Lean Design for the Developing World: Making Design Decisions Through the Use of Validated Learning Techniques in the Developing World

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Douglas Lee Van Bossuyt
Naval Postgraduate School

J. Dean
Colorado School of Mines

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LEAN DESIGN FOR THE DEVELOPING WORLD: MAKING DESIGN DECISIONS THROUGH THE USE OF VALIDATED LEARNING TECHNIQUES IN THE DEVELOPING WORLD

Jordan F. Pease
Graduate Research Assistant
Department of Mechanical Engineering
Colorado School of Mines
Golden, Colorado 80401
Email: jpease@mines.edu

Jered H. Dean
Teaching Associate Professor
Mechanical Engineering
Colorado School of Mines
Golden, Colorado 80401
Email: jdean@mines.edu

Douglas L. Van Bossuyt, PhD*
Assistant Professor
Mechanical Engineering
Colorado School of Mines
Golden, Colorado 80401
Email: dvanboss@mines.edu

ABSTRACT

Current methods for design in the developing world rely on many tools that are used in standard product and system design. Design for the developing world methods, such as Human Centered Design or co-design, often use a user-centered method yet advise the use of design tools developed for use in a market-centered approach. Recent advances in market-centered design from lean startup methodologies and decision-based design hold promise for the development of new methods that allow effective product design for consumers in the developing world. The Lean Design for the Developing World method (LDW) is an iterative method that is based upon three fundamental hypotheses including the growth hypothesis, the value hypothesis, and the impact hypothesis. LDW seeks to provide products for underserved markets of the developing world that are economically viable, have strong market growth potential, and have a net positive impact on the customers and their communities. This paper contributes a novel detailed method to collect and analyze qualitative and quantitative data for the LDW. To enable effective decision making and design tradeoff decision-making in the LDW, effective accounting and gathering of feedback data is vital.

1 INTRODUCTION

In recent years, humanitarian engineering and design for the developing world has focused on the creation of user-centered design methods to aid in the creation of products for use in the developing world. A major limitation in the use of a user-centered method is its inability to generate quantitative data for use in design decision making. Using a market-based method in place of user-centered methods when designing for the developing world could aid in the creation of actionable quantitative data for the decision making process of consumer level product design [1].

Lean Design for the Developing World (LDW) is a novel method that seeks the generation of both quantitative and qualitative data for use in the design of consumer-level products [2]. Using a lean iterative method, the LDW method brings together methods such as Human Centered Design (HCD), The Lean Startup method, systems engineering, and decision-based design. By adapting tools from these methods, the LDW creates a unique perspective and toolset which enables the generation of actionable data for the decision making process in a design challenge.

There are three steps in the LDW method; 1) Product Concept and Deployment, 2) Validated Learning, and 3) Decision Making. The second step of the LDW, Validated Learning, is a step that plays a vital role in creating market validated products. By viewing all aspects of design as learning opportunities, effective recording and preparation of data is important to enable educated decision making during iterations of a design. Rapidly identifying areas of success and failure assures that the lean LDW method is continuing to iterate towards success for a product.

2 Specific Contributions

This paper contributes a detailed and refined approach to the Validated Learning section of the LDW method. Methods to convert the three hypotheses present in the LDW into the monetary value domain are provided. Additionally seven decision gates

*Address all correspondence to this author.

are provided to aid in the decision making process when investigating qualitative data sets.

The detail provided in the Validated Learning step of the LDW in this paper creates a more effective decision making process for a design team. Having effective Validated Learning enables design teams who use the LDW method to more accurately identify necessary a product Pivot, or Perseverance. This accuracy in the decision making process aids in the creation of products that deliver value to both consumers and companies. Presented in this paper is the creation of 7 decision gates, independent hypothesis data collection, and a novel method to convert the three LDW hypotheses to the monetary value domain.

3 BACKGROUND

This section reviews a variety of topics that provide a general background for design in the developing world, the Lean Startup method, systems engineering, decision-based design, and the LDW method. Through the effective collection and analyzing of data Validated Learning can enable the effective use of the LDW method.

3.1 Developing World

It is difficult, if not impossible, to simultaneously address all aspects of development at one time [3]. Therefore, the term 'developing world' in this text will refer to economic development. More precisely, those individuals who live on less than $2 USD per day [4]. Despite limited personal income, the shear size of the population that lives on such limited resources represents a market with around $5 trillion USD in purchasing power parity [5].

3.2 Design for the Developing World

There currently exists numerous methods for design in a developing world context, however most are user-centered approaches. One example of a user-centered approach that was created for use in the developing world is Human Centered Design (HCD). The HCD toolkit was co-written by IDEO and iDE and presents a set of techniques that are deployed in order to create solutions to problems in the developing world. These solutions can take form in many ways including services, environments, organizations, and products [6].

HCD has two key weaknesses when compared to a market-based approach. First, HCD relies heavily on qualitative information, with little to no collection of quantitative data present for future design decision making. HCD runs the risk of producing overly customized products due to this near-exclusive reliance on qualitative user invterviews and observations. Second, HCD can produce sub-optimal results as many people may be unwilling or unable to precisely articulate their needs with a design team. This mis-communication can also arise if the design team is prejudice about a user's needs and unable to effectively listen for key pieces of information [7].

Measurement of the impacts products have on customers and their community is necessary in any design for the developing world challenge. Bridger and Luloff [8] and Engineering and Sustainable Community Development (ESCD) [9] suggest looking at a set of five or six measures of economic diversity. These include the measurement of local economic diversity, environmental sustainability, social justice, and self-reliance [8–12].

