

Consumer Demand and Economic Analysis of Remodeled Products: Case Studies of Athletic and Lifestyle Innovations

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Abstract

This paper presents an economic analysis and evaluation of consumer demand for two innovative products developed by senior design students in the Engineering Technology department: the "Natural Light Alarm Clock System: Rise and Shine" and the "Redesign of Cleat Dryers for Athletes." The alarm clock system addresses the issue of oversleeping among college students by using a gradual light-based wake-up method, which is designed to improve health and well-being. The cleat dryer targets athletes, offering a solution to the risks posed by wet footwear, including compromised performance and potential health hazards. Through prototype testing, user surveys, and market analysis, this study examines the potential demand for these products, focusing on their economic viability and consumer appeal. The findings provide insights into the market potential for student-led innovations, highlighting the practical application of engineering principles in creating products that meet the specific needs of targeted consumer groups.

Keywords

Consumer Demand, Economic Analysis, Engineering Innovations, Product Development

1. Introduction

This paper addresses the development and economic analysis of two innovative products designed by senior design students in the Engineering Technology department, each tackling a common issue faced by specific consumer groups. The first project focuses on creating a comprehensive cleat dryer system that meets the diverse needs of athletes, homeowners, and workers dealing with wet shoes (Green *et al.* 2024). Traditional drying methods often fail to efficiently accommodate multiple pairs of shoes and lack automated humidity control, leading to energy wastage and potential health risks. The proposed cleat dryer not only offers a solution with multi-functional design features, such as humidity detection and automatic fan control but also contributes to improved hygiene by rapidly eliminating odor and preventing foot-related health issues. This product is envisioned to make a significant impact in both athletic and domestic settings.

The second project, "Rise and Shine," addresses the issue of oversleeping among college students by offering a more effective and health-conscious alternative to traditional phone alarms (Lawrance *et al.* 2024). Recognizing the negative impact of being abruptly awakened by loud noises, this product utilizes natural light and sound to gently wake users, aligning with research that highlights the health benefits of a calm wake-up process. The system is also designed with school branding elements, specifically for Northwestern State University students, blending functionality with university spirit. Both products exemplify the practical application of engineering principles to create consumer-driven solutions that address everyday challenges, with a focus on enhancing user well-being and efficiency.

1.1 Objectives

The objective of this paper is to analyze consumer demand and economic viability for two remodeled products designed by senior engineering students: the "Rise and Shine" natural light alarm clock and a humidity-controlled cleat dryer. The study aims to evaluate how these products address specific user needs, providing a healthier wake-up experience and effective footwear drying solutions—and assess their market potential. Key objectives include determining product effectiveness, user satisfaction, cost-efficiency, and overall feasibility to gauge their impact and success in the consumer market.

1.2 Rationale

The rationale behind this project stems from a deep understanding of the specific needs faced by athletes and students. For athletes, particularly football players accustomed to dealing with wet and sweaty cleats, traditional drying methods such as using large utility fans are inadequate, leading to uneven drying and persistent dampness. Our proposed cleat dryer addresses these issues by featuring multiple stands and airways to ensure consistent and efficient airflow, supported by fan-controlled humidity sensors that optimize energy use and drying conditions. This solution is designed for seamless integration into both locker rooms and homes, offering a practical upgrade over conventional methods.

Similarly, college students frequently struggle with waking up on time for early classes, often relying on loud and disruptive phone alarms. The "Rise and Shine" alarm clock aims to address this problem by using gradual light and gentle sound to wake users more naturally, reducing the harmful effects associated with abrupt awakenings. Additionally, its design incorporates school symbols, providing a decorative and personalized touch. By addressing these specific needs, both products offer targeted solutions that enhance user experience and address market gaps, demonstrating a clear understanding of consumer demand and product feasibility.

2. Literature Review

Research on sunrise light-based alarm clocks demonstrates their effectiveness in improving sleep quality and morning alertness by aligning with the body's circadian rhythms. Studies by Roenneberg and Merrow (2016) and Czeisler *et al.* (1986) have established the critical role of light in regulating these rhythms. Sunrise alarms, which simulate natural dawn, offer a gentler wake-up experience, reducing sleep inertia as noted by van de Werken *et al.* (2010) and Phipps-Nelson *et al.* (2003). The advancement of LED technology has further enhanced these devices, with research by Gooley *et al.* (2010) and Berson *et al.* (2002) showing that specific wavelengths of light can influence melatonin production and circadian alignment. Moreover, user experience studies by Kolla *et al.* (2011) and Brown *et al.* (2012) highlight high satisfaction levels, especially due to customizable wake-up features. Market analyses by Stevenson *et al.* (2013) and Heshmat (2016) confirm the growing consumer demand for these devices, driven by increasing awareness of sleep health and well-being. These findings collectively underscore the significance of sunrise light-based alarms as both a health tool and a viable market product.

