

WIP: Identifying Technology Social Ventures for Research on Technology-Based Social Entrepreneurship Education for Engineering Students

Dayoung Kim
Department of Engineering Education
Virginia Tech
Blacksburg, USA
dayoungkim@vt.edu

Bailey K. McOwen
Department of Engineering Education
Virginia Tech
Blacksburg, USA
mcowen@vt.edu

Abstract— In this research work-in-progress paper, we introduce an ongoing research project that aims to establish foundations for technology-based social entrepreneurship education for engineering students. To answer the research questions of this project, we first clearly define what technology social venture means in our research with example organizations that can be classified as technology social ventures. We explain how we identified such organizations for the project in detail. We conclude this paper with an introduction to our future work and implications for engineering education.

Keywords—*technology social venture, technology-based social entrepreneurship, entrepreneurship, social entrepreneurship, entrepreneurship education*

I. BACKGROUND

In this work-in-progress research paper, we introduce a groundwork for an ongoing research project that aims to establish foundations for technology-based social entrepreneurship education for engineering students. Technology-based social entrepreneurship stands at the intersection of technology entrepreneurship and the social responsibility concerns of engineers, each of which has been a topic that engineering educators have taken pains to integrate into engineering curricula [1]-[6]. However, most of the attempts to integrate those two topics have been separate and inorganic.

Indeed, research on technology-based social entrepreneurship is an emerging field of scholarly inquiry [7] that can unite these separate efforts. Here, engineers play an important role in the enterprise given the enterprise's reliance on technology innovation for social good. Accordingly, technology-based social entrepreneurship education for engineers has ample potential to give engineering students the opportunity to become socially responsible engineering leaders with entrepreneurial capabilities.

Despite this potential, engineering programs have made only limited efforts to teach technology-based social entrepreneurship. This is partly because the topic has only recently started to attract scholarly attention, so there has been a lack of understanding of engineering practice in technology

social ventures (TSV), the organizations that have arisen from technology-based social entrepreneurship. Little is known about how engineers identify business opportunities that can balance their social and financial goals, one of the most common challenges in social entrepreneurship. This lack of knowledge makes it challenging to identify the competencies required for successful technology-based social entrepreneurship, and to assess and teach it.

Therefore, in our ongoing research project, we are answering the following research questions to fill this gap: RQ1) How do engineers who founded technology social ventures identify business opportunities that use technology to solve societal problems? RQ2) What competencies, distinguished from the competencies required for technology entrepreneurship more generally, are necessary for engineers to lead their technology social ventures? RQ3) What validity and reliability evidence can be found for the newly developed instrument that measures the competencies for successful technology-based social entrepreneurship?

In this paper, we do not directly answer the research questions. Rather, we introduce our groundwork to answer those research questions. Specifically, to answer those research questions, we first need to clearly define what technology social venture means in our research and identify organizations that can be classified as technology social ventures. In this paper, we describe how we defined and identified the technology social ventures for our research project as an essential groundwork to answer the research questions.

II. TECHNOLOGY SOCIAL VENTURE: DEFINITION AND EXAMPLES

A. Definition of Related Concepts

To define what we mean by technology social venture, we will first define the related concepts, *venture* and *social venture*. To be able to define venture and social venture, it would be helpful to define the concepts *entrepreneurship* and *social entrepreneurship* first.

1) *Entrepreneurship*: While there have been numerous efforts to define entrepreneurship [8]-[12], no single definition

provides a complete picture of it. Comprehensive understanding of entrepreneurship requires each facet of the entire process of entrepreneurial activities, including entrepreneurs' personality traits, their ways to identify opportunities, their methods of acting and managing, and their mechanisms of adapting and reassessing [12]. Therefore, it is difficult to capture its essence in short descriptions.

Gartner [9]'s Delphi study with entrepreneurship researchers revealed that entrepreneurship can be conceptualized around the following themes: 1) entrepreneur, 2) innovation, 3) organization creation, and 4) creating value. The entrepreneur theme reflects the idea that entrepreneurship involves individuals with unique abilities and characteristics, such as risk taking, perseverance, vision, and creativity. The innovation theme reflects the idea that entrepreneurship involves doing something new, such as developing new products or services. The organization creation theme reflects the idea that entrepreneurship involves new venture development. The creating value theme reflects the idea that entrepreneurship creates some or multiple forms of value, such as economic or functional value.

