ESTABLISHING REASONS AND RECOMMENDATION ON HOW TO INCREASE BIOMEDICAL TECHNICAL TRAINING IN ALASKA

By

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BIOMEDICAL TECHNICAL TRAINING IN ALASKA

A

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Establishing Reasons and Recommendations on How to Increase Biomedical Technical Training in Alaska

Abstract

There is an acknowledgement in literature about the increasing healthcare needs, and the disparity among rural area healthcare needs. This project explores and establishes that there is a need for increased biomedical technical training in the State of Alaska. The need and recommendations are discovered through research of current methods within the State and in other locations and analyzes different ways they are currently obtained in Alaska, and suggest hiring locally as a way to increase the number of trained biomedical technicians in Alaska.

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Acknowledgments

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Introduction

Biomedical engineering is one of the fastest growing engineering fields in the United States and can encompass a wide variety of occupations and specific careers (Chen, 2010; Abu-Faraj, 2008). Biomedical technical training commonly falls under the umbrella of Healthcare Technology Management as defined by the World Health Organization, or WHO (WHO, 2005). The aspect being discussed here is applied to implementing, servicing, and fixing medical equipment and systems of medical equipment (WHO, 2005). This could also include other medical equipment needs, depending on the environment working in (Abu-Faraj, 2008). This type of training is used and necessary in hospitals, clinics, medical device companies, and third party vendors (Barry, 2015-16; Bureau of Labor Statistics, 2016; Abu-Faraj, 2008). With the rise of technology growth and increased use in the healthcare field, there is also an increased need for those to implement, service and fix said technology (Bronzino, 2013).

The United States Census has predicted that the population is going to increase in Alaska, and throughout the United States (US Census, 2015). There also has been noticed trends indicating that people are living longer to older ages than before (National Institute of Health, or NIH, 2011; Santhanam, 2015). What this indicates is that there will be an increased need for healthcare due not only to a population increase, but also to an increase in the number of older populations of people. An increase in healthcare needs does not exclude needing biomedically trained individuals, nor the need to replace retiring biomedical technicians. As of 2014 there are 90 medical equipment repairers listed by the Bureau of Labor and Statistics, and the need is expected to increase 6% between 2014-2024 (Bureau of Labor Statistics, 2016). There has also been an expected increase need of about 30% in the field (Abu-Faraj, 2008; Barry, 2015-16).

Currently there are no degree or certifications being taught at an institute of learning located within the State of Alaska (Barry, 2015-16). While the lack of access to training is commonly an obstacle to healthcare, the lack of avenues for academic technical training in Alaska is one of the aspects to note that make assessing the ways in which to increase technical training in the State (Brems et al, 2006). The location, economy and extreme climates in the State increase the difficulty of bringing healthcare throughout the Alaska (Alaska Native Tribal Health Consortium, or ANTHC, et al, n.d.). Particularly in rural Alaska, there could be critical benefits to having locally trained staff to avoid expensive travelling costs in the event of an emergency, and could benefit the community in which that trained worker resides (Johnson, 2013).

The biomedical equipment technician, (BMET), occupation is also known as Medical Equipment Repairers by the US Bureau of Labor and Statistics (Bureau of Labor Statistics, 2016-17). Other common names for BMET are biomedical engineer, biomedical equipment repair specialist, biomedical equipment repair technician, biomed tech, and clinical engineer (Barry 2015-16). Biomedical technical training opportunities should be assessed due to the unique aspects related to Alaska, possible stakeholder interests, and current healthcare and educational gaps that exist locally. This assessment of resources to increase biomedical technical training in Alaska by analyzing the current state to establish why there should be more trained and make recommendations for a viable way to increase the number of trained biomedical workers in Alaska.

Literature Survey

Per the State of Alaska Department of Health and Social Services there are about 26 hospitals and about 500 Community Health Aids/Practitioners that service Community Health Centers in the State of Alaska that service healthcare needs of the state population (State of Alaska, 2009). Community Health Centers are places that have "comprehensive preventive, primary medical care, dental, and mental health services" that were developed in order to minimize the healthcare gap disparity in rural Alaska by training people to work in their communities to initially assess those in need of healthcare in rural areas (State of Alaska, 2009; Smith, 2007). Community Health Aids are a type of "community health worker" that are recommended by the World Health Organization as a way to improve healthcare in places with limited healthcare resources in developed and developing areas (Wilson, 2009; Dolea et. al., 2010). The Community Health Aide Program in Alaska has been listed as a success due to its "employing and training local, indigenous members of remote communities" that "improved the availability and accessibility of primary and emergency healthcare services in frontier areas" (U.S. Department of Health & Social Services, 2003). Following this similar models appears that an investment in locally trained individuals will lead to better success for healthcare in Alaska, an example being the program's expansion to include dental health (U.S. Department of Health & Social Services, 2003).

