

# **Sustainable Implementation of New Technologies: A Valuation Method for Healthcare Supply Chains<sup>1</sup>**

Alexander Mark Ehms

## **Abstract**

The external environment in which most business exists is volatile, ambiguous, and ever-evolving. In the wake of the e-commerce evolution, health care services are adapting to provide online prescription refills, in addition to sharing patient information using database software and cloud computing. Sustainability is a key component and critical measure to consider when implementing change and taking on new projects. Long term sustainability is contingent on supply chain networks (SCN) working in cooperation to produce sustainable economic, social, and environmental outputs. In order for these networks to have successful interrelationships, valuation methods must be used to select projects that produce sustainable solutions. This paper reviews the pertinence of web based technologies to the healthcare industry in order to facilitate sustainable operations, while addressing methods of evaluation for selection of new technologies. The findings conclude that measuring sustainability is relatively subjective and that sustainability might best be managed as a “risk.”

**Keywords:** sustainability, value, healthcare, corporate social responsibility, sustainability performance management, risk management, supply chain, IT, software engineering, quality management

## **Glossary of Acronyms**

- AHP: analytical hierarchy process
- GNH: gross national happiness
- GRI: global reporting initiative
- GSA: general services administration
- HIPAA: Health Insurance Portability and Accountability Act
- PPP: public/private partnerships
- PV: present economic value
- SCN: supply chain networks
- SROI: social return on investment
- VfM: value for money

---

<sup>1</sup> *Second Editions are previously published papers that have continued relevance in today's project management world, or which were originally published in conference proceedings or in a language other than English. Original publication acknowledged; authors retain copyright. This paper was originally presented at the [3<sup>rd</sup> annual University of Maryland Project Management Symposium in College Park, Maryland, USA in May 2016](#). It is republished here with the permission of the authors and conference organizers.*

## **Introduction**

Like most industries, healthcare providers rely on customers in order to continue operations. In our lifetime, we have witnessed advances in modern technology that would have at one time seemed to be the dreamed up concoctions of a science fiction novel. We have also witnessed the rise and fall of many companies, whose failure to implement change had far reaching consequences. “Eastman Kodak is a picture-perfect example. It built one of the first digital cameras in 1975.” (18) For many reasons, some perhaps well justified, the company was slow to change the once highly successful business model. “The development of smartphones that double as cameras, has battered Kodak's old film- and camera-making business almost to death.”(18)

With patients and/or caregivers who are progressively becoming more tech savvy, hospitals, pharmaceutical companies, and medical device manufacturers must tailor their services appropriately. Healthcare services such as nonprofit hospitals have seen a downward trend in terms of revenue growth over the past several years. “Total operating margins have remained negative from federal fiscal year (FFY) 2000 to midway through FFY07, according to the data, although the trend has improved slightly in recent years. That means hospitals are losing money on their core business of providing patient care.”(14) Admissions are falling due to increases in insurance rates and the availability of alternatives such as immediate care facilities, and telemedicine. For healthcare organizations, this means realignment of the firm’s fundamental strategic management plan; goals, objectives, and the strategy of the business operations, including maintaining visibility in a market where alternatives are numerous.

Healthcare facilities share a SCN with private manufacturing, distribution, and logistic firms. Meaning that healthcare supply chains house public/private partnerships (PPP). “A typical PPP example would be a hospital building financed and constructed by a private developer and then leased to the hospital authority. The private developer then acts as landlord, providing housekeeping and other non-medical services while the hospital itself provides medical services.” (2) Because of this relationship, the social/environmental outputs of long term sustainability might not necessarily align with maximizing the present economic value (PV) of the SCN. The concern is insuring that the SCN is selecting the best whole life outcome. This requires that “patient advocacy organizations, clinicians, medical clinics, health care policymakers at the Federal, State, and local levels, purchasers, payers, and both public and private insurers” (3) involved understand the importance of sustainable operations.