3.3 The Lean Startup Method

In "The Lean Startup" Eric Ries defines a startup as "an organization that rapidly turns ideas into products." Within the context of the LDW the term 'startup' will be supplanted with 'design team.' This redefinition narrows the scope of Ries' definition within the context of engineering design, rather than entire corporations and other organizations. The design team thus works to create products from ideas as quickly as possible to get the product into the users' hands [13]. The reason for haste in delivering the product to a customer is to enable what Ries calls 'Validated Learning.' Validated Learning simply proposes that the only way to get real information from customers and the market is to release a product [14]. Once in customer's hands, products can quickly create sales data that can be leveraged to identify what is valued by both customers and markets [15]. By using a combination of qualitative and quantitative data, validated learning seeks to validate a product within a target market [16]. To enable this process of learning a few key steps and terms need be defined.

3.4 Value and Growth Hypotheses

The lean startup uses two hypotheses to generate an initial product concept. These are the value and growth hypotheses. The value and growth hypotheses defined by the Lean Startup Method are detailed below [13].

Value Hypothesis: This hypothesis measures the value delivered to the customers or markets that are using the product. It is a measurable market-based metric that is used by the design to team in order to gauge if a product is providing value to the target market or customer as desired. This is affirmed through positive user feedback and profitable sales for the company [13].

Growth Hypothesis: This hypothesis measures how new customers discover the product or service. The growth hypothesis is used by a design team to determine if a product has consistent sales growth, sustainable adoption rate, and how well a product or service is retaining current customers. The growth hypothesis is tested and confirmed through point-of-sale feedback and sales growth [13].

3.4.1 Pivot and Persevere

Pivots are defined as a rejection of the value hypothesis, growth hypothesis, or the fundamental product vision. Pivots require the design team to change the value hypothesis, growth hypothesis, or both and then reflect the changes in the form of a new product. Product Perseverance is defined as an affirmation of the original value and growth hypotheses. While a perseverance may still require optimization, the underlying project vision and value proposition are affirmed [13].

3.4.2 Minimum Viable Product

A Minimum Viable Product (MVP) is a product that contains the minimum feature set required to produce an economically-viable product. The goal of the MVP is to create a product that can facilitate the learning process by producing only those features necessary to test the original hypotheses. The MVP is not the most simple or least expensive product, but rather a product that delivers value to both the company producing the product and the customers, while also providing valuable information for the testing of the value and growth hypotheses [13].

While the MVP will inevitably lack many features that may later prove essential, it may also contain some that are deemed unnecessary. The Lean Startup method proposes that the only true way to determine what are essential or unnecessary features is to release a product to the market. The MVP in essence is the tool that enables the start of the iterative Lean Startup loop of product design [13].

3.5 Decision-Based Design

Decision-Based Design (DBD) views engineering design as an enterprise-driven decision making process which requires the application of both decision theory and economic principles. DBD seeks to address enterprise needs, through an understanding of a project's big picture, while simultaneously paying attention to engineering details in order to meet technical requirements.

Most approaches to engineering product design are conducted with an engineering-centric perspective that seeks the best possible performance within a given budget. This domain-centric approach is done in many other areas outside of engineering such as marketing, management, and production, with each domain seeking to optimize only domain-specific objectives. This focus often ignores input from any other domain. By optimizing only immediate domain-specific needs, sub-optimal results are often reached, sacrificing potential economic benefit [17].

DBD addresses these shortcomings by using a systems-level perspective to enable the application of decision theory into the design process. Through this perceptive, engineering decision-making becomes an optimization process, iterative in nature, that maintains the end goal of locating the best design alternative in order to maximize delivered utility [17].

One of the key strengths derived from the application of DBD is the realization that the purpose of a product is not only to satisfy what customers desire, but also to sell the product for a price that will make it worthwhile to continue, and ideally, increase production of the product [17]. More succinctly, a product must be economically profitable.

The framework for the use of a DBD method has six major steps. These are 1) market research, 2) alternative generation and engineering analysis, 3) product cost modeling, 4) construction of the demand model, 5) determination of corporate objective and risk attitudes, and 6) performing optimization to determine the preferred alternative [17].

3.6 Lean Design for the Developing World

The Lean Design for the Developing World Method (LDW) is an iterative design method that can be used by design teams interested in creating products specifically designed for use in the developing world. The products that are produced by the the LDW aim to be economically viable for both customers and the companies that produce the products, have strong market growth potential, and create net positive impact for the customers and their communities [2]. The LDW is built upon the idea that the market can best identify product value. Product value must remain the focus of the designer through all steps of the design process. The LDW borrows from design for the developing world methods, the lean startup method, engineering product design, systems engineering, and decision-based design. From the integration of these five areas of design research, a novel approach for the development of products for use in the developing world was created [2].

There are three overarching steps in the LDW, including: 1) Product Concept and Deployment, 2) Validated Learning, and 3) Decision Making. These three steps, and how they interact with one another is shown in 1. The focus of this paper is on expanding and refining the second step, Validated Learning [2].

The first step of the LDW, Product Concept and Deployment, is where both a design challenge is identified and where ideas and customer needs are turned into products. These areas are identified through the analysis of how customers spend their money. This is accomplished through the investigation of data repositories kept by the UN, NGOs, and academic publications [1, 18–23]. Using heterogeneous customer needs and a functional decomposition, a focused set of engineering specifications can be developed. These specifications are then used for the creation of a Minimum Viable Product which enables the design team to enter step 2 of the LDW, Validated Learning [2].

Validated Learning is a step concerned with the attentive collection of both qualitative and quantitative data. This data is then prepared to enable its use in the third and final stage of the LDW, Decision Making. Through the testing of the three hypotheses the LDW moves from the Validated Learning step of the LDW to Decision Making, where a decision to Pivot, Persevere, or Cancel a product is made [2].