Based on further analysis, they also showed that there are two different viewpoints on defining entrepreneurship: 1) defining entrepreneurship based on its characteristics and 2) defining entrepreneurship based on its outcomes. For the first viewpoint, situations that do not involve characteristics like entrepreneurial individual and innovation are not entrepreneurial. For the second viewpoint, situations that do not involve value creation are not entrepreneurial. Regardless of their viewpoints of entrepreneurship, the organization creation was considered as one of the most essential aspects of entrepreneurship – the theme was highly ranked consistently across individuals. Therefore, in this study we will define entrepreneurship and related concepts with organization creation as a central element.

We can say entrepreneurship involves engaging in innovative activities to establish and develop an organization to create value.

2) *Venture*: A venture is an organization that is created during the process of entrepreneurial activity. It can be either for-profit or nonprofit [9],[13].

3) *Social entrepreneurship*: Social entrepreneurship is a unique type of entrepreneurship, distinguished from commercial entrepreneurship. While commercial entrepreneurship aims at creating individual or shareholder wealth, social entrepreneurship creates social value to solve a societal problem [14]. Societal problems created by market failures generate opportunities for social entrepreneurs.

Wu et al. [15]'s literature review for defining social entrepreneurship revealed that the primary mission of entrepreneurship is a definitive factor for social entrepreneurship. According to the publications across various fields, social entrepreneurship is a type of entrepreneurship with social mission – solving a societal problem – as its primary

mission. Here, social mission focuses on benefits and positive changes for society, rather than benefits for shareholders.

To sum up, social entrepreneurship involves engaging in innovative activities to establish and develop an organization to create social values by tackling social challenges.

4) *Social venture*: A social venture is an organization that primarily targets social challenges through innovative and market-oriented solutions [16]. While some researchers limit social ventures to nonprofit organizations, social ventures can be either for-profit or nonprofit [15].

5) *Technology-based social entrepreneurship*: Reflecting the definition of social entrepreneurship this paper suggested above, we can define technology-based social entrepreneurship. In technology-based social entrepreneurship, entrepreneurs suggest technology-based solutions in creating social values and solving social problems. Thus, technology-based social entrepreneurship involves engaging in activities to establish and develop an organization that creates social value by tackling social challenges through innovative technologies.

6) *Technology social venture*: As an outcome of the technology-based social entrepreneurship, a technology social venture is an organization that primarily targets social challenges through innovative technologies in a financially sustainable, market-oriented manner [17].

B. Social Challenges: Five Focus Areas

As we define social venture and technology social venture with the term social challenges, it is important to clarify what can be considered as social challenges. As discussed, market failure, which refers to the phenomenon that inefficient allocation of resources by a free market leads to a net social welfare loss, provides opportunities for social entrepreneurs. Many social challenges arise directly from market failures, as it means there are unaddressed social needs.

While there are numerous social challenges, for our research purpose we decided to focus on five specific social challenges, which were narrowed down to two criteria: 1) public awareness of its significance, and 2) significant approaches to solve the challenge as through technologies.

We reviewed a few existing statistics of the social issues that Americans find most pressing; issues such as inflation, the affordability of healthcare, gun violence, and climate change are among the issues listed [18]. According to the statistics, issues like healthcare and climate change were pointed out as important social issues, and those are readily addressed by innovative technologies. Therefore, healthcare and climate change issues meet the two criteria. However, issues like gun violence, although those were listed as prominent social issues among Americans, other approaches (e.g., policy) have been considered as more significant approach to solve the challenge than developing new technologies.

Based on the criteria, we eventually chose to focus on the social issues of climate change, healthcare, water inequality, food security, and accessibility. These were found using statistics offered by organizations prioritizing research on one or multiple social issues, including Pew Research, Kaiser Family

Foundation, Centers for Disease Control and Prevention Foundation, and The Rockefeller Foundation.