## **The Industry**

There is a very real structural shift in the healthcare industry. Patients and caregivers are more technologically inclined. Convenience, ease of use and cost are highly important during the decision-making process. Paul Matsen, CMO of Cleveland Clinic is quoted as saying “about 80% of patients who are diagnosed with an illness go on the web to find information about their condition.”(12) We know that search engines play an important role in the use of the internet and identifying online resources. As researchers it is important to acknowledge trends in consumer behavior as it relates to interaction with each other, and our electronic devices. Google conducted a study using historical search data. The company used “term buckets” such as hospital brand, conditions, treatment, procedures, and symptoms in order to extrapolate their findings. The results showed that “search drives nearly 3x as many visitors to hospital sites

compared to non-search visitors.”(17) This same study also identified that mobility plays a role in the decision-making process. Approximately 44% of patients who research hospitals are using mobile devices, schedule appointments. This statistical evidence is a good indicator of the consumer’s increase in accessibility and utilization of healthcare-related digital information. With 76% of patients using hospital websites for research, not only does digital media have the largest audience base of the cumulative total market, accessibility to digital media has a significantly high conversion rate for consumer purchase. By understanding these market trends, the importance of implementing new technologies including web-based services becomes pertinent to the SCN’s sustainability.

Pew Internet has examined the social media trend as it relates to the healthcare market. According to the Pew Internet survey “About one in five internet users have consulted online reviews of particular drugs or medical treatments, doctors or other providers, and hospitals or medical facilities.”(5) This finding illustrates the importance of social media in relation to healthcare marketing. Firms should be monitoring social media in order to gain feedback and address consumer concerns.

A good example of successful implementation of web based technologies is the Mayo Clinic. Mayo Clinic is a nonprofit healthcare leader, with operations in several states. The company has been successful at implementing responsive website designs that enable/promote a mobile friendly experience. The clinic has an app for patients to book appointments, access information, in addition to a special pregnancy app for expecting mothers. While other healthcare providers are losing market share with operating revenues decreasing, “The Mayo Clinic in Rochester, Minn., reported operating income of \$347 million for the first six months of 2014.” (21) This figure represents a 131% increase from the prior year.

### **Behavioral Economics**

Once the concern has been identified e.g., the need for innovative services and tailored marketing, the second step is understanding the psychological selection process of the end-consumer. Behavioral Economics is a methodology for reviewing human behavior relative to conventional economic models.

In making a purchase decision, consumers review the market and identify their preferences. However with the presence of multiple choices, our brains tend to simplify the process and make fast “executive decisions.” Advertising as a general statement is hugely dependent on the consumer remembering and identifying with the ad. Because there is typically a time delay between the consumer’s exposure to the ad and the decision-making process, the memory cues are quite critical to the advertisement’s effectiveness.

In digital advertising, an alternative is to capture the sale immediately before the patient leaves the site/page. The typical end consumer values convenience, and targeted products. Whether it’s creating an account, scheduling an appointment, or refilling a prescription, ease of use is a significant variable.

Consumers tend to “suffer” from several types of phenomenon when making decisions. “Present Bias” is when “decision makers tend to put too much weight on costs and benefits that are immediate and too little on those that are delayed.” (9) When we consider healthcare, there is little obvious immediate benefit from attending an annual physical or dental cleaning. What

consumers perceive rather is the immediate cost in terms of time, energy, hassle, transportation, and monetary co-payments. Forgoing multiple visits over an extended period of time can be attributed to the “Peanuts effect.”(22) This is when a consumer makes repeated decisions based on present bias, and does not perceive the cumulative consequence of their actions.

Healthcare facilities can use defaults as a means of persuasion. Utilizing online accounts linked to patient emails, facilities may default to scheduling follow up appointments and send email reminders. So long as the facility is HIPAA compliant in their communication. They may guide the decision, making it harder to opt out. This plays off the aforementioned tendency to make simplified fast decisions. Since the end consumer has limited attention, the brain creates mental shortcuts. There is a greater chance an individual would accept a default versus making the cognitive decision to opt in or out.

### **Barriers of Entry**

HIPAA was enacted in 1996 and sought to regulate the exchange of electronic information. Doctors must be careful to abide by HIPAA regulations in their marketing. Although Doctors are afforded the right to market to current patients, targeted marketing is limited as patient records and information must not be disclosed. Having patient data accessible online often requires that the data be passed along to IT personal who manage the site.

With added technology comes increased complexities. Cybersecurity is an important variable. Risks include both authorized and unauthorized transmission of data. “Hospira was the first medical device company to receive an FDA safety communication because of a cybersecurity risk.” (4) The FDA discouraged healthcare facilities from purchasing Hospira’s infusion pump medical device because it was vulnerable to cyber-attacks. The vulnerability would allow hackers the ability to administer higher or lower levels of drugs to the patient. Even malware may be transferred to medical devices if USB devices are used to transmit data from the device and general hospital computer systems. This malware has the potential to interrupt the normal operation of the infected medical device.