According to the United States Department of Labor, Bureau of Labor Statistics biomedical technical training occupation can be termed as "medical equipment repairers" (Bureau of Labor Statistics, 2016-17). They are defined as individuals who "install, maintain, and repair patient care equipment" within a patient-care environment (Bureau of Labor Statistics, 2016-17). This environment includes any facility that gives medical care to patients with biomedical equipment. They are also commonly referred to as biomedical technicians, biomedical equipment specialists, biomedical engineers, and clinical engineers depending on the location and extent of training and/or education the individual has as described in Figures 1 and 2 (Barry, 2015-16).

Figure 1 Medical Technology School Biomedical Technician Career Facts (Barry, 2015-16)

Medical Technology Schools

MTS » Biomedical Technician

CAREER FACTS	BIOMEDICAL TECHNICIAN
Related Careers	Medical and Clinical Laboratory Technician
Common Job Titles	Bio Medical Technician, Biomedical Technician (Biomed Tech), Biomedical Electronics Technician, Biomedical Engineering Technician (BMET), Biomedical Equipment Technician (BMET), Dental Equipment Technician, X-Ray Service Engineer
Technology & Equipment	Pressure Indicators, Ventilator Accessories, Voltage or Current Meters, Office and Productivity Software

Sourced from BLS, January 2015

Figure 1 gives many common job titles that this field is commonly used as, which was important to determine the scope of this project. Determining what is covered and what is not considered in biomedical technicians was important to collecting and analyzing data.

Figure 2 Medical Technology School Biomedical Technician Fast Facts (Barry, 2015-16)

Medical Technology Schools

MTS » Biomedical Technician

BIOMEDICAL TECHNICIAN FAST FACTS	
Projected Jobs Created	12,800
Projected Job Growth	30%
Low Salary	$26,550
Average Salary (Median)	$44,570
High Salary	$72,080
Entry-Level EDU	Associate's Degree

Sourced from BLS, January 2015

Figure 2 gives general information about entry level biomedical technicians such as education level, salary ranges and job growth (Barry, 2015-16). This information was used during the calculation of expenses, particularly the 30% job growth to determine how many more technicians would be needed annually.

Biomedical equipment technology or engineering education, usually at least an associate's degree level is commonly expected, but can vary depending on the individual's experience and expertise (Bureau of Labor Statistics, 2016-17). There are certifications that can be obtained through organizations such as the Association for the Advancement of Medical Instrumentation, or AAMI, that are recognized in the field (AAMI, 2015). AAMI has several certifications that would be applicable to biomedical technical training: Certification of Biomedical Equipment Technician, or CBET, Laboratory Equipment Specialist, CLES, and Radiology Equipment Specialist CRES (AAMI, 2015). These certifications can be maintained upon renewal (AAMI, 2015). Specialized training for specific types of equipment is common due to the fast and growing pace of technology in this field (Abu-Faraj, 2008; Barry, 2015-16; Bureau of Labor Statistics, 2016-17).

In addition to education and certification, work experience and on-the-job training is highly valued and sought after, particularly since technology changes over time (Bureau of Labor

Statistics, 2016-17). There is also the avenue of the military that can result in biomedical technical training and experience (Barry, 2015-16).

There are organizations in the United States that connect people to others in the field, and allow for networking and access to information on becoming biomedically trained. There are conferences held by AAMI, in which you can take their certification tests during the conferences (AAMI, 2015). Another such organization is the Medical Equipment and Technology Association with their goals of "protect[ing] the public health and its well-being by advancing computer risk management practices to ensure wide availability of innovative and safe medical devices" (Medical Equipment & Technology Association, 2003-2012). Another example is a Biomed Association that supports college students and professionals, linking with companies in the industry for which many states excluding Alaska currently have one (Washington Biomed Association, n.d.). It has been documented that such organizations are often the sources of career guidance in the biomedical field (Abu-Faraj, 2008).

In the United States the industries that hire BMET workers are 4% health and personal care stores, 8% ambulatory healthcare services, 27% in professional and commercial equipment and supplies merchant wholesalers, 19% electronic and precision equipment repair and maintenance and 13% state, local and private hospitals per the Bureau of Labor Statistics (Bureau of Labor Statics, 2016). They are imperative to maintain compliance in regulatory bodies such as The Joint Commission, as well as State and Federal regulations related to medical equipment for hospitals (The Joint Commission, 2014).