1) *Climate change*: The amount of carbon in the air has risen by 25% since 1958, and this has had an increasing impact on accessibility to water, food, human health, infrastructure, and the environment at large through the effects of extreme weather events [19]. Polling conducted in 2023 by Pew Research noted that 66% of the participating population viewed climate change as a “moderately big” or “very big” problem [18]. 67% of Americans are in favor of prioritizing the identification of alternative energy sources while 69% would favor the United States becoming carbon neutral by 2050 [20]. The combination of the physical implications of climate change with the increasing alignment in public perception of the importance of addressing climate issues demonstrates the need for engineering solutions.

2) *Healthcare*: Polling conducted by Pew Research in June 2023 shows that 64% of the participating population view accessibility of healthcare, particularly affordability, as being a very big problem in the United States; this was a nine-point increase from the previous year’s polling [18]. As of March 2024, approximately one-half of Americans report difficulty in affording healthcare costs in the United States [21]. This inaccessibility can be associated with socioeconomic descriptors of insurance status, race and/or ethnicity, and household income. Healthcare costs include the services of medical professionals and the necessary goods associated with one’s medical treatment. For instance, one in four adults report having skipped or postponed getting health care due to cost while six in ten uninsured adults (61%) report going without necessary care due to cost. These experiences and behaviors reported by Americans convey the state of inaccessibility to healthcare goods and services. For these reasons, healthcare was included as a social issue with prominent and severe implications that may be addressed by innovative technology.

3) *Water inequality*: It is estimated that approximately 2.2 million Americans are living in shelter without running water or plumbing [22]. Beyond this, inadequate water and septic infrastructure prevents millions from safely disposing of human and water waste. Indigenous communities, communities of color, and low-income communities are often subject to structural disparities in affordability, water quality, and/or flooding that prevents them from accessing safe, clean water and partaking in the economic, social, and environmental benefits that stem from such access [23]. The disproportionate experience of water inequality by people of color, indigenous communities, and individuals with low-income demonstrates the social implications of the issue while the funding of organizations working to address water inaccessibility indicates a space for entrepreneurial individuals to establish a company that can make an impact addressing the issue.

4) *Food security*: The Rockefeller Foundation published a report in 2020 revealing the reality of food inaccessibility in the United States post-Covid from farm to table [24]. The report also notes that approximately 33% of Americans are unable to

afford the amount or quality of food wanted despite massive amounts of food waste. As of 2022, 49 million Americans across every county in the country turned to food assistance programs for support [25]. The combination of the sheer number, spread, and demographics of individuals experiencing food insecurity justifies its inclusion as a social issue. Additionally, the barriers faced in the agricultural industry despite government subsidization and the negative impacts of their practices demonstrates an opportunity for innovative technology solutions.

5) *Accessibility*: One in four adult Americans experience a disability and encounter limitations on their social and economic prospects, mental and physical well-being, and human rights [26]. The Disability and Philanthropy Forum broadly defines disability as “including mental, behavioral, and chronic health conditions, and physical, intellectual, and developmental” impairments (p. 12). It is this population that often experiences obstacles in receiving adequate education and/or training, attaining and/or maintaining employment, and receiving healthcare and services [27]. Accessibility was included in this study due to the high number of individuals in the U.S. who experience one or multiple disabilities in their lives. The combination of the number, spread, and disproportionate experience of these social issues by vulnerable populations demonstrates the prevalence and importance for the public. Additionally, these social issues receive organizational and governmental focus and assistance to alleviate the symptoms experienced because of them [28],[29],[24],[26]. This indicates a space for entrepreneurial individuals to establish a solution or alternative means to assist in addressing these issues.

C. Example Organizations

Based on our definition of technology social ventures and our five focus areas of social challenges, we developed a list of technology social ventures. The following are some of the examples in the list, selected to help readers better understand the definition of technology social venture.

1) *Climate change*: The company named HYCO1 provides a technology named HYCO1 CUBE, which captures industrial CO2 emissions from the source and turns it into high-value, sustainable products. Their goal is specifically addressing CO2 emissions head on rather than storing it for the future [30].

2) *Healthcare*: The company named SafeBeat [31] aims to increase accessibility to remote patient monitoring (RPM), event monitoring, remote therapeutic monitoring (RTM), and cardiac implantable electronic device monitoring by leveraging their artificial intelligence software. SafeBeat’s mission is to provide remote care for individuals to specifically circumvent the overcrowding and understaffing experienced at healthcare offices while still providing high quality, reliable care to patients.

