A Paradigm Shift of University-Industry Collaboration: A Transition to an Innovation Ecosystem in the Jewelry Industry

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Abstract

This paper illustrates the technology transfer process in the jewelry industry, emphasizing the role of universities in driving innovation from academia to industry with sustainability. Guided by the triple helix model, the processes include building human competency development, transferring innovation to manufacturing, leading to innovation-driven enterprise establishment.

The paper argues that successful and sustainable innovation transfer from university to industry starts with the development of educational programs that enhance student and faculty performance to meet industry needs. These initiatives strengthen the university's role in shaping an innovation ecosystem by preparing students and faculty for the challenges of the jewelry sector. Key innovations, such as a niello bar pilot plant and sustainable anti-tarnish alloys, are analyzed as examples for successful and sustainable innovation transfer. The paper emphasizes that program development and sustainable collaboration with industry are key milestone to create a sustainable and innovation-driven ecosystem within the jewelry industry.

Keyword

Triple-Helix, University holding company, Jewelry Education, Nielloware, Anti-tarnish alloy

1. Introduction

The jewelry industry faces increasing challenges in aligning traditional craftsmanship with modern innovation and sustainability. Technology, innovation, and sustainable practices caught attention[1]. The technology transfer process is essential to this transition. However, bridging the gap between academia, industry, and government needs to be structured.

The Triple Helix Model, which is universities, industry, and government collaboration, is important in driving sustainable innovation and economic development[2,3]. Universities serve as knowledge hubs, conducting research and building human capital for the industry. Industry contributes practical insights and market perspectives. Government roles are to support the infrastructure and policies to drive the collaboration sustainably[4]. This relationship holds small and medium-sized enterprises (SMEs) and artisan-driven production within the jewelry industry. It would be beneficial to have a synergistic approach combining traditional craftsmanship with modern technological advancements. This engagement model among these stakeholders ensures that innovations are developed and effectively implemented within the industry.

The development of human competencies starts at university, where curriculums that meet industry needs and lead to experience and real-world applications are designed. Internships, joint research, and training activities can transfer technical skills and innovative mindsets to humans in the industry, bridging the gap between theory from university and practice from industry. Networking and collaborating in the community can build co-creativity and idea-sharing, leading to students' learning experiences and allowing industry professionals to stay at the frontier of knowledge and innovation. This two-way relationship lays the foundation for a sustainable innovation ecosystem where knowledge flows seamlessly across boundaries and technology transfer becomes an ongoing, adaptive process.

This paper examines the application of the Triple Helix Model within jewelry education and industry, focusing on the role of human competency development offered by university programs and the importance of building a collaborative community. Specifically, the paper argues that strong interaction between educational programs and industry will lead to a framework that promotes sustainable, innovation-driven growth that benefits all stakeholders.

2. Role of Universities in Innovation and Sustainability

Adopting the perspective from industry and government within the Triple Helix Model enhances universities' traditional mission by enabling reciprocal knowledge exchange and collaboration[5] . The role of universities is to contribute knowledge via educational programs, giving value that drives research development. For example, the university set up a hub for a network to exchange ideas, questions, and solutions with the industry, contributing to the innovation ecosystem[6]. Such an approach reinforces the university's mission as knowledge management and expands its capacity to inspire creativity and innovation across all spheres of the Triple Helix.

The Bachelor of Science in Gems and Jewelry program is an example to support the above argument. The program use standard approach of AUNQA tp develop the structure and objective of this program. This practice can enhance human development and build research innovation with sustainability concepts for industry. Shown in Figure 1, the quality framework by AUNQA, introduced, trained, and encouraged by the university, ensures the program meets international quality standards while addressing local and regional needs through Outcome-Based Education (OBE), the Plan-Do-Check-Act (PDCA) model and stakeholder feedback to stay aligned with market demands and trends.

