S investments. The ability of the tool to accurately quantify ROI for a project depends highly on the availability and accuracy of the inputted costs and benefits. One challenge to accurately estimating ROI for COES was the lack of a complete dataset. While a considerable amount of COES data from MTFs were collected and analyzed, a considerable amount was not uploaded from the systems; many MTFs uploaded data for some months but not others. Stronger participation by MTFs in reporting COES data will strengthen future ROI estimates. Another significant challenge is pulling historical benefit data. An investment's impact on patient outcomes (e.g., survival rate, frequency of complications) is of significant interest in the medical training community. However, it is difficult to realize this impact without an established process in place to adequately measure outcomes resulting from a medical treatment or procedure. Rigorous documentation and reporting of data on patient outcomes, both before and after the introduction of a new solution, would significantly strengthen the ability of the ROI Tool to measure impact of that new solution compared to the status quo.

FUTURE DIRECTIONS

With the increasing costs of healthcare, the resources required to conduct simulation, and the competing priorities for healthcare provider time, it is critical to assess whether the outcomes of simulation investments justify the costs. The two examples shown in this paper (SimLEARN and COES) were the attempt to prove out the developed ROI methods. Additional data collection and analysis using additional simulation programs will be conducted to continue to refine the model. In some instances, there were difficulties in obtaining historical data. Developing a data collection methodology for use in future data collection efforts will be useful in the continued refinement of the ROI model. Further, there may be utility in expanding the tool to encompass additional features, such as multi-year analysis and break-even point of the investment, along with introducing data integrity and validation checks.

CONCLUSION

The ROI Tool presented in this work has both advantages and disadvantages associated with its existence as an Excel-based tool. One advantage is that it provides the user with the ability to personalize the tool to a particular project in a straightforward manner; this might involve adjusting the number costs or benefits entered or tailoring the display of the results. Another advantage is that the supporting "behind the scenes" calculations for quantifying ROI are available for observation by the user. This allows the user to understand the specific effect that an input or parameter might have on the ROI estimates generated by the tool; for example, understanding how the weighting attributed to the ROI calculation affects the MADM utility score. However, there are also disadvantages to the tool in its current form. Being an Excel-based tool means that it requires careful version control, especially when balancing ROI spreadsheets across multiple projects. Furthermore, there are no significant data integrity or validation checks in the current ROI Tool; users can input any data that they wish and can edit the formulas without restriction.

Overall, implementation of the ROI Tool to estimate ROI for COES showed the potential benefit that the tool can provide to PM MST and other DoD MMS communities. First, the tool incorporates multiple ROI methods which focus on intangible benefits, not just those which have an associated cost. This is critical when assessing the value of an M&S technology to the DoD and other government entities where there is a greater emphasis on providing intangible benefits such as saving lives, improving readiness, and improving patient outcomes. Second, the tool provides a formal, structured method to evaluate the impact of M&S investments that will allow for decisions in the MMS community to be made based on measurable data rather than by expectations unsupported by results. It is our hope that use and continued development of the ROI Tool will lead to better informed decisions and enhance PM MST's ability to efficiently transition the procurement of products to established Programs of Record. While the current use case focused on COES simulators, the ROI Tool and its underlying principles can be applied to fields outside of the medical training community as well. Any program focused on quantifying ROI of an M&S technology based on both its financial and non-financial impact could benefit from having the structured methodology presented in this work.

APPENDIX

Table 5. Snapshot of the ROI Tool: Cost and Benefits for the 2-Mannequin (left) and 4-Mannequin (right) alternatives – SimLEARN. CPR = Cardiopulmonary Resuscitation, ALS = Advanced Life Saving, AMI = Airway Management and Intubation.

