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Bridging the Gap in the Technology Commercialization Process

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ABSTRACT
Cogeneration merges the production of usable heat and electricity into a single process that helps to reduce carbon emissions, energy waste and energy costs. Until now, this source of sustainable energy has been used mostly in the industrial sector, the consumer market is unknown. One type of cogeneration system, the Stirling engine, is a heat engine that is operated by a cyclic compression and expansion of air or other gas at different temperatures. This cogeneration system is capable of charging a smartphone's battery using the heat of everyday objects like a hot cup or a radiator, or a human hand.

There are two main goals of this project; 1) is to design and build a small prototype using the Stirling engine technology to generate electricity; and 2) to conduct a market test to assess the appeal of the Stirling sustainable charger among consumers. Online surveys will be employed to conduct research to evaluate overall purchase interest in this new technology. The information to be collected will include demographic and attitudinal characteristics that can be used to help build consumer profiles, and identify which profiles correlate with higher levels of purchase interest for the Stirling sustainable charger. This research will be used to help position the Stirling charge, and to identify key target segments for the marketing of this product.

Keywords
Cogeneration, sustainable charger, Stirling engine, consumer marketing

1 INTRODUCTION

The Stirling Engine is a future technology advancement that when put forth shows how far the world has come to creating energy in a multitude of ways. The Stirling engine will not only be a transcendent tech, but will be able to show vast improvement in the economic market when delivered to the right audience. In many walks of the earth, the Stirling engine is the technology consumers have been waiting for in order to charge their cellular device or other essential technology on-the-go. The Stirling engine introduces a new way to do this through a hot or cold beverage. While the size of the product is larger than others, it poses a unique way of recharging your tech in a more enjoyable way. The Stirling engine could be the future for many countries who don't have access to other certain technology tools available to them. The research we have provided shows the potential of the Stirling engine being able to be marketable to a larger audience and why the need for it is now.

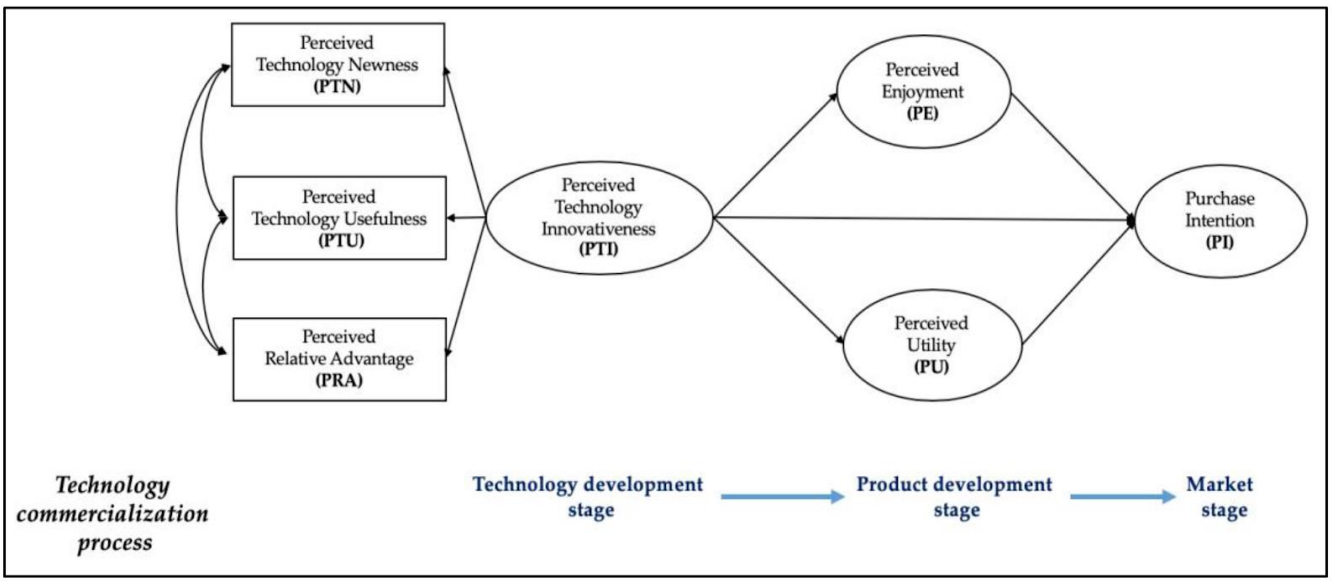
2 LITERATURE REVIEW

According to the article *Bridging the Gap in the Technology Commercialization Process: Using a Three-Stage Technology–Product–Market Model* (Kim, Park, Sawng, and Park, 2019). There should be a lot of research and development in order for the technology you are introducing to not fail as it launches for consumers to purchase. The Stirling engine motor is an innovative and transcendent technology that introduces a new way of charging your dead phone or tablet. But new technology is frightening and certain technology has to be introduced at the right time in order for consumers to accept the product into current day society. The Stirling engine motor is integral for many consumers to understand the type of power it takes to recharge their technology from 0% to 100%. With this article it thoroughly explains why the developmental process of getting the right research goes a long way for a new product like the Stirling engine to sell, especially to the right target market. The market demand for new ways to recharge phones is currently a necessity for many people who phone dies extremely fast. This creates an opportunity for the Stirling.