When considering digital marketing for the healthcare industry, it is not just a question of law but also ethics. The American Marketing Association states: “1. Do no harm, consciously avoiding harmful actions or omissions. 2. Foster trust in the marketing system, striving for good faith and fair dealing as well as avoiding deception, and 3. Embrace ethical values, building relationships and enhancing consumer confidence in the integrity of marketing.”(15)

“Perceptual barriers” are the biggest concern regarding the ability to assign value and address the importance of societal and environmental outputs among PPPs. “Insurers may resist approving an expensive new heart drug even if, over the long term, it will decrease their payments for cardiac-related hospital admissions.”(6) This is a good example of “present bias”, in which the insurer only perceives the present cost and not the future benefit.

Physical barriers are evident in all industries, and including variables such as monetary cost of entry/implementation.

In order for healthcare supply chains to remain sustainable, they need to be able to express the importance of their continued operation to the privately owned partners that make up the SCN. Sustainability as it relates to the example of web based technologies is twofold. First, the SCN

needs to be aware of the need for new technologies in order to sustain current operations. Second, in selecting which new technologies to adapt, the SCN must evaluate the sustainability of the project, processes, and equipment. How may the healthcare supply chain evaluate a new technology, process, or project in the planning stage?

### **Risk**

Risk is an uncertainty that may ultimately lead to a positive or negative influence on a project's objectives. Sustainability needs to be managed similar if not identical to risk. During the initial planning process, prior to the implementation of any new equipment or processes, a cross-functional project team should determine possible problems. By identifying the risk event, the probability of its occurrence, and if occurred its potential impact, the team may avoid making costly mistakes. Sustainability as a risk has the possibility of being mitigated by first understanding the drivers that could facilitate the lack of sustainability in a project, process, product, or service. In the case of web based technologies drivers may include foreseen or unpredictable changes in federal or state policy, vulnerability to threats such as malware or malicious cyber-attacks, and an inability to add-on, or change the service offerings and capacity of the new technology without removing it entirely and starting over. Using the drivers, the team may identify the likelihood or probability of the event occurring and the total loss if the event occurs. Expected loss then becomes a function of probability of event, probability of impact, and total loss. Managing sustainability from both present and future perspectives the SCN should also consider the expected useful life of the new technology. By conducting a risk reduction leverage analysis, the SCN may determine the added benefit of taking certain preventative actions in comparison to the initial exposure of the risk.

The SCN will also need to navigate endogenous risks such as market volatility and exogenous uncertainties such as economic volatility during both the implementation and ongoing control stages. If sustainability is a risk, the drivers and counter forces become risks inside of the risk and must be managed as both individual and collective.

In order to manage sustainability as a risk, evaluation of the drivers, events, impact, and loss must be quantifiable. Learning through association (classical conditioning) tells us that "if a neutral stimulus (a stimulus that at first elicits no response) is paired with a stimulus that already evokes a reflex response, then eventually the new stimulus will by itself evoke a similar response." (19) This means that the relationship between economic return and sustainability is essential to understanding its value and to relate this value to stakeholders.

### **Value for Money**

Understanding the importance of sustainability is partially dependent on the ability to quantify its value. Value for Money (VfM) as a method of assessment may determine what projects within the supply chain are deemed most appropriate for the use of public resources and those best fit for a PPP. In a sense VfM may be used in the decision making process of whether to make or buy a product/service. Once these relationships have been established a VfM analysis may be used as a tool to periodically assess the value of the PPP. This valuation method may be applied to determine what technologies to implement, and what portion of these services should be outsourced to PPPs.

## **Cost Effectiveness**

One method used to measure VfM is Cost Effectiveness or CE ratio. CE ratio is the cost per unit of effectiveness, which in the case of a social infrastructural institution such as a hospital, the unit of effectiveness may be the number of patients treated. A low CE ratio means a low cost per patient treated. CE ratio may also be used in order to select the most appropriate treatment method to be used in a hospital. Take for example the Alameda County Medical Center in Oakland, California, a “mismanaged urban safety-net hospital system in one of America's most violent cities.”(8) Wright L. Lassiter took over as CEO in 2005, a time when ACMC was losing over a million dollars per month. Lassiter is attributed for numerous changes that eventually turned the hospital around. One example of the many changes was realizing the Cost effectiveness of an umbilical-cord blood test kit used by the hospital. The kit ACMC was using prior to Lassiter taking over cost \$96.50 per unit. A similar testing tool was available on the market that would do the same job, and only cost \$.29 cents per unit. This similar tool offered a lower cost to unit of effectiveness ratio. “ACMC had been choosing the premium option, at a cost of \$322,000 a year. Now, the teams decided, ACMC could not afford it.”(8)