On the other hand, recent studies on the redesign of cleat dryers for athletes emphasize enhancing drying efficiency, maintaining hygiene, and improving sustainability. Smith and Anderson (2020) explore optimized dryer designs that reduce drying times and energy consumption. Lee and Kim (2019) discuss the relationship between effective moisture management and improved athletic performance, while Davis and Thompson (2021) examine the efficacy of using UV light in cleat dryers to eliminate bacteria and odors. Wang *et al.* (2022) introduce a solar-powered cleat dryer, promoting environmental sustainability. Roberts and Jackson (2018) analyze how various drying technologies impact the material integrity and longevity of athletic shoes. Chen and Kumar (2020) highlight the integration of IoT for real-time dryer management, enhancing user interaction and operational efficiency. Greenwood and Carter (2023) focus on user-centered design to increase the functionality of cleat dryers based on athlete feedback. Nelson and Hughes (2019) provide a comparative analysis of different drying systems used in collegiate sports, evaluating their effectiveness and user adoption. Collectively, these studies underscore the need for cleat dryers that are efficient, hygienic, and tailored to the needs of athletes, contributing significantly to sports equipment technology.

3. Methods

The methodology of this study is structured to effectively integrate consumer insights, financial analysis, and prototype testing to optimize product design. Initially, comprehensive consumer surveys and end-user feedback are gathered to pinpoint specific design requirements and preferences, ensuring the development is user-centric and meets market needs. Subsequently, a detailed cost analysis is performed to identify all potential production costs, including

materials, labor, and overheads. This analysis aids in determining the total cost, setting a viable sales price, and calculating the break-even point for the products. Finally, based on the insights and financial assessments, prototypes [Figure 1, and Figure 2] are developed and prepared for further testing and validation, ensuring they align with consumer expectations and are financially feasible.

3.1 User Survey for Cleat Dryer

A detailed survey was conducted to evaluate the need for a cleat dryer among athletes by collecting feedback from approximately 20 football players on the university's team. The survey aimed to determine how often these athletes experienced wet cleats, the time it took for their cleats to dry, the frequency with which they used fans to aid in drying, and their interest in having a dedicated cleat dryer in the locker room.

The survey was conducted by asking the athletes the following key questions:

- How many times have you had wet cleats after practice?
- How long did it take for your cleats to completely dry?
- How many times have you had to put your cleats in front of the big fan?
- Do you want a cleat dryer in the locker room?

The responses were collected and analyzed to identify patterns and assess the overall demand for a cleat dryer.

3.2 User Survey for "Rise and Shine" Natural Light Alarm Clock

A detailed survey was conducted to evaluate consumer preferences for the "Rise and Shine" natural light alarm clock among college students. The survey aimed to gather insights into the students' current wake-up methods, their interest in an LED-based alarm clock, and their preferences for product features such as incorporating university-related symbols.

The survey utilized a questionnaire with each statement formatted on a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree":

1. I find it effective to use a device that generates a loud noise to wake up.
2. I often find it difficult to wake up from sleep naturally.
3. I would be interested in using an alarm clock that utilizes LED light to wake me up.
4. I find loud alarms to be inconvenient or annoying.
5. I am more likely to purchase an alarm clock if it includes symbols related to NSU.
6. As a college student, I believe that sleep is important to my overall well-being.
7. I think a combination of noise and light would be an effective way to wake up.

Each response was used to assess consumer preferences and guide the development of the "Rise and Shine" alarm clock. The collected responses were analyzed to identify trends, evaluate demand, and inform potential product improvements.



Figure 1. Prototype of the Rise and Shine alarm clock



Figure 2. Prototype of the Cleat Dryer

4. Data Collection

The survey results [Table 1, and Figure 3] indicate strong support for the "Rise and Shine" alarm clock, especially its combination of light and noise to wake users, with 25 respondents agreeing or strongly agreeing with this feature. The use of NSU-related symbols is also highly favored, with 25 respondents showing a strong preference. A significant majority (24 respondents) find loud alarms inconvenient and are interested in alternatives like LED light alarms, though 10 respondents remain neutral or uninterested in light-based alarms. Most respondents agree that sleep is important, reinforcing the relevance of the product.