3) *Water inequality*: The company named Aquagga, Inc. stood out as a company solving a problem such as per- and polyfluoroalkyl substances (PFAS) in water, which can lead to severe health problems [32]. Using what they call the “HALT”

process, Aquagga, Inc. harnesses hot, compressed water to mineralize PFAS into benign salts at a fraction of the energy consumption and cost of other solutions which also require specialized disposal. This company's desire to provide accessible, continuous outputs of clean water for their customers warrants the technology social venture label.

4) *Food security*: The company named Crop Convergence aims to address the systemic lack of affordable, high-quality produce by building on work being done in Controlled Environmental Agriculture (CEA) [33]. Noting the need for more efficient means of identifying the best combinations of soil, energy, plant nutrition, and genetics to overcome the produce gap, this company uses artificial intelligence (AI) and machine learning (ML) technologies to create a solution. This solution comes in the form of a modeling system which offers descriptive, predictive, and prescriptive analyses that can be used across farming operations to address these needs in a timely manner. Crop Convergence's emphasis on addressing the nutrition density, product quality, and produce yield issues exacerbating the food security epidemic in America through the innovative application of AI/ML technology makes them an interesting candidate for a technology social venture.

5) *Accessibility*: Regarding the prioritization of accessibility, 4Blind emerged as an example of a company with a mission to assist in socializing and improving the health and well-being of people with visual disabilities [34]. Their products, such as their Braille Pad which uses braille to pixelate words as well as images, utilize tactile software technology which provides an opportunity for them to participate more fully in life by mitigating the additional barriers they may experience.

III. IDENTIFYING TECHNOLOGY SOCIAL VENTURES

We searched for example technology social ventures online. We first explored several directories of startups. For example, Y Combinator has a directory where their classes of companies are listed [35]. Additionally, we also referred to some articles through web searches that listed companies such as "25 impressive medical device startups to watch in 2024" or "11 Tech Startups Building Better Senior Care" [36]. Here we found several companies that met our criteria for technology social ventures. University startup organizations and funds were also explored so long as they offered a portfolio of companies that could be further researched to ensure they met the study criteria. Some universities even had organizations that focused on the facilitation of startups with a goal of solving a societal problems, such as Columbia University's Tamer Institute for Social Enterprise and Climate Change [37], though they were rare.

To be included in our technology social venture list, the company had to address one of the five social challenges we introduced through their innovative technology. Also, considering our goal of studying engineers who founded or are involved in founding technology social ventures, we also reviewed whether a senior member of the company had an engineering background. Determining whether a company fulfilled these criteria required going directly to company websites to determine whether their introduction on their

business and mission statements discussed addressing social issues, exploring the technology they applied as a solution to that issue, and determining who the leaders were in each company and whether they had an engineering degree.

IV. FUTURE WORK

As discussed in the introduction section, the three research questions we try to answer in our ongoing research project are: RQ1) How do engineers who founded technology social ventures identify business opportunities that use technology to solve societal problems? RQ2) What competencies, distinguished from the competencies required for technology entrepreneurship more generally, are necessary for engineers to lead their technology social ventures? RQ3) What validity and reliability evidence can be found for the newly developed instrument that measures the competencies for successful technology-based social entrepreneurship? Although these questions are not answered in this paper, we will conduct empirical research to answer these questions based on the groundwork we introduced in this paper.

The list of technology social ventures we have developed can be utilized to identify potential study participants for these research questions. For example, to answer the RQ1, we plan to apply grounded theory [38]-[41] as a methodology. As grounded theory is a primarily qualitative research methodology, we plan to interview engineers who founded or are involved in founding the technology social ventures. We plan to invite potential interview participants by using the list of TSV we created.

V. IMPLICATIONS FOR ENGINEERING EDUCATION

The outcomes of this research project can contribute to developing materials for the technology-based social entrepreneurship education for engineering students. For example, by better understanding the way engineers identify business opportunities for establishing their TSV, engineering educators can better facilitate problem identification of engineering students in the engineering entrepreneurship classroom. Also, by better understanding competencies required for successful technology-based social entrepreneurship, engineering educators can redesign their engineering entrepreneurship courses to be able to better facilitate students' development of such competencies. Moreover, by developing an assessment instrument for measuring the identified competencies from this project, educators can better assess whether their technology-based social entrepreneurship course or engineering entrepreneurship course with the TSV module can effectively facilitate engineering students' development of those competencies.