Alternative Name: 2 Mannequin, 1 Year

Costs (2 Mannequin, 1 Year)

Cost Name	$ Per Unit	Units	Reccuring?	Times per Year	# of Years	Cost
Acquisition Fee	$ 4,500.00	0	NO			$ -
Cleaning (trauma team)	$ 10.00	100	NO			$ 1,000.00
Cleaning (CPR)	$ 10.00	100	NO			$ 1,000.00
Cleaning (ALS)	$ 10.00	80	YES	2	1	$ 1,600.00
Material (trauma team)	$ 150.00	50	NO			$ 7,500.00
Material (ALS)	$ 40.00	80	NO			$ 3,200.00
Maintenance	$ 100.00	2	NO			$ 200.00
Fee for AM&I	$ 123.00	25	NO			$ 3,075.00
					TOTAL:	$ 17,575.00

Non-Financial Benefits (2 Mannequin, 1 Year)

Benefit Name	Min	Max	Score	Normalized Score	Weight	Weighted Score
Improvement in Airway Management Skills	1	9	1	0.000	30%	0.00
Improvement in Trauma Outcomes	1	9	5	0.500	40%	20.00
Flexibility in scheduling classes	1	9	1	0.000	20%	0.00
Risk avoidance	1	9	4	0.375	10%	3.75
				Total:	100%	23.75

Financial Benefits (2 Mannequin, 1 Year)

Benefit Name	$ Per Unit	Units	Reccuring?	Times per Year	# of Years	Savings
Improved Survival Rate	$ 200,000.00	0.0205	NO			$ 4,100.00
ALS cost avoidance	$ 56.00	80	NO			$ 4,480.00
					TOTAL:	$ 8,580.00

Alternative Name: 4 Mannequin, 1 Year

Costs (4 Mannequin, 1 Year)

Cost Name	$ Per Unit	Units	Reccuring?	Times per Year	# of Years	Cost
Acquisition Fee	$ 4,500.00	2	NO			$ 9,000.00
Cleaning (trauma team)	$ 10.00	200	NO			$ 2,000.00
Cleaning (CPR)	$ 10.00	150	NO			$ 1,500.00
Cleaning (ALS)	$ 10.00	90	YES	2	1	$ 1,800.00
Cleaning (AMI)	$ 10.00	25	NO			$ 250.00
Material (trauma team)	$ 150.00	100	NO			$ 15,000.00
Material (ALS)	$ 40.00	90	NO			$ 3,600.00
Material (AMI)	$ 80.00	25	NO			$ 2,000.00
Maintenance	$ 100.00	2	NO			$ 200.00
					TOTAL:	$ 35,350.00

Non-Financial Benefits (4 Mannequin, 1 Year)

Benefit Name	Min	Max	Score	Normalized Score	Weight	Weighted Score
Improvement in Airway Management Skills	1	9	7	0.750	30%	22.50
Improvement in Trauma Outcomes	1	9	7	0.750	40%	30.00
Flexibility in scheduling classes	1	9	3	0.250	20%	5.00
Risk avoidance	1	9	6	0.625	10%	6.25
				Total:	100%	63.75

Financial Benefits (4 Mannequin, 1 Year)

Benefit Name	$ Per Unit	Units	Reccuring?	Times per Year	# of Years	Savings
Improved Survival Rate	$ 200,000.00	0.025	NO			$ 5,000.00
ALS cost avoidance	$ 56.00	90	NO			$ 5,040.00
AMI cost avoidance	$ 71.00	25	NO			$ 1,775.00
					TOTAL:	$ 11,815.00

Table 6. Snapshot of the ROI Tool: Summary of ROI Results for the 2-Mannequin (status quo) and 4-Mannequin alternatives – SimLEARN.

ROI Comparison Tab												
Traditional ROI			Cost Benefit Index			MADM			Hybrid			
2 Mannequin, 1 Year	48.82%		2 Mannequin, 1 Year	378.74		2 Mannequin, 1 Year	46.63		2 Mannequin, 1 Year	0.00		
4 Mannequin, 1 Year	33.42%		4 Mannequin, 1 Year	369.18		4 Mannequin, 1 Year	65.16		4 Mannequin, 1 Year	2.59		

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