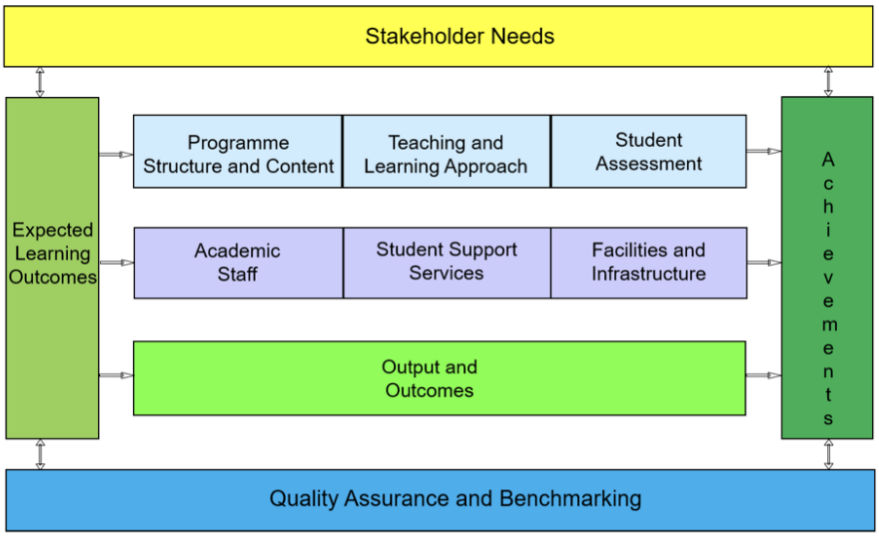

Figure 1 Guide to AUN-QA assessment at programme level in version 4.0[7]

The approach of the program to let students meet with real-world applications includes key concepts as follows:

- Special talks from industry experts: The program organizes regular professional guest lectures to update students on industry trends. These activities allow students to understand the gap between academic concepts and practical applications.
- Classroom collaboration with industry: Students collaborate with industry in their work. For example, in the "Jewelry Season" activity, students work and collaborate directly with manufacturers, gaining knowledge of product development concepts and design processes. The "Jewelry on Sale" activity shows a booth exhibition that allows students to experience the real market.
- Work-Integrated Learning (WIL): Internships and cooperative education projects allow students to gain experience that is aligned with industry requirements. Feedback from employers is integrated into the program to refine and enhance student readiness.

The jewelry curriculum has been the seventh revision since 1992; grounded in the triple helix model and incorporating input from industry and government, it recently introduced essential elements of entrepreneurship and sustainable practices to the program, as shown in Figure 2. It highlights the feedback, collaboration, and working mechanisms between stakeholders and the program, focusing on entrepreneurial skills with a sustainability mindset. The process involves academic staff and students, aligning learning outcomes, teaching and learning, and work-integrated learning to ensure the curriculum addresses industry and societal needs. Integrating experiential learning, active participation in industry projects, and program improvement enhances student outcomes with a leadership role of innovation and sustainability. Through these efforts, the university exemplifies how standardized quality programs can drive human development and develop a sustainable innovation ecosystem.

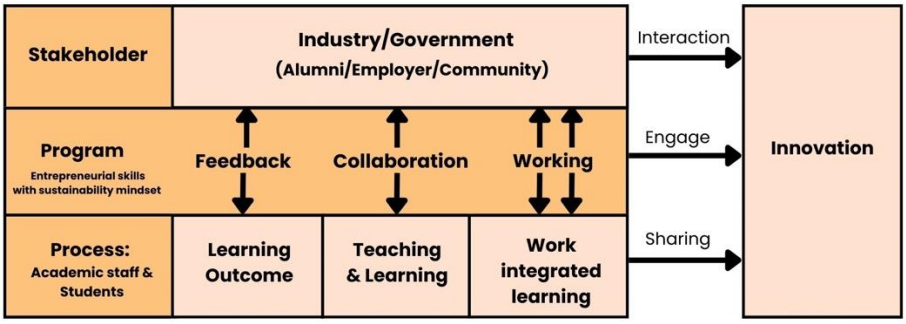

Figure 2 Framework for stakeholder integration for program development.