Table 1. Variable indicators.

Variable	Indicator
Perceived Technology Newness (PTN)	This technology is new This technology is different This technology is unique This technology is original
Perceived Technology Usefulness (PTU)	Using this technology is useful Using this technology improves performance Using this technology increases productivity
Perceived Relative Advantage (PRA)	This technology is higher quality than the competition This technology solves problems I had with existing technology
Perceived Technology Innovativeness (PTI)	How innovative is this technology? This is an innovative technology
Perceived Enjoyment (PE)	Using this product is exciting Using this product is fun This product is enjoyable
Perceived Utility (PU)	This product is effective This product is helpful This product is practical
Purchase Intention (PI)	I need this product I want to purchase this product

What the article continues to say moving forward is how we might perceive certain technology that is introduced to us. Is the technology we are introducing new? Is it useful? Does it give us a relative advantage? And if it answers any of those questions with a positive yes, then it would be perceived to be innovative according to the *Three-Stage Technology-Product-Market-Model* (Kim et al., 2019). Furthermore, with that model, would it be perceived as an enjoyment or utility? And continuing on that trend if the answer was a yes, would it then be enough for a consumer to have the right perception of the product to purchase the intended product (Purchase Intention - PI). Those three steps explained above are considered the technology developmental stage, product developmental stage, and the market stage. All three stages the Stirling engine must go through in order to see the success rate increase of a product with this type of innovation to become trending to a consumer.



Throughout the article we are taken to the vantage point of the consumer thought process and perceive look at the product rather than the developer's perspective. Though the developer of the product will come to the conclusion of why wouldn't you purchase the product, the consumer may see a few reasons why they wouldn't, so therefore explaining how the research and development process of reaching the right consumer base will be important to gauge how the product will actually be perceived in the marketplace.

Through the study we see that a competitive advantage can be gained through this type of three step model. Though it may not lead to quick emergence of the product leading the tech world, the model can help the product avoid market failure if taken the right steps. The Stirling engine has a lot of promise and can achieve great advancements in the tech industry if handled by the right company and introduced in a proper manner. Consumers want to buy products that will change their daily lives and that will make their lives easier in the long run. Can the Stirling engine do that for our current day society?

3 METHODOLOGY

A survey was developed in Qualtrics, a leading survey management platform, and was distributed via email in the US, Belgium and Netherlands. The research was conducted from April 14 - April 21, 2020. A total of 120 surveys were completed. Based on the study objective, a key component of this research was to evaluate attitudes towards the environment, and correlate them with planned behavior (purchase intent). Based on the literature (Chen & Chai, 2010) a list of six statements was developed to measure attitudes using a 7-point Likert scale. Another objective was to collect reactions and perceptions to the Stirling battery. A list of ten attitude statements was developed, also based on the literature review (Kim, Park, Sawng & Park, 2019).

An a priori power analysis was conducted to determine the required sample size for regression analysis of the total sample of respondents using GPower (Faul, Erdfelder, Buchner, & Lang, 2009). For the regression analysis, the power analysis indicated that 89 participants would be needed to detect a small to moderate effect size ($f2 = .15$) with a power of .95, and an alpha level of $\alpha = .05$ for one tested predictor and ten total predictors. As such, these analyses suggest that the sample size ($N = 110$), was sufficient for statistical analyses.