ACKNOWLEDGEMENT

This work was supported by the National Science Foundation Grants # 2321188. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

- [1] National Academy of Engineering, "The Engineer of 2020: Visions of Engineering in the New Century." Washington, DC: The National Academies Press, 2004.
- [2] A. Huang-Saad, C. Morton, and J. Libarkin, "Unpacking the impact of engineering entrepreneurship education that leverages the Lean LaunchPad curriculum," in *Proceedings of the 2016 IEEE Frontiers in Education Conference*, 2016.
- [3] S. Purzer, N. Fila, and K. Nataraja, "Evaluation of current assessment methods in engineering entrepreneurship education," *Advances in Engineering Education*, 2016.
- [4] J. R. Herkert, "Engineering ethics education in the USA: Content, pedagogy and curriculum," *European Journal of Engineering Education*, vol. 25, no. 4
- [5] J. L. Hess and G. Fore, "A systematic literature review of US engineering ethics interventions," *Science and Engineering Ethics*, vol. 24, no. 2, pp. 551-583, 2018.
- [6] D. Kim, "Promoting professional socialization: A synthesis of Durkheim, Kohlberg, Hoffman, and Haidt for professional ethics education," *Business and Professional Ethics Journal*, vol. 41, no. 1, pp. 93-114.
- [7] E. Grassi and L. Toschi, "A systematic literature review of technology social ventures: State of the art and directions for future research at the Micro-, Meso- and Macro-Level," *Journal of Social Entrepreneurship*, 2021.
- [8] D. Diandra and A. Azmy, "Understanding definition of entrepreneurship," *International Journal of Management, Accounting and Economics*, vol. 7, no. 5, pp. 235-241, 2020.
- [9] W. B. Gartner, "What are we talking about when we talk about entrepreneurship?," *Journal of Business Venturing*, vol. 5, no. 1, pp. 15-28, 1990.
- [10] S. Prince, S. Chapman, and P. Cassey, "The definition of entrepreneurship: is it less complex than we think?," *International Journal of Entrepreneurial Behavior & Research*, vol. 27, no. 9, pp
- [11] S. Gedeon, "What is entrepreneurship," *Entrepreneurial Practice Review*, vol. 1, no. 3, pp. 16-35, 2010.
- [12] J. B. Cunningham and J. Lischeron, "Defining entrepreneurship," *Journal of Small Business Management*, vol. 29, no. 1, 1991.
- [13] D. A. Shepherd, V. Souitaris, and M. Gruber, "Creating new ventures: A review and research agenda," *Journal of Management*, vol. 47, no. 1, pp. 11-42, 2021.
- [14] S. F. Ascigil, "Social entrepreneurship: From definition to performance measurement," *American Journal of Entrepreneurship*, vol. 1, pp. 26-36, 2012.
- [15] Y. J. Wu, T. Wu, and J. Arno Sharpe, "Consensus on the definition of social entrepreneurship: a content analysis approach," *Management Decision*, vol. 58, no. 12, pp. 2593-2619, 2020.
- [16] G. Casanovas and A. V. Bruno, "Scaling social ventures: An exploratory study of social incubators and accelerators," *Journal of Management for Global Sustainability*, vol. 1, no. 2, pp. 12, 2013.
- [17] K. Ismail, M. H. Sohel, and U. N. Ayuniza, "Technology social venture: A new genre of social entrepreneurship?," *Procedia-Social and Behavioral Sciences*, vol. 40, pp. 429-434, 2
- [18] C. Doherty, J. Kiley, N. Asheer, and T. Price, "Inflation, health costs, partisan cooperation among the nation's top problems," Pew Research Center, 2023. [Online]. Available: <https://www.pewresearch.org/politics/2023/06/21/inflation-health-costs-partisan-cooperation-among-the-nations-top-problems/>
- [19] National Oceanic and Atmospheric Administration. (2021). Climate change impacts. National Oceanic and Atmospheric Administration; NOAA. [Online]. Available: <https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts>