3. Examples of key innovations in jewelry technology transfer for industry

This section highlights the examples of innovation that transfer technology to industry. This pilot project shows the critical mechanisms between traditional manufacturing methods and advanced technological solutions. The case study reveals the transfer of innovation and collaboration with industry and community.

Preserving Nielloware: Sustainable Craftsmanship and Innovation
Initially, lead-free niello bars were introduced to the community to reduce the hazards of the toxic compound. Substituting Tin in niello alloys obeys regulatory standards and aligns with sustainable goal[8]. Subsequently, jewelry manufacturing requested to produce Nilleo bars for the market. Then, the project emphasizes scaling and standardizing to expand in the market. The niello bar pilot plant focuses on developing lead-free niello alloys with scientific methods, such as microstructure analysis (SEM, XRD), to ensure high-quality products—consistent quality for commercial enhancements the potential of exporting niello-based products, boosting cultural and economic value. Collaboratives were designed to produce an example of this alloy, as shown in Figure 3. These prototypes show modernized traditional craftsmanship while promoting innovation in jewelry, supporting sustainable industrial practice concepts.

Figure 3. The Nielloware designed and work with local community

Eco-Friendly Anti-Tarnish Silver Alloys

The project was started in 2021 due to innovation requests in the market after COVID-19. The challenge was addressed on the topic of tarnish resistance of sterling silver. The research was performed to solve the industry's problem of extending the lifespan of sterling silver. Initial research was conducted with students as part of an academic program, demonstrating the project's potential. Subsequently, the project expanded through collaboration with other universities, companies, and government co-funding. The research focuses on developing innovative anti-tarnish silver alloys synthesized from waste carbon-based materials9. These alloys were rigorously tested for durability and aesthetic retention, including comparative simulations such as sweat and H_2S tests.

The developed alloy can be recycled with 50% old alloys when it mixes the alloy. It is also reused up to three times while consistently maintaining high-quality casting properties. This recycling capability offers significant cost savings by reducing waste and promoting sustainability. The wire drawings are also tested to make the variety of uses of these alloys. The alloy was tested on scaling and standard, which is now ready for commercialization under the university's holding company; through collaboration with the university's holding company and industry partners, the project ensures that research outcomes are practical and impactful, contributing to the industry's long-term growth and innovation while benefiting academic and industry.

Figure 4 Several form of products alloys pioneer in manufacturing.

4. Building a Sustainable Innovation Ecosystem

Universities can transform as hubs of knowledge creation by establishing innovation ecosystems via university-holding companies creating collaborative networks. By leveraging these strategies, the college aims to enhance innovation-driven enterprise establishment, align educational programs with industry needs, and make continuous feedback loops between academia, industry, and community, improving the concept of the triple-helix model to the quadruple-helix model[10]. By supporting the establishment of holding companies at college levels, the university enables investment in research-driven value creation, generating new revenue streams and expanding the capabilities of startups and spin-offs. These efforts encourage investment in innovative businesses and maximize the utility of research, positioning universities as key stakeholders in driving sustainable industrial growth.

Figure 5 shows the framework for how the concept could start with the integration of social sciences and science and technology research, creating cooperation between classroom-based learning, social labs, and innovation-driven problem-solving. This comprehensive research ecosystem discovers new solutions to societal and industrial innovation challenges. Intellectual Property (IP) and Technology Licensing Offices (TLOs) are assets transferring these innovations to the company structure.