The State of Alaska (2013) may be interested in this topic as the Department of Labor and Workforce Development has an Alaska Workforce Investment Board that is:

> required to report to the Legislature each year on the performance and evaluation of training programs within its purview, as specified by Alaska Statute 23.15.580(b)(9). The Board reviews reports prepared by the Alaska Department of Labor and Workforce Development's Research and Analysis Section, as well as its efforts and initiatives to improve the quantity and quality of available training.

Out of 50 States plus Washington DC and Puerto Rico, the State of Alaska had the lowest retention rate at 84% (US Department of Labor, 2004). The State of Alaska has a high rate of "brain drain" in which students often leave the state in search of educational and occupational opportunities (Hadland, 2004). Migration dynamics that influence the economics of a location have been said to be influenced by "selective geographical matching of productive resources, skills and institutions of coordination" to which in the biomedical field the State of Alaska is lacking (Storper et. al., 2008). Movement of workers to a location for education as well as job opportunities are beneficial to that area's economy (Storper et. al, 2008; Cooke et al, 2011).

Roughly one third of Alaska's population lives in rural areas, which is the area with the least healthcare available in the state (U.S. Department of Health & Social Services, 2003). Previous research has shown that the strongest correlation to healthcare workers working in rural areas is being from a rural area (Wilson, 2009). This would promote the idea of local hire for the best long-term goal of closing a need-gap for the rural parts of Alaska (Wilson, 2009). It has also been shown that the majority of rural Alaskans do not leave their rural homes (Huskey, 2004).

In running Healthcare Technology Management there are budget models that can help determine costs, which are based on collection of a facility's, such as a hospital's, specific and accurate data and is tailored to that location (Netwal, 2010). While this is a promising method, the method is heavily reliant on plentiful and accurate data that is not always available even within a single facility (Netwal, 2010). Another management aspect is the idea of the triple bottom line that incorporates economic, social and environmental factors as part of the operation (Mcwilliams, 2014; Norman et. al. 2004). If the triple bottom line method is used to measure success, social and environmental impact to the community would have to be considered (Mcwilliams, 2014).

Approach

Based on the literature research presented above there is growth in the population and in the field that indicate reasons biomedical training should be increased in Alaska. Introduction of avenues for local workers to pursue this field appear to be beneficial to the economy, and offer another option as an attempt to reduce brain drain (Cooke et. al., 2010; Hadland, 2004). There are currently no local avenues in which to obtain the education required for the State of Alaska's needs. This can create a challenge in recruitment for management that needs to hire biomedical technicians with the growing healthcare and technological needs. My analysis of current options is presented from a managerial perspective as though they were to be used as decision making tools, through methods learned in the Engineering & Science Management (ESM) Program at the University of Alaska Anchorage.

There are pros and cons to every avenue of obtaining biomedically trained workers. The idea is to analyze each method, stating all assumptions for evaluation, in order to recommend a viable path to increase the number of biomedically trained workers in Alaska. The methods of obtaining biomedically trained workers that I'm viewing are hiring from out of state, hiring from the military, sending people to training, and developing training in Alaska. In order to assess the different pros and cons a Strength Weakness Opportunities Threats (SWOT) analysis done; the results being displayed in Figure 3 that show that there are opportunities that can come from the established lack of methods to increase biomed technicians in Alaska.

Figure 3 SWOT Results

Strengths
- Healthcare growth
- Local resource

Weaknesses
- Location
- Formal education access

Opportunities
- Education
- 3rd Party Company

Threats
- Retention
- Costs

Data Gathering & Analysis

Table 1 displays data of average number of clinical devices maintained, BMET and total Full Time Employees, or FTEs, per the number of clinical devices maintained from the ECRI Institute (ECRI, 2015). From this data it was calculated that the range of total FTEs used for BMET as opposed to director, clerical, etc. is between 71 and 80% (ECRI, 2015). The full ECRI table with data they have collected of the relationships between the size of a hospital, how many medical devices they have, and how much staff they have can be viewed in Table 1 (ECRI, 2015). It should be noted that an FTE is an abbreviation for full time employee, to which the IRS details this as an individual who works at least 30 hours per week (IRS, 2015). Table 1 from ECRI Institute, a well-known non-profit institute that collects and distributes science-based research to healthcare and medical equipment (ECRI, 2015). The ECRI published data that shows FTEs for Director, BMET, Clerical and Total FTEs per the total number of devices and the sizes of hospitals. There is limited data available on such information, which accounts for the large confidence intervals.