## **Social Return**

Indicators of sustainability may be broken down into three separate groups; environment, social, and corporate governance. Environmental indicators may include such business practices as non-investment expenditures for environmental protection, total emissions, consumption of renewable energy, and production of waste. Corporate governance includes indicators such as code of ethics, stakeholder impact, and collective agreements. Lastly, social sustainability focuses on indicators such as monetary support of local community, gender in the workplace, diversity, number of terminated employees, wages, and education expenditures.

Many of these indicators are critically important. For the purpose of this paper, let us focus on social sustainability for a moment. Organizational success cannot be defined by a single “financial” measure. Non-financial objectives play an intricate role in driving performance. These social drivers may influence financial performance in both positive and negative ways. Social return on investment (SROI), looks at both financial and social impact of the corporation and may be calculated as;

$$\text{SROI} = (\text{Social Impact} - \text{Investment}) / \text{Investment}$$

Supporting local community is important to the reputation of the organization. Employee morale is essential to both employee retention through a reduction of voluntary turnover, and for recruitment. Especially within the healthcare industry, as skilled labor is a limited resource and a necessary component. Making investments in non-financial objectives, may be quantified using this method, and justified based on the weighting criteria as it relates to the firms goals, objectives, and business model.

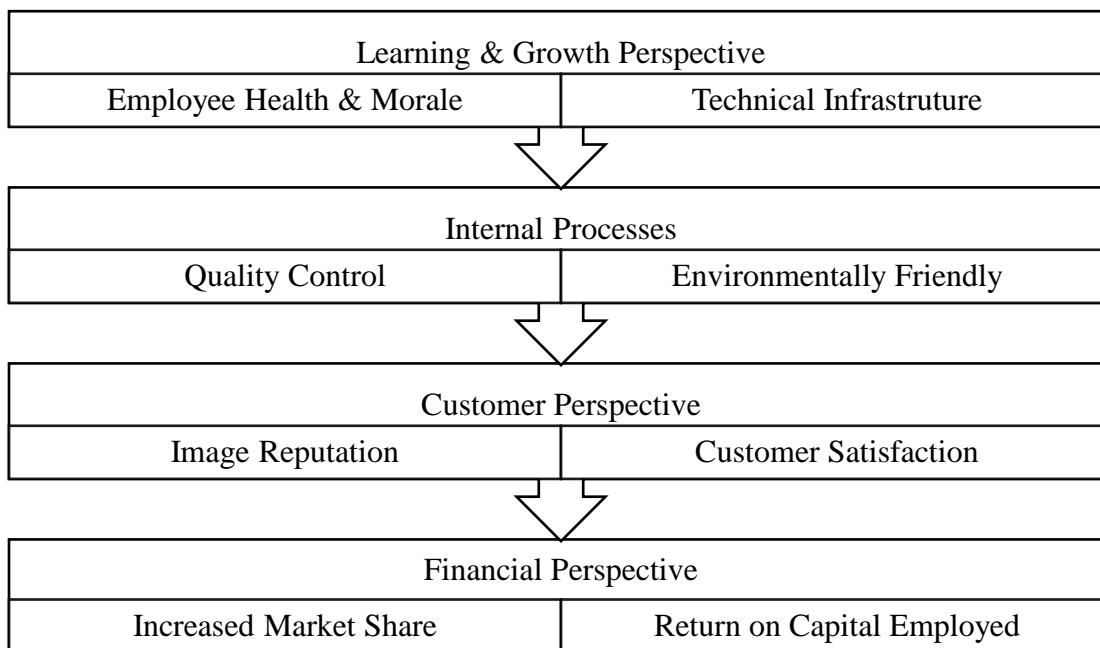
## **AHP**

Through the use of the “Scale of Relative Importance” (13) the analytical hierarchy process (AHP) allows the user to assign value similar to that of a project selection scoring model. This ability to prioritize and assign a weighted value has proven effective in health care related selection models. Hoechst AG, is a pharmaceutical firm. The firm utilizes a scoring model based

on a total of 19 questions developing five types of criteria. “The five categories include: probability of technical success, probability of commercial success, reward to the company, business strategy fit, and strategic leverage (ability of the project to employ and elevate company resources and skills).”(11)