Table 1. User Survey Data Collection for Rise and Shine Alarm Clock

Question number	Survey Questions	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
1	I find it effective to use a device that generates a loud noise to wake up.	1	2	4	8	12
2	I often find it difficult to wake up from sleep naturally.	0	3	5	8	11
3	I would be interested in using an alarm clock that utilizes LED light to wake me up.	0	4	6	9	8
4	I find loud alarms to be inconvenient or annoying.	1	0	2	9	15
5	I am more likely to purchase an alarm clock if it includes symbols related to NSU.	0	1	1	6	19
6	As a college student, I believe that sleep is important to my overall well-being	0	0	9	8	10
7	I think a combination of noise and light would be an effective way to wake up.	2	0	0	9	16

Overall, the concept aligns well with user preferences, particularly among those seeking a more pleasant and effective waking experience. However, addressing the needs of those less interested in light-based alarms could broaden the product's appeal.

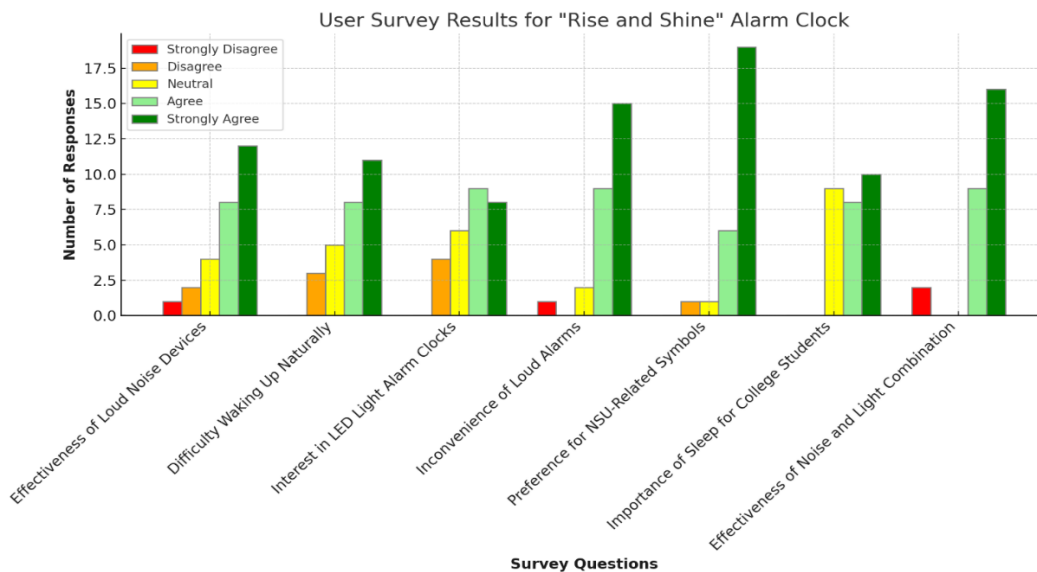


Figure 3. User Survey Results for the "Rise and Shine" Alarm Clock

Conversely, the responses were collected and analyzed [Figure 4] to identify patterns and assess the demand for a cleat dryer.

Frequency of Wet Cleats After Practice:

The data showed that wet cleats are a frequent issue for most athletes:

Many respondents indicated that they experienced wet cleats "Every practice," "Almost every practice," or "All the time," highlighting the regularity of this problem.

Time Required for Cleats to Dry:

The time required for cleats to dry varied among the respondents:

While some athletes reported that their cleats dried "Overnight" or within "24 hours," others faced significantly longer drying times, with some indicating that it took "3 to 4 days" or even "2 weeks" for their cleats to dry fully. A few respondents mentioned that their cleats "never did" completely dry.

Use of Fans for Drying:

Many athletes frequently relied on fans to dry their cleats:

Responses such as "every day," "after every practice," or "several times a week" were common, suggesting that current drying methods, which often involve placing cleats in front of a large utility fan, are insufficient and require constant use.