- [20] A. Tyson, C. Funk, and B. Kennedy, "What the data says about Americans' views of climate change," Pew Research Center, 2023. [Online]. Available: <https://www.pewresearch.org/short-reads/2023/08/09/what-the-data-says-about-americans-views-of-climate-change/>
- [21] A. Montero, L. Hamel, M. Brodie, and A. Kearney, "Americans' challenges with health care costs," Kaiser Family Foundation, 2024. [Online]. Available: <https://www.kff.org/health-costs/issue-brief/americans-challenges-with-health-care-costs/>
- [22] R. O'Neill, "Addressing a growing water crisis in the U.S.," www.cdcfoundation.org, 2023. [Online]. Available: <https://www.cdcfoundation.org/blog/addressing-growing-water-crisis-us>
- [23] Water Equity. (2024). US Water Alliance. [Online]. Available: <https://uswateralliance.org/issue/water-equity/>
- [24] Reset the table: Meeting the moment to transform the U.S. Food system. (2020). The Rockefeller Foundation. [Online]. Available: <https://www.rockefellerfoundation.org/report/reset-the-table-meeting-the-moment-to-transform-the-u-s-food-system/>
- [25] Feeding America. (2023). Hunger in America. [Feedingamerica.org](https://www.feedingamerica.org); Feeding America. [Online]. Available: <https://www.feedingamerica.org/hunger-in-america>
- [26] S. Lawrence, "Foundation giving for disability: Priorities and trends," Disability and Philanthropy Forum, 2023. [Online]. Available: <https://disabilityphilanthropy.org/foundation-giving-for-disability/>
- [27] R. Vallas, K. Knackstedt, H. Brown, J. Cai, S. Fremstad, and A. Stettner, "Economic justice is disability justice," The Century Foundation, 2022. [Online]. Available: <https://tcf.org/content/report/economic-justice-disability-justice/>
- [28] Strategic Priority: Mobilizing climate action. (2024). Skoll. [Online]. Available: <https://skoll.org/climate-action/>
- [29] S. Ricketts, C. Bast, and H. Argento-McCurdy, "Implementing America's clean energy future," Center for American Progress, 2023. [Online]. Available: <https://www.americanprogress.org/article/implementing-americas-clean-energy-future/>
- [30] HYCO1, "CO2 solved," HYCO1, Apr. 29, 2024. [Online]. Available: <https://hyco1.com/>
- [31] SafeBeat RX, "SafeBeat Rx - Cardiac treatment should start at home," SafeBeat.com. [Online]. Available: <https://safebeat.com/>
- [32] Aquagga, Inc., "Aquagga," [Aquagga.com](https://www.aquagga.com). [Online]. Available: <https://www.aquagga.com/>
- [33] Crop Convergence LLC, "Crop Convergence: Maximizing Crop Yield and Enhancing Sustainability," [cropconvergence.com](https://www.cropconvergence.com/). [Online]. Available: <https://www.cropconvergence.com/>
- [34] 4Blind, "4Blind: For limitless abilities," 4Blind.com. [Online]. Available: <https://4blind.com/en>
- [35] Y Combinator, "The YC startup directory," Y Combinator. [Online]. Available: <https://www.ycombinator.com/companies>
- [36] L. Furlong, "25 impressive medical device startups to watch in 2024. #1 Cloud-based Quality Management Software for MedDevice & Pharma," Qualio.com. [Online]. Available: <https://www.qualio.com/blog/medical-device-startups>
- [37] Columbia Business School. "Social Ventures Portfolio," Columbia University, [Online]. Available: <https://business.columbia.edu/socialenterprise/initiatives/social-ventures/portfolio>.
- [38] B. G. Glaser and A. L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Study*. New Brunswick, NJ: Aldine Transaction, 1967.
- [39] S. R. Jones, V. Torres, and J. Arminio, *Negotiating the Complexities of Qualitative Research in Higher Education*. New York, NY: Routledge, 2014.
- [40] J. W. Creswell, *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*, 4th ed. Noida, India: Pearson India Education Services, 2015.
- [41] K. Charmaz, *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. Sage, 2006.