4 METHOD

The LDW method uses techniques from decision-based design to enable for informed decision making during the iterative design process. To enable this, the LDW uses a combination of both qualitative and quantitative data in the Validated Learning step of the method. The qualitative data is gathered in the form of feedback from both customers and point-of-sale or distributor feedback. The quantitative data is obtained through the collection and analysis of sales data. Through careful preparation

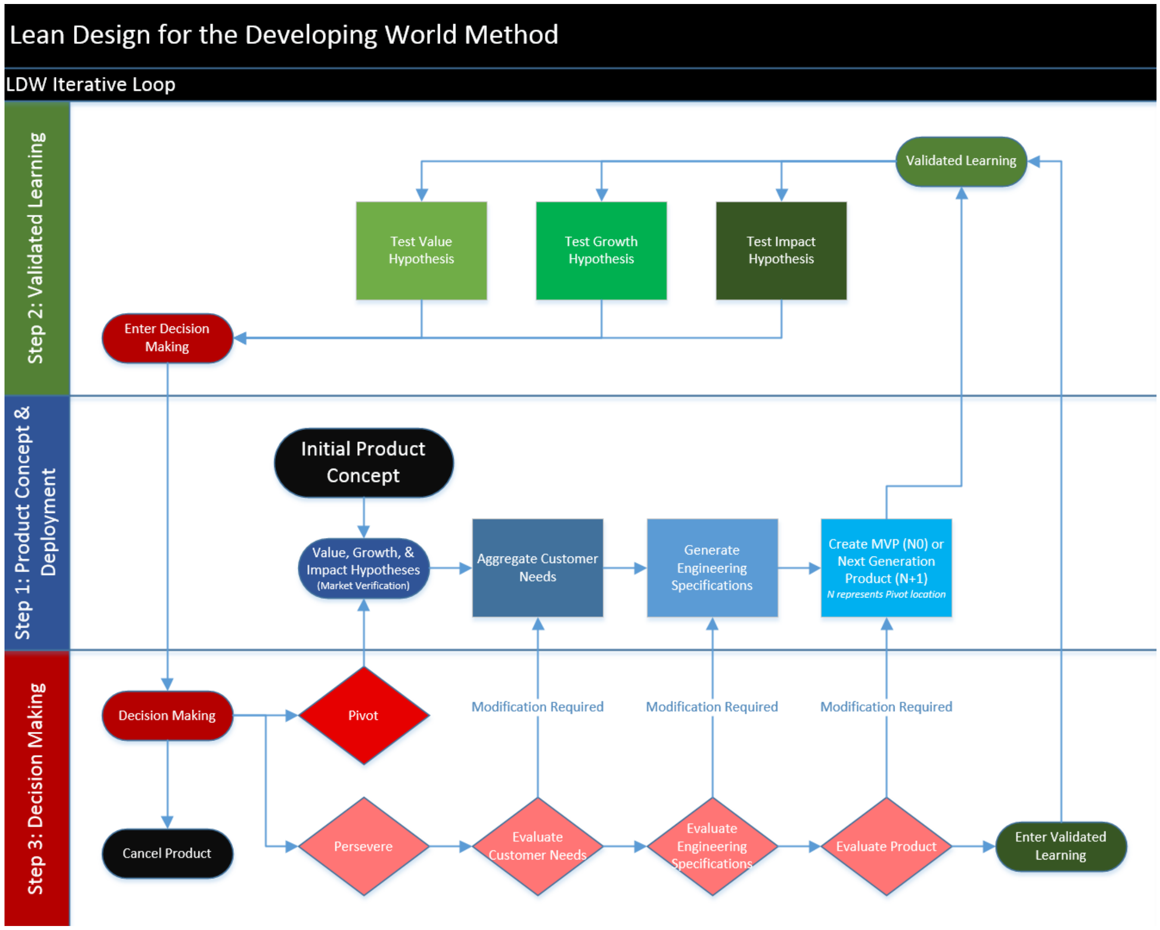

FIGURE 1. Flowchart showing the three main steps present in the LDW and how each interacts with one another during the iterative design process.

and analysis of sales data, great insights into the effective value delivery of a product to both customers and companies can be obtained.

A paper case study inspired by Nokero will be discussed during each stage of the expanded and refined Validated Learning step. Nokero designs and manufactures solar powered light bulbs for use in the developing world. While Nokero did not implement the LDW directly during its creation of its solar lighting solutions, it is one of the chief motivators for the LDW's creation. Nokero's design methods and decision making over the last three years closely follow those proposed in the LDW. The LDW was created in consultation with Nokero to formalize and improve upon existing design process.

4.1 Validated Learning

The LDW has numerous novel components that contribute to its ability to combine both qualitative and quantitative data into the decision making stage of the design process. Validated Learning is a process that demonstrates empirically whether or not a design team has found valuable truths about a products present and future prospects in the target market. Validated Learning follows each successive product release from the initial MVP to the eventual canceling of a product. As can be seen in figure 2 the three main steps of the Validated Learning stage for the LDW are the testing of each of the value, growth, and impact hypotheses. All of the hypotheses generally follow the same testing procedure, however they do vary slightly. Three parallel swim lanes representing the three hypotheses can be seen in figure 2.

Value, growth, and positive impact are all central focuses of Nokero, and during each iteration of product Nokero has looked at all three areas of focus in making a decision on whether or not to Pivot, Persevere, or cancel a product [24, 25]. While many of the ideas and tools used in the second step of the LDW, Validated Learning, are used by Nokero, many have yet to be utilized. The LDW was created in response to many of the challenges faced by numerous companies, such as Nokero, who design products for use in the developing world [26].