Table 1 ECRI Biomedical Benchmark Table (ECRI, 2015)

CE DEPARTMENT STAFFING

BiomedicalBenchmark™
THE TECHNOLOGY SUPPORT SYSTEM

STAFFING TABLE

Total Beds Served	CE Serves 1 Hospital	Total Clinical Devices Maintained Avg ±CI (N)	Total Annual Work Orders (Medical and Non-Medical Equipment) Avg ±CI (N)	Director/CE (FTE) Avg ±CI (N)	BMET (FTE) Avg ±CI (N)	Clerical (FTE) Avg ±CI (N)	Total (FTE) Avg ±CI (N)	Total Non-Maintenance Activities (FTE) Avg ±CI (N)
701-800	27%	11,082 ± 5,267 (9)	17,413 ± 5,660 (4)	2.3±0.6 (15)	13.9±2.0 (15)	1.1±0.3 (15)	17.3±2.3 (15)	1.2±0.4 (9)
601-700	33%	8,773 ± 3,483 (4)	17,692 ± 6,878 (5)	1.5±0.2 (18)	8.0±2.0 (18)	0.8±.1 (18)	10.1±2.4 (18)	1.6±0.5 (8)
501-600	42%	9,122 ± 2,211 (14)	11,455 ± 4,185 (6)	2.1±0.8 (24)	13.3±2.5 (24)	1.1±0.4 (24)	16.6±2.9 (24)	1.3±0.4 (12)
401-500	67%	5,043 ± 1,984 (16)	13,083 ± 4,505 (10)	1.9±0.6 (33)	8.9±1.5 (33)	0.9±0.3 (33)	11.7±1.8 (33)	0.9±0.3 (15)
301-400	69%	5,041 ± 966 (35)	13,189 ± 4,179 (27)	1.2±0.2 (59)	6.0±0.9 (59)	0.6±0.1 (59)	7.8±1.1 (59)	1.0±0.2 (31)
201-300	74%	3,522 ± 748 (40)	10,322 ± 3,243 (30)	1.3±0.2 (90)	5.8±0.8 (90)	0.6±0.2 (90)	7.7±1.0 (90)	1.1±0.2 (60)
101-200	85%	2,612 ± 492 (39)	3,951 ± 790 (29)	1.1±0.1 (61)	3.5±0.8 (61)	0.3±0.1 (61)	4.9±1.0 (61)	0.9±0.2 (37)

Total Beds Served: Total number of beds served by the CE department (may include beds from more than one hospital)

CE Serves 1 Hospital: % of responses where the data comes from only one hospital

Total Clinical Devices Maintained was derived from inventory data for Biomedical, Clinical Lab and Imaging devices maintained.

CI: All numbers are presented as the Average ± 90% Confidence Interval (CI)
N: Number of hospitals that provided data

Total FTE includes Totals from the Non-Maintenance Activities Table converted using 46 weeks = 1 FTE

See "CE Demographic Data Explained" under Resources and Guidance for additional details

The data was collected in April 2012 from US Hospitals

According to data collected by ECRI about the number of clinical equipment maintained versus how many biomed technician FTEs were used, Figure 4 and the linear regression was created from the data presented in Tables 1 and 2 (ECRI, 2015). Table 2 is an excerpt of Table 1, indicating which data the calculations of this project were used to create linear regression on how many BMET FTEs would be required per total devices maintained.

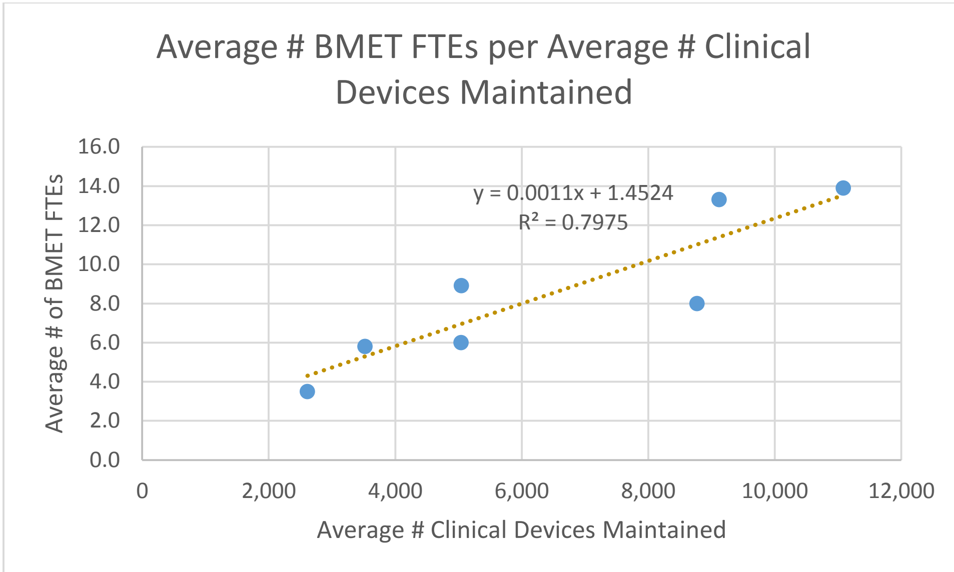
Table 2 ECRI Excerpt of Biomedical Benchmark Table Displaying Devices Maintained and BMET FTEs Table