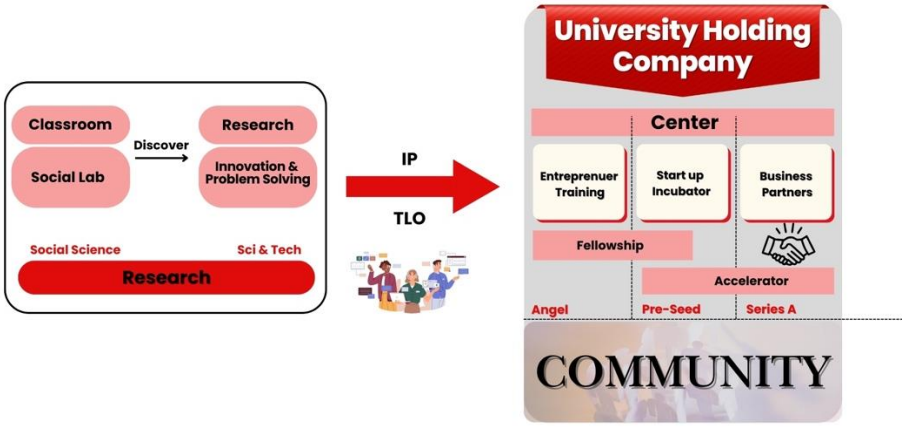

Figure 5. University-driven Innovation Ecosystem

The activities include start-up incubation programs, entrepreneurial skill development, business partnerships, and collaborative investment platforms. The academic staff under the program can generate knowledge via research, obtaining innovation addressing societal needs. These methods allow the community to build innovation-driven entrepreneurship through the program structure, becoming sustainable education. The model in Figure 6 demonstrates how sustainable innovation ecosystems can transform innovation into industry and build trust through collaboration in the community. It incorporates a social enterprise model of service subsidization, as shown in the diagram, where profits from innovative outputs, such as anti-tarnish alloys, are reinvested into preserving Thai craftsmanship of niello bars, providing university training, and impacting soft power.

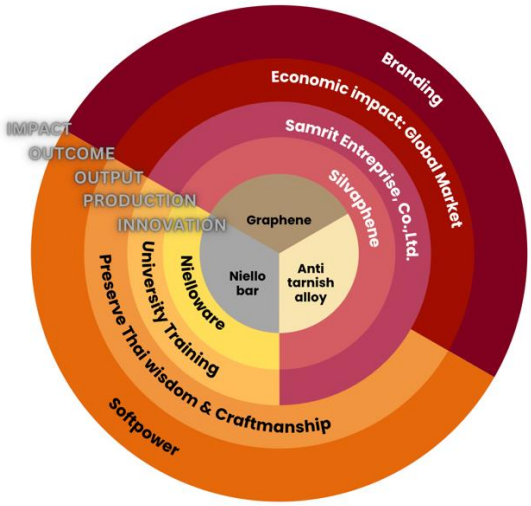

Figure 6. Sustainable Innovation Ecosystem Model

5. Conclusion

Several examples of innovation discussed in this paper emphasize the important role of universities as key players within a knowledge-based society[11]. Universities' primary mission has evolved from knowledge to generate new ideas and innovations through continuous interaction and engagement with industry stakeholders. Community engagement with activities in a sustainable innovation ecosystem is key to enhancing graduates' entrepreneurial skills and preparing them for the demands of rapid market change. Furthermore, innovation and technology transfer create potential in the university with business development and innovation-driven growth[12].

The quadruple helix model emphasizes community engagement as a core of sustainable innovation, establishing academic networks, innovation transfer to industry, policymaker for government, and community building. Collaboration and co-creation of knowledge can develop the innovation technology transfer process with the community, where long-term partnerships can be a plus. It also prepares future entrepreneurs and enhances the quality standard in manufacturing. Milestones to achieve a sustainable innovation ecosystem are the alignment of educational programs and research collaboration with industry. The feedback loop of PDCA is acquired to ensure it remains and responds to societal and market needs. University can implement an educational policy for a potential group of people to autonomy body, such as a holding company, to drive innovation and community with a sustainable approach to technology transfer, where mutual benefits drive long-term partnerships and innovation outcomes adapting to this paradigm shift.

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