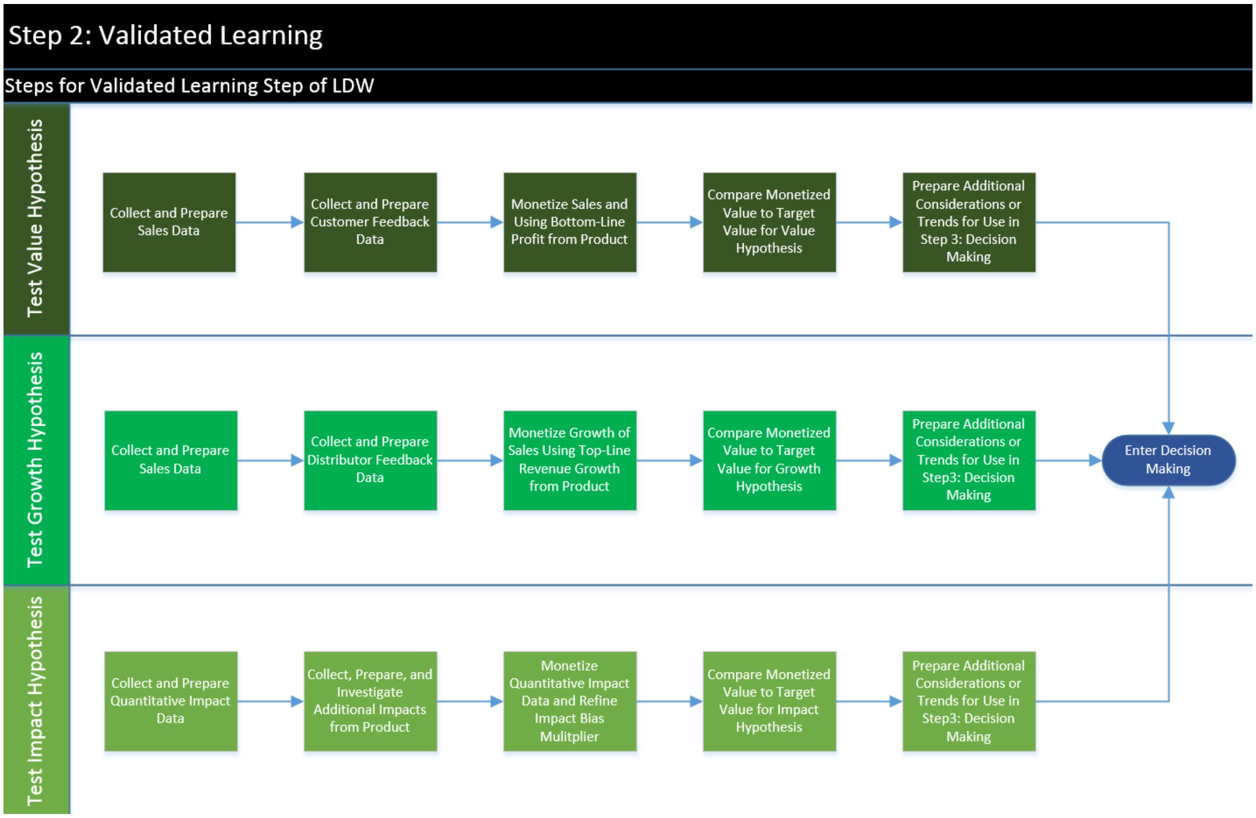

FIGURE 2. Flowchart showing the separate steps located within Step 2 of the LDW, Validated Learning.

4.2 COLLECT AND PREPARE SALES DATA

The first step in the testing of the three hypotheses is to collect and prepare sales data. All three of the hypotheses require accurate collection and preparation of sales in order to begin the validated learning process. This sales data is required to enable the conversion of the three hypotheses into a singular monetary value domain for use in the decision making stage of the LDW. The impact hypothesis will require the collection of further quantitative data beyond sales to gain a more complete picture of impacts delivered by a product, for example carbon credits or public health measures. Nokero uses monthly accounting to enable product specific sales data to be used as quantitative data for eventual decision making [27].

4.3 COLLECT AND PREPARE PRODUCT FEEDBACK DATA

Attentive collection and preparation of product feedback data provides contexual grounding of raw sales data during the decision making stage of the LDW than when looking only at sales and other forms of quantitative measures. For the value hypothesis customer feedback is collected and analyzed for insight. The growth hypothesis uses point-of-sale and distributor feedback for qualitative feedback. The impact hypothesis looks to the community and customer for feedback on potential improvements or detriments to the user and the community to gain a qualitative understanding of the impacts delivered by each product. This data provides a qualitative data bank that when used in combination with qualitative measures can enable more effective decision making. Nokero uses a mix of both engineers in the field and point-of-sale feedback to gain qualitative data from users [26].

4.4 CONVERSION TO SINGLE CRITERION FOR DECISION MAKING

Next in the Validated Learning step of the LDW method is the conversion of the various quantitative measures into the monetary value domain, to enable more structured decision making by the design team. Conversion to a single criterion allows for comparison of the variety of factors that play into the decision making process. In essence, a single criterion is one unit of measure from which all factors of a decision process can be based. Within the context of the LDW this single criterion will be the monetary value domain.