Total Clinical Devices Maintained			BMET (FTE)	Total (FTE)	% BMET FTE
Average	+/- CI	N	Average	Average	
11,082	5,267	9	13.9	17.3	80%
8,773	3,483	4	8.0	10.1	79%
9,122	3,483	14	13.3	16.6	80%
5,043	2,211	16	8.9	11.7	76%
5,041	1,984	35	6.0	7.8	77%
3,522	966	40	5.8	7.7	75%
2,612	748	39	3.5	4.9	71%

The linear regression equation found was as described in Equation 1:

$$BMET\ FTEs = 0.0011(\#\ clinical\ devices) + 1.4524, R^2 = 0.7975 \qquad (1)$$

Figure 4 Average Number of BMET FTEs per Average Number of Clinical Devices Maintained



Equation 1 was the regression line for the data that resulted in a correlation coefficient of 0.8931 with +1.0 indicating positive correlation and -1.0 indicating negative correlation (Black, 2008). It should be noted that these FTEs did not include others that would assist in the department such as the director, clinical engineers, or clerical FTEs. This data does not take into consideration the complexity of the equipment, or if outside contractors are also used. With an R^2 value of 0.7975 and a correlation coefficient of 0.8931there appears to be some linear correlation that agrees with common sense idea that the more equipment you have, the more people you may need to work on them. Due to the lack of data and possibly large amount of error, this may not be the most accurate way to estimate how many biomed techs would be needed based on the number of equipment that is maintained.

The State of Alaska is listed to pay on average annual wage of $69,280 for medical equipment repairers (Bureau of Labor Statistics, U.S. Department of Labor, 2016-17). This is the value used as the cost per employee wage. The Alaska Native Medical Center's Biomedical Engineering website publicly lists that it has over 6,000 medical devices that they service, so the estimate for all equipment was assumed to be 6,000 for the purpose of this analysis (Alaska Native Medical Center, 2016).

Out of State Hire Expenses to Increase the Number of Biomedical Technicians

Alaska Department of Labor and Workforce Development's Trade Adjustment Assistance Program will pay up to 90% of relocation expenses of travel, food, and lodging or up to $1,250.00 (State of Alaska Department of Labor and Workforce Development, 2013). As an assumption I will assume that the cost to relocate an employee to Alaska will be $1,250 each.

For out of state hire relocation costs it is assumed that all techs will need to be hired the first year and additional techs each year, but that the expenses from the previous hires is not included. For example, if five techs are hired the first year and there are seven techs in the second year, the second year's expenses are for the two new techs that were hired, not for seven. Table 3 lists out the assumption descriptions and numerical values used for out of state hire option to increase biomed techs in Alaska calculations.

Table 3 Assumptions for Out of State Hire BMET Expenses Calculation Table

Out of State Hire Expenses					
# of Devices	# Biomed Techs Needed = 0.0011(# Devices)+1.4524	Cost Relocation Per Tech	Annual Increase Techs	Annual Cost per Tech	Inflation
6,000	8.0524	$1,250.00	30%	$69,280	2.54%

Once the expenses are calculated the present value, or PV, and future value, or FV were calculated using the Equation 2 and Equation 3:

$$FV = PV(1 + r)^n \tag{2}$$

$$PV = FV/(1 + r)^n \tag{3}$$

where *PV* is present value, *FV* is future value, *r* is the rate per period, and *n* is the number of periods as described by Mike Fisher (Fisher, 2012). The rate r used was 2.54% as is listed as Anchorage's inflation rate (State of Alaska Department of Labor and Workforce Development, 2010). The results of out of state hire option expense calculations are tabled below in Table 4, as well as graphically displayed in Figure 5.