**Economic Value Added**

The purpose of SCN sustainability is to successfully satisfy major stakeholders. This includes industry players such as “physicians, hospitals, and an array of powerful intermediaries, including group purchasing organizations, or GPOs, which consolidate the purchasing power of thousands of hospitals.”(6) This means that for the private firms involved, maximizing profits is a part of the SCN success. (Figure 1) is similar to a strategy map in that it illustrates the chain reaction from investment to financial outcome. A firm may estimate the future economic value as to express the importance of the investments in new technologies to maximizing the wealth of the stakeholders involved. The goal of the SCN then should be to find a relationship between the non-financial objectives and future financial value. Making changes from the ground level will also allow the firm to optimize the degree of operating leverage by taking advantage of processes that reduce costs.



*Figure 1*

**Gross National Happiness**

“The concept of well-being was first discussed by the Bhutan Gross National Happiness initiative which referred to subjective well-being as central to sustainable development.”(16) GNH is a measure of sustainable infrastructure (SI). GNH measures well-being in terms of obesity, chronic illness, mental disorders, depression, and insomnia. GNH recognizes the interdependencies that exist between SCs and the SCN. Long term success of a civilization is dependent on the mental and physical health of the population. This means that healthcare supply

chains must be sustainable. “An important objective for appraisal should be to foster learning of more than one type and, potentially, to modify the belief systems and behavior of individuals and organizations over time.”(10) If GNH is an indication of a country’s sustainability, and this is dependent on SI, then GNH is an indicator of successful healthcare supply chains. GNH may also be used as a measure of effectiveness, as a subjective, weighted system of indicators that assigns a rank or score to either an individual facility, or the SCN on a local, regional, national, and global scale.

The United States’ General Services Administration (GSA) is one of the world’s largest single procurement bodies. The GSA procures for all of the government’s non-military related needs and spends over \$600 billion annually. “The GSA and the Department of Defense are actively involved in the management of sustainability in their supply chains.” There is a global push for non-financial reporting. National laws and regulations are being enacted, and the demand for transparency is increasing. The global reporting initiative (GRI) has 8770 organizations who have issued reports to their database worldwide. These non-financial indicators are becoming more and more popular with investors and the GRI is slowly being “integrated into stock exchange listing guidelines, requested by large asset owners and managers and expected by large institutional customers.”

## **Conclusion**

The Baldrige framework’s 11 foundational and interrelated core values for health care organizations are “visionary leadership, patient-focused excellence, valuing people, organizational learning and agility, focus on success, managing for innovation, management by fact, societal responsibility and community health, ethics and transparency, and delivering value and results.”(1) In order to achieve quality in both products and services, healthcare supply chains must focus on these core values. Many of which are addressed by the need for sustainable practices, and evaluation methods.

It is not just the healthcare industry that needs to recognize the importance of sustainable technology. “Surveys of published studies show over 50% of those on sustainability in software engineering were published between 2010 and 2012, indicating the emergence of the topic in the software-development community.” (7) Although ISO/9126 and ISO/IEC 25010 do not consider sustainability as a property of software quality, the Third Working Draft of ISO/IEC 42030 Systems and Software Engineering Architecture Evaluation has much to offer software practitioners. Assisting in “making trade-offs, not only among technical and economic aspects of business sustainability but also in relation to society and the environment.” (7)

This paper has looked at several varying methodologies. Many of which are interrelated, and most of which have merit in this field. Further research would be necessary in order to make additional conclusions regarding sustainability as a risk, and the nature of the valuation methods that may be used. Conclusions that may be derived from the current research show that managing sustainability as a risk allows project managers, SCNs, and stakeholders to make educated decisions that allow for continued growth and operations. While evaluation methods for sustainability are primarily subjective, use of data sensitivity analysis would help assign weighted values to the various indicators, and the use of interrelated valuation methods may increase the success of risk management as it relates to sustainability, particularly in the



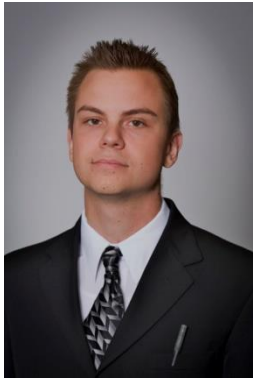
planning, selection, implementation, and control of web-based technologies for healthcare supply chains.