The value hypothesis is brought into the monetary value domain through bottom-line profit generated by the product over a set amount of time. The value, as defined in the Validated Learning step of the LDW, is concerned only with generating value for the company. The value delivered to the customer as defined by the LDW will be to set a target ROI such as the 100% suggested in one year, or 300% or a product life cycle. This customer value can never be sacrificed for additional company value, the value hypothesis simply measures the value that is being delivered to the company after the assumed customer delivery value has been met. Equation 1 is a simple example of how one may calculate the value delivered by the value hypothesis in the monetary value domain.

$$ValueHypothesis = Income - C_g - C_o \tag{1}$$

In this equation Cg is the cost of goods and Co the operational on a per unit basis. The value hypothesis is concerned with the accounting income as expressed through the calculation of the difference between generated income and the cost of the goods and operating expenses to product those goods.

The growth hypothesis is converted into the monetary value domain through the investigation of top-line revenue growth over a set amount of time. This top-line revenue growth value is generated by taking the average growth over the previous set amount of time to generated a forecasted growth rate. This projected growth rate is then set to project sales in the coming months of sales. This sales projection is then used to calculate the projected net profit increase as shown in Equation 2. The growth hypothesis is a great predictor in the future prospects of a product and can generate valuable insights into whether a product is likely to remain viable in the near future.

$$GrowthHypothesis = S_{projected} * NP_{unit} \tag{2}$$

$S_{projected}$ is the projected sales growth and NP_{unit} is the net profit generated on a per unit basis. This measure of growth is constantly adjusted and can vary greatly depending on the time scale selected.

The impact hypothesis is converted to the monetary value domain by investigating the quantitative impact data multiplied by a biasing value that encompasses additional considerations that cannot be readily quantified. The biasing value is a multiplier that is multiplied to the quantified impact value generated at a per unit basis. This biasing value is present in order to augment those measures, such as carbon credits, that are not completely representative of the positive impacts created by a product.

The impact hypothesis value is generated by both quantitative impact measures and the addition of a biasing multiplier that works to encompass non-quantifiable positive impacts generated by a product on a per unit basis. This is reflected in Equation 3. U represents units sold, B the impact bias factor, and I the quantifiable impact factor per unit.

$$ImpactHypothesis = U * (\beta * I) \tag{3}$$

4.5 PREPARE ADDITIONAL CONSIDERATIONS

Next the design team must investigate the qualitative data gathered earlier in the validated learning stage to produce a more complete picture than can be created when looking only at quantitative data. These considerations will be tested by seven decision gates as defined by the LDW. These considerations when tested against the seven gates will provide additional means from which to test the hypotheses against a set target value. This testing will allow for the identification of whether a product should enter a Pivot or Perseverance for the next iteration of the product.

4.6 DECISION GATES

The seven decision gates as defined by the LDW are highlighted below. These seven gates provide a means from which to test both the qualitative and quantitative measures for each hypothesis beyond just meeting a target value.

1. **No hypotheses can result in a negative value over the long-term (greater than 1 year.)** In the short-term, the value or growth hypotheses can be negative because the focus of the LDW is long-term sustainable growth. Sacrificing short-term growth or value for long-term gain is advisable. The impact hypothesis should never be a negative value as producing a product that creates a net negative impact on the target user or their community is not an acceptable proposition even over a short time frame.
2. **The Value hypothesis must sustainably deliver value to both the consumer and business.** Value is measured in monetary terms. Remember that the monetary units of measure represent many considerations beyond profit following the monetization of value, growth, and impact considerations as defined by the hypotheses generated in step one of the LDW.
3. **The Value hypothesis must create income-generating tools or products that are able to pay back their purchase price to the customer within one year.** This represents the 100% ROI within one year, and 300% ROI over product life cycle as proposed by Paul Polak [28]. The income generated by a product needs provide value for both the consumer and producer of products.
4. **The Growth hypothesis shall enable scaling measures to reach one hundred thousand resource-poor customers within 3 years.** This measure is creating a sufficient scale to both increase revenue as well as make a notable impact on resource poor regions in the developing world.
5. **The Growth hypothesis shall retain scaling capacity and identifiable future markets for expansion.** Sustainable growth and expansion of potential markets is one of the biggest advantages that a market-based strategy maintains over user-centered approaches. Attentively measuring and understanding growth is a central consideration for the LDW.
6. **The Impact hypothesis shall have a quantitative value that can be brought into the monetary value domain.** To enable effective decision making, the net impacts of a product must be able to be brought into the monetary value

domain in order to assure a well-informed balancing of the three central hypotheses in the LDW.

7. **The Impact hypothesis shall retain future goals or community planning when applicable.** Support and service is an important portion of all design methods. In the developing world, development of the community is vital if meaningful support and service is to be possible by a design team [29]. Providing support is not only vital to providing products in a sustainable manner, but is also vital to allowing effective, efficient, and meaningful information for future iterations of products. One of the greatest challenges faced by startups working in the developing world is the consistent and accurate gathering of customer feedback data [25]. Collecting this data in imperative for a design team utilizing the LDW method. By focusing on creating a positive impact for community development, the design team will allow for informed decision-making, a consistent and established market, and increasing positive impact from their products.

When a product fails to meet any of the seven decision gates as determined by the design team, a Pivot or canceling of the product is advised. These gates assure that a product is viable for both the company producing the products and customer. Additionally these gates measure whether or not a product is creating net positive impact for both the end users and their communities. The gates were developed through the investigation of existing methods from ESCD, adopted from Bridger and Luloff [8–12]

These gates all have varying time frames for effective application. For example each month it should be confirmed that no hypothesis is delivering a negative value. At the end of each financial quarter the design team should assure that the product is on track to deliver sufficient ROI to the customer. Every six months the design team is advised to look at the product for longer term trends in the data and complete an iteration of the LDW to determine if a Pivot or Perseverance is required. In the 3 to 5 year time frame design teams should assure that sufficient return is being generated for the company and its shareholders.