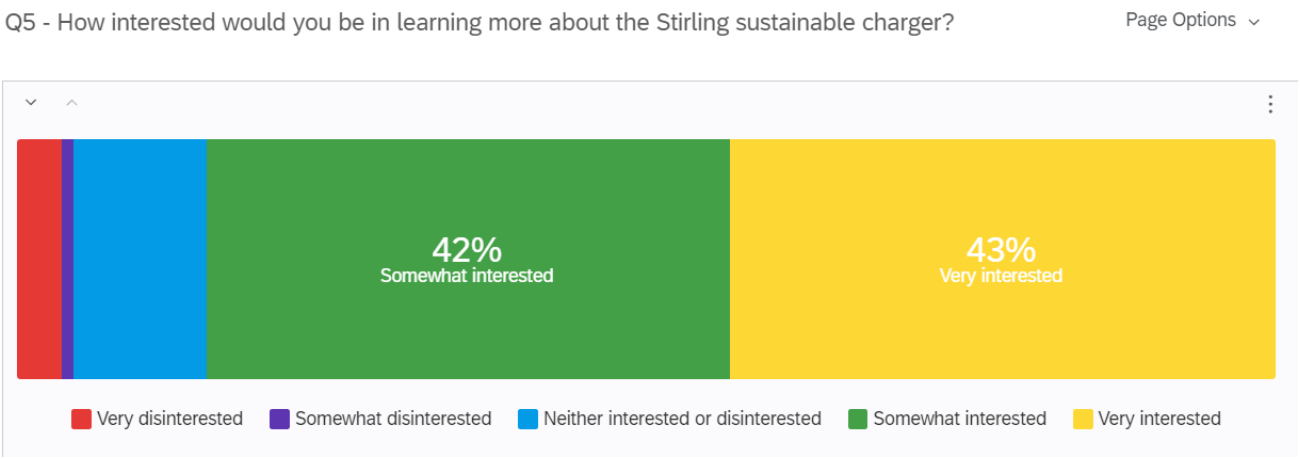
4 RESULTS

Scale Reliability

A seven point Likert scale was also used to measure respondent attitudes towards the environment. The reliability score is a measure of the internal consistency, which is reported using Cronbach's alpha coefficient α. The Cronbach's alpha for the six attitudinal variables pooled into a single aggregate measure was calculated as $\alpha = .808$, indicating that the scale items are a reliable and consistent measure of attitudes towards collaborative apparel consumption. All six items were worthy of retention, resulting in a decrease in the alpha if deleted.

Key Questions

The beginning of our survey captured the key characteristics of our respondents. A statement explaining benefits of cogeneration and a picture of what the Stirling engine charger would look like were introduced. After participants were shown the statement and picture, they were asked "How interested would you be in learning more about the Stirling sustainable charger?" A majority of respondents answered somewhat interested (47) and very interested (49). These two choices accounted for 85% of our sample. Only 5 respondents showed negative attitudes towards the product with 1% somewhat disinterested and 4% very disinterested.



Since the Stirling engine charger is based on using "lost heat" from radiators or drinks, it was important to gauge our samples viewpoint on environmental issues. Respondents were given a scale to rate the importance of the statements listed below, where 1 indicated strongly disagree and 7 indicated strongly agree. The statement " Everyone is responsible for protecting the environment" was very popular as 68% of respondents strongly agreed. 74% of respondents strongly agreed with the statement "The deterioration of the environment is a serious problem." Both results showed a strong interest from our sample in environmental issues.

After the environmental statements, we asked the respondents "How interested would you be in buying the Stirling sustainable charger if it was available to you today?" 22% were neither interested nor disinterested, 46% were somewhat interested and 17% were very interested. Respondents were not willing to commit fully to purchasing the charger. We then asked why they answered that way. Many did not find it to be practical and failed to see the need for the product when they already have an efficient way of charging their mobile devices. They were not given enough information regarding potential cost or how long the charge would last.

Regression Analysis

A regression analysis was conducted to examine the relationship between environmental attitudes and Stirling charger purchase interest. Overall, the six attitudinal items had a significant impact on purchase interest, $\Delta R^2 = .25$, $\Delta F\ (1, 84) = 4.58$, $p <$ 000. Four of the six statements had a significant impact on purchase interest, while two of the statements did not. These were "Everyone is responsible for protecting the environment" and "Everyone should recycle".

Demographics

Our audience demographic was 53% male, 54% aged 18-24, and 35% earned less than $20,000 in the previous year. To learn more about our audience, we asked targeted questions such as their highest degree of achieved education as well as their preferred devices to use while shopping online. There was an even spread for education achieved with 36% holding a bachelor's degree, 23% holding a master's degree and 20% holding a high school diploma. When shopping on the internet, 45% of respondents prefer to use a laptop, 41% prefer a smart phone and only 10% prefer to use a desktop computer. This diverse group of respondents ensured there would be no bias in the answers we received.

5 DISCUSSION

This research makes a contribution to both theory and practice by creating a framework in which R&D activities can be aligned with the marketplace with the objective of commercializing new technologies. While innovation through R&D is important for economic growth, inventions must be successfully transferred to the market in order to create value. Few studies have emphasized that it is necessary to understand the market at the R&D stage in order to reduce risk of failure. Furthermore, consumers do not always want new or innovative technologies since they require a lot of changes in existing behaviors. This study extends the "three-stage technology–product–market model" (Kim, 2019) by testing a new technology with potential environmental positioning, across three different countries. We also demonstrate how positioning strategies and marketing communications can be enhanced by understanding consumer motivations. Directions for future research include replicating this study for testing new technologies in expanded markets.

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