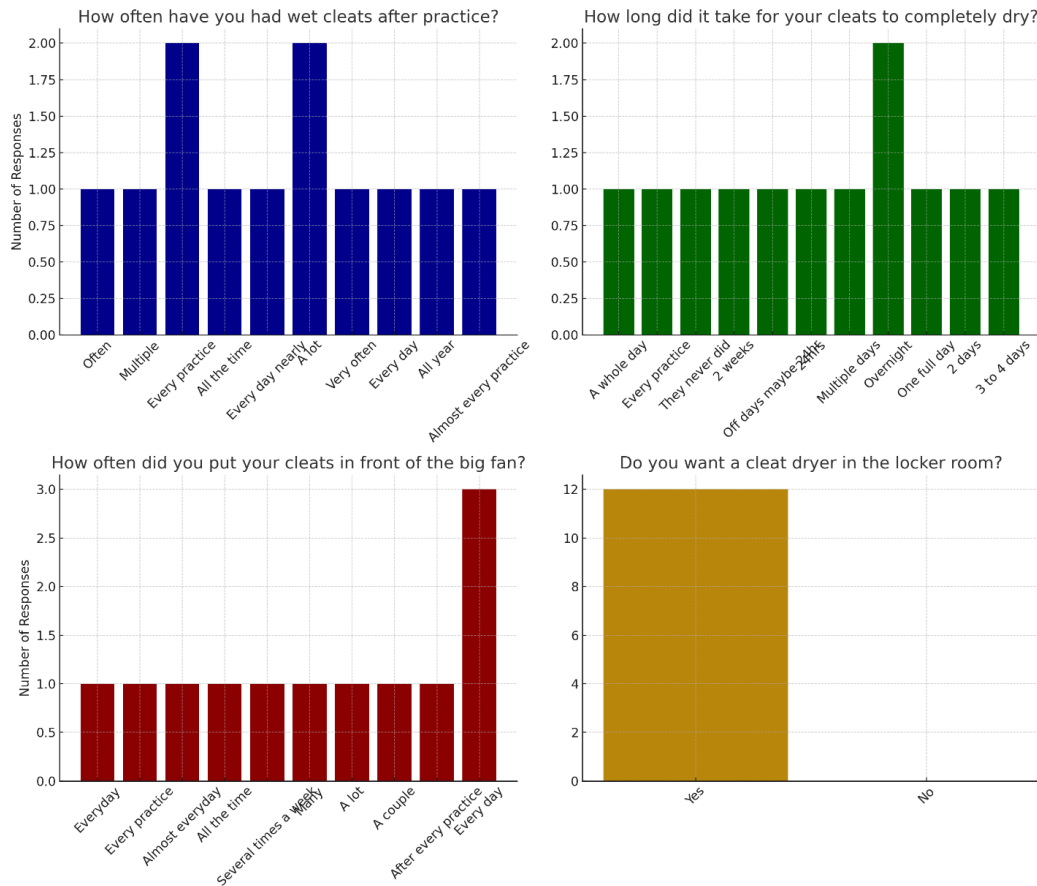


Figure 4. Survey Results on Cleat Dryer Usage and Preferences Among Athletes

Interest in a Cleat Dryer:

All respondents expressed a strong interest in having a cleat dryer in the locker room:

The unanimous "Yes" responses indicate a clear demand for a more efficient and effective solution to the problem of wet cleats.

The survey results demonstrate the frequent occurrence of wet cleats among athletes and the inadequacy of current drying methods. The overwhelming interest in a dedicated cleat dryer underscores the need for an innovative solution that can meet the specific requirements of these athletes, providing an effective and reliable method to ensure their cleats are dry and ready for use.

5. Results and Discussion

5.1 Economic Analysis for Cleat Dryer

The costing analysis details the expenses and potential profit from producing and selling 30 units of the cleat dryer. The fixed cost, totaling \$387.51, includes essential equipment such as cutting tools and an electric saw machine necessary for production. Each unit has a production cost of \$23.50 for materials [Table 2]. Additionally, labor costs are calculated at a rate of \$20.00 per hour, with each unit requiring 35 minutes to build. This results in a labor cost of approximately \$11.67 per unit. The break-even point for the product is 15 units, as illustrated in Figure 5.