4.7 SETTING OF TARGET VALUE

To enable effective testing of the hypotheses a target value must be set for the product. This target value is created by considering the long term target value delivered by a product. More specifically the target value considers that when all three hypotheses are assumed equal and balanced the value delivered by the product will create sufficient value for the company to provide adequate return on investment for investors and customers. As noted before customer value cannot be sacrificed below the suggested targets of 100% ROI within one year or 300% ROI for a product life cycle. This is simply a suggested value and naturally providing greater value and thus greater ROI for the customer is ideal.

4.8 Sol-D Paper Case Study

To show how effective Validated Learning can influence a design teams success in Pivots and Perseverance, a paper case study is provided on a company called Sol-D. Sol-D, like Nokero, develops solar lighting solutions for use in the developing world. The paper case study will provide an example of how the Validated Learning step of the LDW method, as inspired by Nokero, could improve on the design decision making process.

The original product concept for the Sol-D team was to create a solar light bulb to replace kerosene lamps used throughout the developing world. The target value to successfully create value for the end user is to deliver 30 lumens of light, for six hours per day, and at a price point below $18 USD. This would create a product that could produce %100 ROI to the customer within six months of purchase. This ROI would be created through the elimination of the need to purchase kerosene fuels for the lamps.

The product was created using the LDW process. Going from initial product concept to aggregate customer needs, generation of technical specifications, and creation of the MVP the product exited step 1 of the LDW method. With the MVP released, Validated Learning could begin. The Validated Learning process took 6 months before sufficient data was collected for the LDW method to move forward. The results were less than convincing after 6 months with the value and impact hypotheses both being below expected. A graph showing the expected value against the three hypotheses values over the first six months of sales is shown if figure 3

The Sol-D design team, through investigation of both the quantitative data shown in the graph above, and the qualitative data through the 7 decision gates, determined a Pivot was required. To determine which direction to take the product the Sol-D design team looked back to a previously conducted multinomial logit model survey that was conducted. This survey was conducted as a means to gather qualitative data to measure against the 7 decision gates. However, this survey also served an additional purpose, which was creating quantitative feedback data when investigated in aggregate. Looking at customers as heterogeneous groups the multinomial logit model fit well with the goals of Validated Learning through its generation of both qualitative and quantitative data generation for use in later design decision making. Using Validated Learning techniques the data gathered from quantitative sales and qualitative feedback could be leveraged more effectively in the Sol-D design team's decision making process because of effective Validated Learning implementation.

The use of functional decomposition during the generation of the MVP gave the design team three distinct areas of function to adjust for the product Pivot. Having only the minimum set of features allows for a more complete understanding of quickly highlighting which of the delivered features are most valuable to customers. In figure 4 the FAST method of functional de-

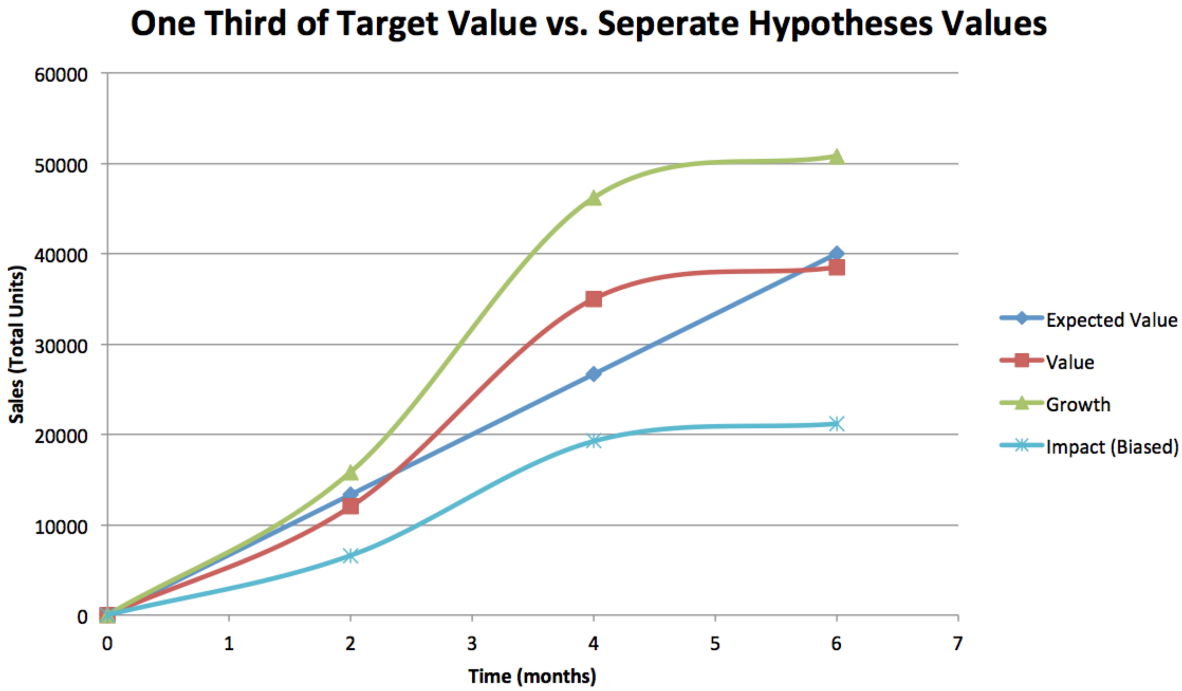

FIGURE 3. Graph showing the monetary value domain returns of each of the three hypotheses against the expected value, over the first six months of sales of the Sol-D product.

TABLE 1. Multinomial Logit model survey for results for limited cash flow customers.