Table 4 Out of State Hire BMET Expenses Calculation Table

Year	BMET FTEs	Annual Cost/FTE	Relocation Costs	Total Cost	PV	FV
1	8.05	$557,870.27	$10,065.50	$567,935.77	$553,867.54	$582,361.34
2	10.47	$725,231.35	$3,019.65	$728,251.00	$692,619.10	$765,715.99
3	13.61	$942,800.76	$3,925.55	$946,726.30	$878,101.07	$1,020,714.73
4	17.69	$1,225,640.99	$5,103.21	$1,230,744.20	$1,113,254.72	$1,360,633.15
5	23.00	$1,593,333.28	$6,634.17	$1,599,967.45	$1,411,382.03	$1,813,751.21
Total		**$5,044,876.66**	**$28,748.07**	**$5,073,624.73**	**$4,649,224.45**	**$5,543,176.43**

Figure 5 Out of State Hire Calculated Expenses Over Time

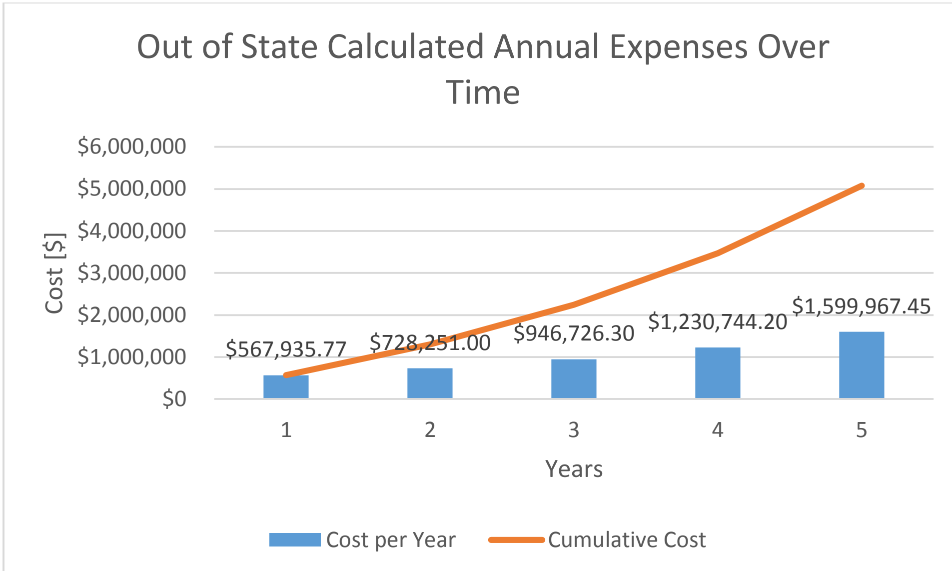


Figure 5 shows the cost estimates over five years of an expected 30% job need increase per Figure 2 and a review of Biomedical Engineering field as a whole (Abu-Faraj, 2008; Barry, 2015-16). The calculated values are listed in Table 4 with assumptions listed in Table 3. It was found that the annual cost in salary in five years for 23.00 BMET full time employees would be $5,044,876.66 with relocation costs of $28,748.07 making it $5,073,624.73 total. It should be noted that Bureau of Labor and Statistics predicts a 6% increase in the job market for the years 2014-2024, warranting there may be a need to determine why such a large gap in estimates (Bureau of Labor Statistics, U.S. Department of Labor, 2016-17). It should be noted that since all of the values are cost, negative numbers were not used.

Sending People to Training Expenses to Increase the Number of Biomedical Technicians

Sending someone to training is a broad term that can either mean sending an individual for an associate's degree, bachelor's degree, or to take a certification test. The closest state with a school offering an associate's degree for biomedical technical training is in the state of Washington which has at least three schools that offer programs geared towards this profession (Barry, 2015-16). Of the three listed in the state of Washington, Bate Technical had the number of highest graduates as of 2013 so that was the school used for cost comparisons (Barry, 2015-16; Bates, n.d.). For an associate's degree the program at Bates Technical Training for Biomedical Service Technician the tuition costs were calculated based on a 12-credit quarter, four quarter per school year and tuition rates published by Bates Technical (Bates, n.d.). An average annual tuition increase for a public two-year institution was published to be 2.6% from the academic year 2005-06 to 2015-2016 as published by College Board, and was used to estimate the annual tuition costs over time (College Board, 2016). It was assumed that the biomed tech would not earn a salary until after the two-year degree was completed. It should be noted that since all of the values are cost, negative numbers were not used.