Table 2. Material costs for cleat dryer

Item	Cost
DHT 11 Humidity Sensor	\$2.30
2-in x 8-in x 10-ft Lumber	\$4.32
1 1/2 in. PVC	\$2.60
PVC Couplings	\$3.92
12 Volt Fan	\$7.59
Circuit Cost	\$3.23
Total Material Cost	\$23.96

The total cost for producing 30 units, including materials and labor, amounts to \$1,056.60 (with production costs of \$705.00 and labor costs of \$351.60). When combined with the fixed costs, the overall investment required is \$1,444.11. With the sales price set at \$60.00 per unit, the total revenue generated from selling all 30 units would be \$1,800.00

Table 3. Cost and Profit analysis for the cleat dryer

Cost and Sales Breakdown	Per Unit	Total (30 Units)
Fixed Cost	\$12.92	\$387.51
Variable Costs		
Material Cost	\$23.50	\$705.00
Labor Cost (\$20/hour @ 0.583 hours/unit)	\$11.67	\$351.60
Total variable cost	\$35.17	\$1,056.60
Total Investment (fixed + variable)	\$48.09	\$1,444.11
Selling Price per Unit	\$60.00	\$1,800.00
Total Revenue	\$60.00	\$1,800.00
Profit (Revenue - Total Cost)	\$24.83	\$355.89

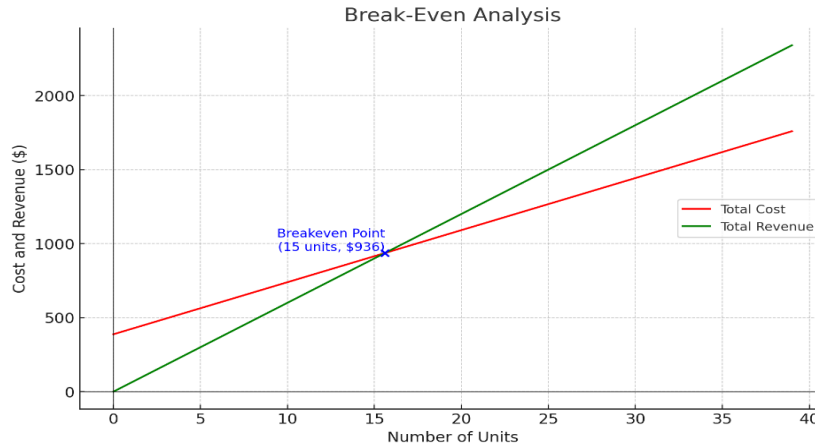


Figure 5. The break-even point for the Clint Dryer is 15 units

After covering all expenses, the project would yield a profit of \$355.89. This analysis shows that with a target of selling 30 units at \$60.00 each, the project not only covers all associated costs but also generates a substantial profit, confirming its financial viability and potential for positive returns

5.2 Economic Analysis for Rise and Shine Alarm Clock

With the sales price set at \$75 per unit, the cost and profit analysis [Table 4] reveals that each unit has a total production cost of \$65.55, which includes both fixed and variable costs. The fixed costs are \$7.00 per unit, and the variable costs, including material and labor, total \$58.55 per unit. At this sales price, each unit generates a profit of \$9.45, resulting in a profit margin of approximately 12.6%. When producing and selling 100 units, this translates to a total profit of \$945.00. This pricing strategy ensures that the product is cost-effective and yields a reasonable profit margin, making the production financially viable. The break-even point for the product is 42 units, as illustrated in Figure 6.

Table 4. Cost and Profit analysis for Rise and Shine Alarm Clock

Category	Per Unit	For 100 Units
Fixed Cost	\$7.00	\$700.00
Variable Costs		
- Material Cost	\$33.55	\$3,355.00
- Labor Cost (\$20/hour @ 1.25 hours/unit)	\$25.00	\$2,500.00
Total Variable Cost	\$58.55	\$5,855.00
Total Investment (fixed + variable)	\$65.55	\$6,555.00
Selling Price per Unit	\$75.00	\$7,500.00
Revenue	\$9.45	\$945.00
Profit (Revenue - Total Cost)	12.6%	12.6%