Attribute	MVP	Pivot
Brightness (Lumens)	30	15
Run Time (Hours)	6	4
Price (USD)	$15	$8

composition can be seen comparing the MVP Sol-D to that of a kerosene lantern.

From the gathering of data early in the Validated Learning step, two distinct markets were identified by the Sol-D design team. Highlighting the recognized markets, the multinomial logit model survey for the Sol-D product lead to the development of refined product attributes in the form of a lowered bulb luminance, run time, and price. The selected attributes can be seen in table 1.

Underestimating the demand for a lower price point and overestimating the desired feature set, lead the first generation product to require a Pivot. By using Validated learning techniques the Sol-D team was able to identify the Pivot rapidly by investigating the sales data. The value and impact hypotheses were lacking and thus a Pivot required. Designing a second generation product more in line with the logit model lead to the development of second generation product that better met the market demands. This is reflected visually in figure 5 where the three hypotheses can be seen exceeding the expected value return line. This helps to confirm that the Sol-D design team made an effective Pivot, creating a product that more precisely met market demands.

The Sol-D paper case study shows an example of how effective Validated Learning can enhance a startups ability to quickly identify necessary Pivots, thus minimizing the amount of resources allocated to products that are not viable in the target market place. In design for the developing world applications the gathering of data is often one of the greatest challenges for any design team. The Validated learning stage of the LDW provides a methodology for companies, like Sol-D and Nokero, to make educated design decisions based off both qualitative and quantitative data in the developing world.

4.9 Methodology Conclusion

The second step of the LDW is a vital step in assuring that the lean process maintains a vision for a viable product for both customers and the company producing the products. Without effective Validated Learning the decision making step of the LDW is unable to make informed decisions about the future of the products being produced. Attentive collection and accounting of sales data is vital to create accurate data for decision making. Beyond this careful and focused collection of feedback data

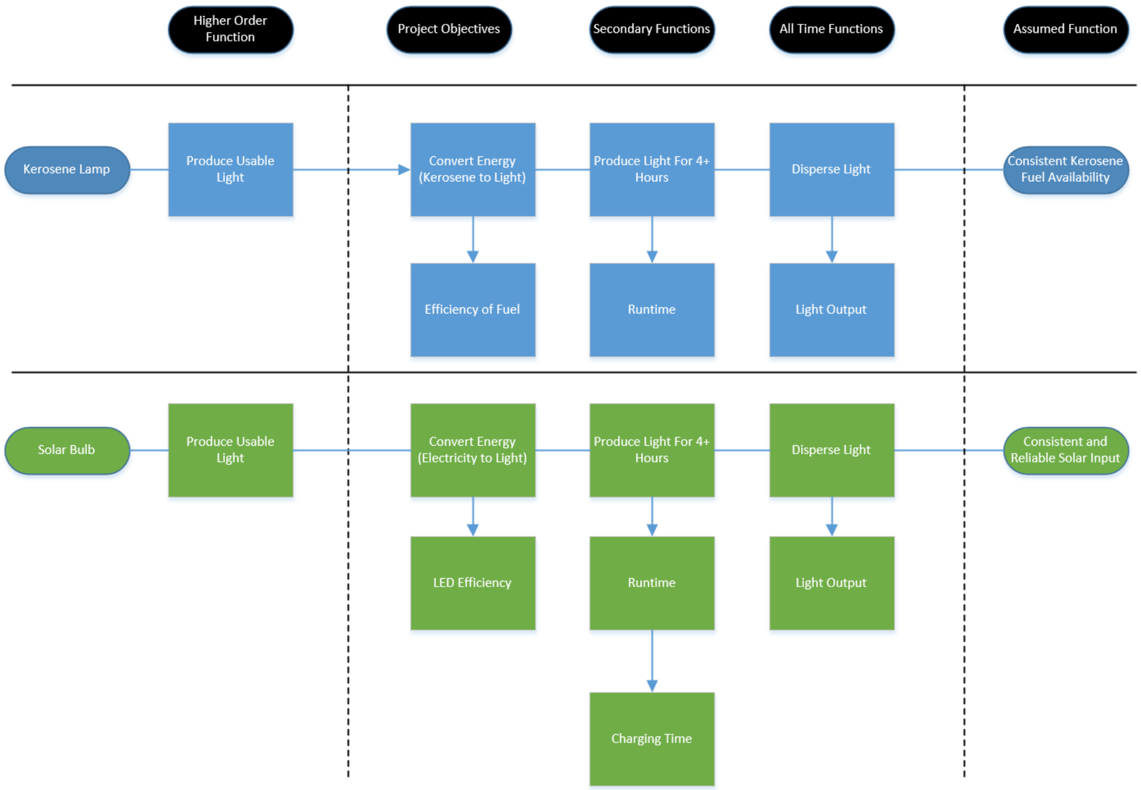

FIGURE 4. A FAST method functional decomposition of a solar lantern and a kerosene fuel lantern.