Table 5 Assumptions for Sending to Training BMET Expenses Calculation Table

2 Year Associate's											
# Credits/ Quarter	Quarters / School Year	Quarterly Tuition	Total Credits Required	Total Quarters Required	Cost/ Year	# of Devices	# Biomed Techs Needed = 0.0011(# Devices)+1.4524	Annual Increase Techs	Annual Cost per Tech	Annual Tuition Increase	Inflation
12	4	$1,334.70	118	9.833333	$5,338.80	6,000	8.0524	30%	$69,280	2.60%	2.54%

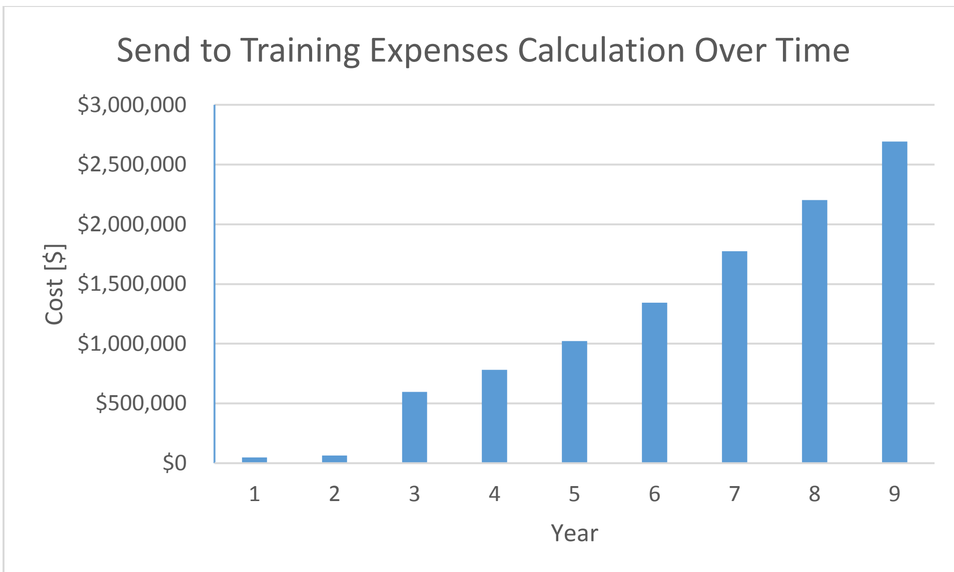
Table 5 lists out the assumption descriptions and numerical values used for sending people to training before hire option to increase biomed techs in Alaska calculations. Table 6 shows the sending people to training before hire option expense calculation results, which are displayed graphically in Figure 6.

Table 6 Sending to Training BMET Expenses Calculation Table

Year	BMET FTEs Needed	Annual Cost/FTE	Annual Tuition Costs Over Time	Total Annual Tuition Costs	Total Cost	PV	FV
1	8.05		$5,338.80	$42,990.15	$48,328.95	$47,131.81	$49,556.51
2	10.47		$5,620.03	$58,831.11	$64,451.14	$61,297.67	$67,766.84
3	13.61	$557,870.27	$6,069.88	$33,725.23	$597,665.38	$554,342.48	$644,374.05
4	17.69	$725,231.35	$6,726.20	$48,583.38	$780,540.93	$706,028.82	$862,916.82
5	23.00	$942,800.76	$7,647.27	$71,807.17	$1,022,255.21	$901,763.74	$1,158,846.46
6	29.90	$1,225,640.99	$8,920.53	$108,891.84	$1,343,453.37	$1,155,746.85	$1,561,645.57
7	38.87	$1,593,333.28	$10,676.34	$169,422.17	$1,773,431.79	$1,487,857.36	$2,113,818.44
8		$2,071,333.27	$13,109.96	$117,588.44	$2,202,031.67	$1,801,677.50	$2,691,349.29
9		$2,692,733.25			$2,692,733.25	$2,148,589.83	$3,374,684.30
Total		$9,808,943.18	$64,109.02	$651,839.50	$10,524,891.69	$8,864,436.05	$12,524,958.27