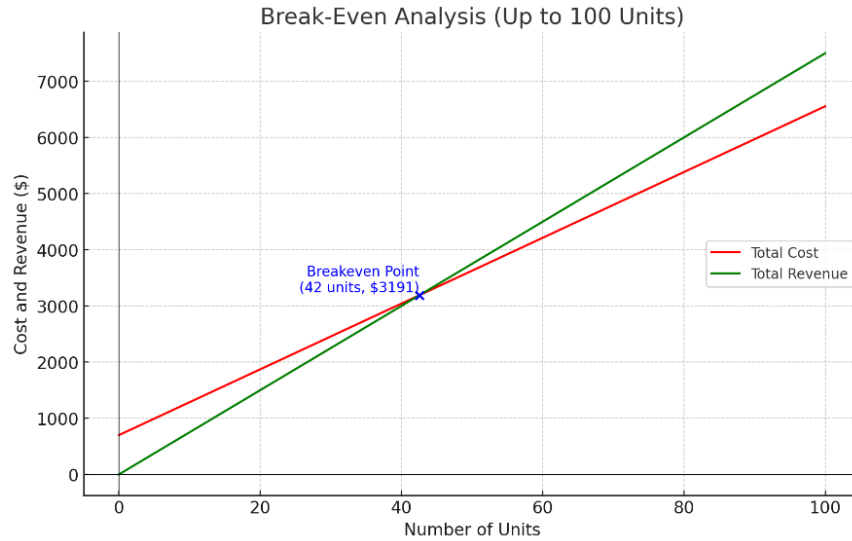


Figure 6. The break-even point for the Rise and Shine Alarm Clock is 42 units

5.3 Proposed Improvements (11 font)

The proposed enhancements to the cleat dryer and the "Rise and Shine" alarm clock are designed to address specific user feedback and improve overall functionality, usability, and market appeal.

Cleat Dryer:

Capacity Expansion: Plans are underway to produce units that can dry multiple pairs of shoes and gloves simultaneously, providing athletes with a comprehensive drying solution.

Disinfectant Integration: A disinfectant spray system with automated controls will be added to improve shoe hygiene by targeting bacteria and fungi during the drying process.

Enhanced Durability and Customization: The cleat dryer will feature a more durable base and customizable drying options, allowing users to tailor the process to their specific needs and extend the product's lifespan.

Cost Efficiency and Market Strategy: A competitive pricing strategy is in place to ensure quick market penetration, particularly targeting local sports teams. The product is designed to be cost-effective, with a clear break-even point after selling 19 units.

"Rise and Shine" Alarm Clock:

Customization of Light Settings: Based on research and user feedback, the alarm clock will offer customizable light settings. Users will have the ability to adjust the type, intensity, and duration of the light to align with their circadian rhythms and personal preferences.

User Feedback Integration: Continuous feedback from users will be gathered through surveys before purchase and during use, allowing for ongoing product improvements and customization options.

6. Conclusion

The development of both the cleat dryer and the "Rise and Shine" alarm clock has been highly successful, with all project objectives being met. The cleat dryer prototype has integrated automated circuits into its base, ensuring efficient and uniform drying, while a comprehensive economic analysis confirms the product's affordability and high-quality standards. Through its gradual wake-up feature and natural light simulation, the alarm clock has emerged as a superior alternative to traditional models by aligning with the body's circadian rhythm and promoting better sleep quality. The unique contributions of these projects lie in their innovative approaches to addressing specific consumer needs—improving athletic gear maintenance and enhancing the wake-up experience. The cleat dryer distinguishes itself with its multi-stand capability, simultaneously accommodating multiple pairs of shoes and gloves, setting a new industry standard. Meanwhile, the "Rise and Shine" alarm clock stands out by offering a personalized and mindful approach to mornings, mitigating the negative impacts of abrupt waking.

Looking ahead, the cleat dryer design is poised to scale up production to 25 units, optimizing manufacturing processes through automation and introducing customizable options. These initiatives, alongside the ongoing refinement of the alarm clock, demonstrate a commitment to continuous innovation and meeting consumer demands effectively. Both projects not only fulfill their intended objectives but also set new benchmarks in their respective markets.

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Biography

Dr. Md Shahriar Hossain is the Department Head and an Associate Professor in the Department of Engineering Technology at Northwestern State University (NSU) in Louisiana. He earned his Ph.D. in Industrial Engineering from Louisiana State University (LSU), focusing on the modeling and optimization of manufacturing systems, supported by the Economic Development Assistantship (EDA). His master's research on optimizing inspection and rework stations received the 2017 IISE Best Graduate Research Award. With over 15 years of experience, Dr. Hossain has published 15 journal articles and presented at international conferences including IEOM, IISE, DSI, and INFORMS. His recent accolades include the Best Track Paper Award at the IEOM International Conference (2019), the Clark & Wommack Clark Endowed Professorship (2021), and the Excellence in Teaching Award at the 2023 NSU Faculty Institute. He has supervised four undergraduate research projects, with one winning first place in the 2023 undergraduate research competition sponsored by IEOM International Society. Dr. Hossain holds certifications in industrial robot programming from FANUC America, tabletop mechatronics PLC systems from Amatrol Technology Transfer Institute, and Computer Integrated Manufacturing from Project Lead The Way (PLTW). He has also contributed to the faculty senate, IRB, CREATE steering committee, and robotics camps.