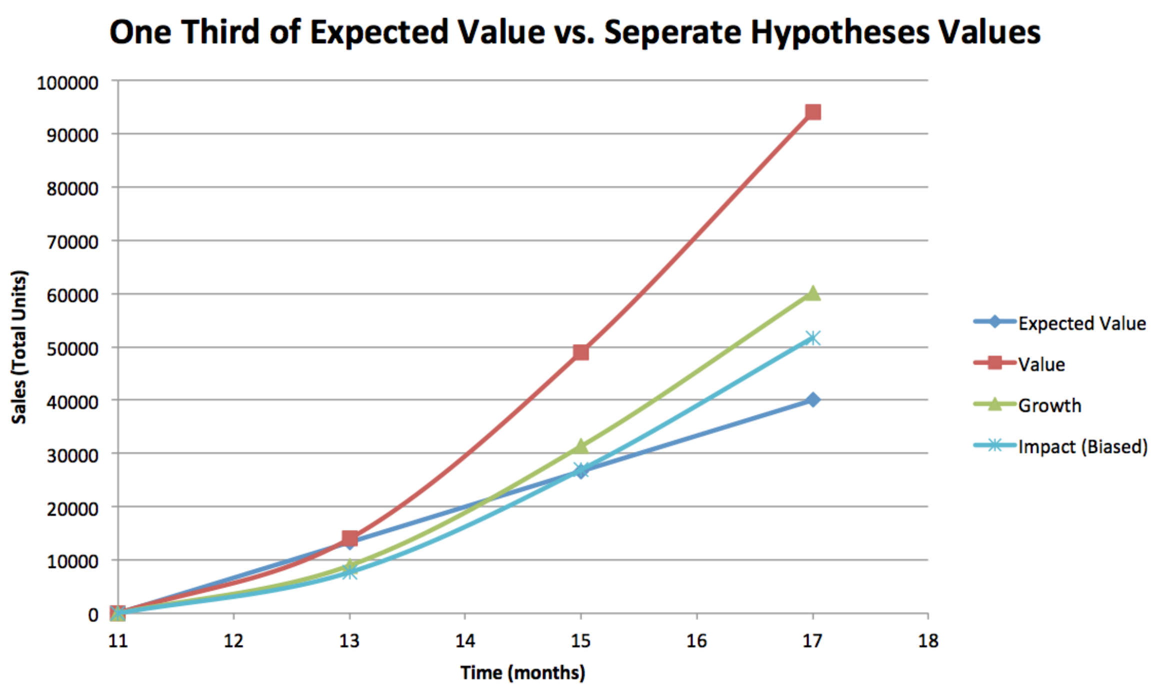

FIGURE 5. Graph showing the monetary value domain returns of each of the three hypotheses against the expected value during months 6-12 of the pivoted Sol-D product.

is necessary to create qualitative data from which to augment the quantitative sales data. This combination of both qualitative and quantitative data enables for much more accurate information from which iteration can take place within the context of the LDW method.

5 DISCUSSION

The preparation of data is a vital step to any effective implementation of a lean iterative method. This preparation of data is completed in the Validated Learning step of the LDW method. Validated Learning not only requires effective data collection, but also tools to convert raw data into data that can aid in the decision making process. Additionally, Validated Learning also needs to have a product that was designed in such a manor that effective learning can take place.

The initial product that allows for effective learning to take place in Validated Learning is the MVP. Since the MVP seeks the minimum product functions for a viable product it allows for a lean approach from which better informed decision making can take place. In the LDW, the focus on learning and gathering of actionable data is an ever present concern for the a design team. Rather than simply looking at the learning process and decision making as an end game following the release of a product, these processes are instead an ever present focus for a design team.

This focus on learning and effective decision making are keys to keeping the focus on the lean iterative LDW method on products that create value, and quickly realizing when products are not providing sufficient value for customers or the company producing the products. Since the LDW method focuses so much on learning and effective decision making, it is ideally suited for environments with greater levels of uncertainty, such as the developing world. Environments where information and feedback is limited and difficult to obtain, focusing on learning throughout all phases of the design process allows for the creation of products that can both provide value to customers and companies, as well as fuel the learning process for what is desired by markets.

The importance of the Validated Learning step becomes even greater as products expand into larger product portfolios. As more products are released in response to market demands, effectively tracking and investigating trends and demands takes on a greater importance. Being able to effectively utilize information from all products present in a product portfolio or architecture will allow for both larger databases of both qualitative and quantitative feedback. As these databases become ever larger, efficiently and rapidly identifying market needs becomes even more complex.

6 FUTURE WORK

The Validated Learning step of the LDW method will require additional refinement through investigation of a few key areas. These topics are both areas of concern for engineering design as well accounting.

For many companies, one of the greatest challenges is the consistent collection of accurate data. More effective accounting methods are required to increase the accuracy of quantitative measures of market data, such as sales. This problem is one that extends beyond simply a developing world challenge as it is also a shortcoming of many startups. Many startups underestimate not only the power of accurate sales data, but also many times lack the open systems-level perspective required to fully leverage the agility of the company. For a startup sized organization operating in a developing world context the challenges are great, which means every advantage and tool available should be utilized in the creation of products. The creation of a more uniformly used method of accounting by startups operating in the developing world will allow for further refinement of the Validated Learning stage of the LDW. This refinement will in turn create a more automated and consistent decision making process for the LDW method.

One of the greatest challenges in the Validated Learning step of the LDW method is the weighting and comparison of qualitative and quantitative data. Relying to heavily on one or the other can lead to sub-optimal design decision making. While Validated Learning as presented in the LDW presents a novel method from which to investigate both qualitative and quantitative concerns, it does not give a uniform method of presenting a combination of the two for use in the decision making stage. Methods and tools to enable a more accurate representation of both qualitative and quantitative considerations would further strengthen the Validated Learning step of the LDW method.

7 CONCLUSION

Despite the numerous challenges for design in a developing world context there exists opportunities that have largely been overlooked. Approaching a design for the developing world challenge from a mark-based approach views the people in the developing world as customers, not victims. If real change and development is to be brought to the billions of resource poor on the planet, first the way in which these resource poor are viewed must change. Once these resource poor are viewed as customers and the challenges are approached from a market perspective, tools such as those from systems-engineering and decision-based design can implemented. Within the context of the LDW method these tools enable effective Validated Learning, which in turn provides actionable data for design teams.

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