Figure 6 shows the calculations of costs for paying for tuition of all technicians needed, also showing the present value and future value of those total calculations displayed in Table 6 and assumptions in Table 5. These calculations are based on Bate Technical's tuition, assuming a 2.54% annual increase in tuition, and that the degree will be completed in two years. This indicates that the initial students needed to have their education paid for two years, and each year the difference in biomed techs needed their education cost is also paid for during the two years of an associate's degree. Paying for tuition over two years per tech means that the calculations had to be drawn out longer than the previous calculations, and there are no BMETs for the first two years. Over 9 years there was a calculated $9,808,943.18 in salary expense, $651,839.50 in tuition expense and a total cost of $10,524,891.69 which included salary and tuition expenses. The relocation and room & board costs were not included in this calculation. While the cost of tuition is high, if the focus is to increase biomedically technically trained individuals in rural Alaska, most rural Alaskans are Native and there are funding opportunities to ease the financial burden (Huskey, 2004; ANTHC, n.d.). Funding opportunities for Natives interested in healthcare fields include ANTHC's scholarships, as well as scholarships from Indian Health Services (ANTHC, n.d.).

Figure 6 Send to Training Expenses Calculation Over Time



Developing Training to Increase the Number of Biomedical Technicians

In 1989 it was recommended that developing countries that receive medical equipment should have a department created to manage the equipment, and a training program that works with that department as a response to outside funding and sources leaving after a short duration of stay to install and service medical equipment in the area (Weed, 1989). As these were the top two recommended things that should be in place in a developing country, it is proposed that this may be a reason to increase biomedical training in a State that belongs to the developed country of the United States. The World Health Organization has guidelines on how to develop a program in technology healthcare technology management programs that would employ biomedically trained individuals, and there are hospitals in Anchorage, AK that currently use healthcare management (WHO, 2005; ANMC, 2016).

The State of Alaska has a CHAP program to address the gap in medical healthcare in rural Alaska that was successful enough to expand to dental healthcare as well (U.S. Department of

Health & Social Services, 2009). There seems to be evidence that if workers were trained locally that they would stay and address the needs of rural community (Wilson, 2009; Huskey, 2004). Composing a SWOT Analysis, Figure 1, shows that some opportunities that can come from this gap in the number of trained biomedical technicians are educational avenues such as programs, or companies that can provide these services.

As a part of Total Quality Management course at UAA's ESPM program the idea of a triple bottom line was introduced as a viable means to approach businesses. Incorporating training and hire of local peoples would adhere more to the triple bottom line model of sustainability, particularly including the social aspect of sustainability that can allow for better retention rates of employees and aiding the economy (Mcwilliams, 2014).

Discussion & Conclusion

Comparing the data in Figures 5 and 6, displayed in Figure 7 shows that with the accepted assumptions, costs of hiring out of state workers is cheaper than paying for the students' tuition and then employing them. While the initial two years appear to be a lower cost, this may not be realistic because an accredited institution would need to either have BMET on staff or have contracted workers to maintain compliance of standards until their trained employees have completed their education. A more realistic application would be local education or program that allows for the individual to work, obtaining hands-on experience under supervision until competency levels are achieved.

Figure 7 Cost Comparison Graph

Overall with the State of Alaska having a work retention of 84% there may be a need to further researched to see how often these costs would need to be incurred, which would make hiring from out of Alaska costly and not viable long-term (US Department of Labor, 2004). The analysis is based on a very rough estimate of how many techs would be needed, based on the number of equipment estimated and the cost based on listed assumptions.

There are varying information on statistics and benchmarks, and it would be beneficial to further look into the more accurate data relaying amount of biomed techs needed per number of beds in a hospital, per number of equipment serviced and incorporation of specialty device needs that would require additional FTEs and/or other requirements. With such large confidence intervals, the raw data that is currently collected and published is not statistically significant

With the above findings it is recommended that Alaska increase biomedical technical training in order to meet the healthcare needs of the state through the investment of local peoples, by either developing a training program or sending them to training depending on the availability and economic feasibility. While hiring techs from out of state appears economically the best choice short-term, with the State's retention rates that is not likely to be a long-lasting solution unless the staff are willing to stay to meet the needs in Alaska. Promoting social sustainability is a triple-bottom line practice that would support local hire that is more likely to remain in the community in which they're living.

As the University of Alaska Anchorage vamps up their healthcare fields of education that could also be an avenue in which a collaboration on this could benefit from growth in the healthcare field locally via formal education. Based on the population of Alaska and the current universities available it may not be feasible in the current economy to incorporate a new degree for this major, but a specialization under another engineering degree could meet a growing demand. An alternative solution that is unique to Alaska that could aid in increasing the number of trained biomedical staff to join Alaska's workforce would be to expand the already successful CHAP program to include biomedical engineering.

Gauging the interest in the local community, and further looking at different models to estimate staffing level needs are items that can be looked into for future work.

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