## References

1. Another Reason Health Care Organizations Need the Baldrige Framework. (n.d.). Retrieved February 23, 2016, from <http://nistbaldrige.blogs.govdelivery.com/2016/02/02/another-reason-health-care-organizations-need-the-baldrige-framework/>
2. Barlow, J., Roehrich, J.K. and Wright, S. (2013). Europe Sees Mixed Results From Public-Private Partnerships For Building And Managing Health Care Facilities And Services. Health Affairs.
3. Chapter 3: Getting Involved in the Research Process. February 2014. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/research/findings/evidence-based-reports/stakeholderguide/chapter3.html>
4. FDA. 2015. Cybersecurity vulnerabilities of Hospira Symbiq infusion system. FDA Safety Communication, July 31. Silver Spring, MD. Available at <http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm456815.htm>
5. Fox, S., & Duggan, M. (2013, January 14). Health Online 2013. Retrieved December 24, 2015.
6. Herzlinger, R. (2006, May 01). Why Innovation in Health Care Is So Hard. Retrieved February 23, 2016, from <https://hbr.org/2006/05/why-innovation-in-health-care-is-so-hard>
7. LAGO, P., AKINLI KOÇAK, . S., CRNKOVIC, I., & PENZENSTADLER, B. (2015). Framing Sustainability as a Property of Software Quality. *Communications Of The ACM*, 58(10), 70-78. doi:10.1145/2714560
8. Mitchell, R. (2011). Medical Wonder: Meet the CEO Who Rebuilt a Crumbling California Hospital. Kaiser Health News.
9. O'donoghue, T., & Rabin, M. (n.d.). The economics of immediate gratification. *Journal of Behavioral Decision Making J. Behav. Decis. Making*, 233-250.
10. Owens, S., Rayner, T. and Bina, O. (2004) 'New agendas for appraisal: reflections on theory, practice, and research', *Environment and Planning*.
11. Pinto, J. (2007). *Project management: Achieving competitive advantage*. Upper Saddle River, N.J.: Pearson/Prentice Hall.
12. Rodriguez, A. (2014, September 16). Why Digital Marketing Has Become the Health-Care Industry's Rx for Revenue. Retrieved December 24, 2015.
13. Saaty, T.L. (1980). *The Analytic Hierarchy Process*. McGraw-Hill International, New York, NY, U.S.A.
14. Schuhmann, T. M. (2007). Medicare margins trending downward. *Hfm (Healthcare Financial Management)*, 61(12), 30-32.
15. Statement of Ethics. (n.d.). American Marketing Association. Retrieved December 24, 2015.
16. Sustainable Development Solutions Network (SDSN). (2013). An action agenda for sustainable development: Report to the UN Secretary-General.

17. The Digital Journey to Wellness. (2012). 2012 Google/Compete Hospital Study. Retrieved December 24, 2015.
18. The last Kodak moment? (2012). Retrieved February 23, 2016, from <http://www.economist.com/node/21542796>
19. Three Major Types of Learning. (n.d.). Retrieved December 31, 2015, from <http://faculty.washington.edu/robinet/Learning.htm>
20. Wallace, M. (2016, January 28). Sustainable supply chains: The new information highway. Retrieved February 23, 2016, from <http://www.greenbiz.com/article/sustainable-supply-chains-new-information-highway>
21. Weaver, C. (2014, August 27). Nonprofit Hospitals' Earnings Fall as Costs Outrun Revenue. Retrieved December 24, 2015.
22. Weber, B., & Chapman, G. (n.d.). Playing for peanuts: Risk seeking is more common for low stakes gambles. PsycEXTRA Dataset.

## About the Author



**Alexander Ehms**

Buffalo, NY, USA



**Alexander Ehms** recently received his Master's degree in Supply Chain and Operations Management from the University at Buffalo (The State University of New York) in Buffalo, New York, USA. Alexander holds a Bachelor's of Science degree in Business and Associates of Science in Business Management, and has completed a four year university level certification program in Business/Environmental Sustainability. During five years of professional experience, Alexander has held titles such as supervisor, workforce coordinator, and Marketing Analyst. He can be contacted at [amehms@buffalo.edu](mailto:amehms@buffalo.edu)