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Study on Lean Startup Methodology with Lean Critical Tools and Lean Research Framework for Sustainability of Startups

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Abstract

In the age of globalization, a startup's objective is to determine what it should build to meet the needs of its customers and make a profit as soon as possible. A long, consistent operating history and a comparatively unchanging environment are prerequisites for the accuracy of traditional management techniques. Startup have neither! And so, the Lean Startup with critical Lean tools and Lean research framework for the startups came into the picture.

This paper examined the three key pillars of the Lean Startup Methodology—Vision, Steer, & Accelerate—and how a startup may use them to lower potential risks along the way. We also looked at the various Critical Lean Tools and the Lean Research Framework that are helpful for the sustainability of startups.

This paper also explores awareness and its adoption about the Lean Startup methodology and other related aspects in first generation rural entrepreneurs those who undergo training in entrepreneurship education and Integrated Digital Entrepreneurship Training and startup methodologies. The sample size was 126 startup founders-entrepreneurs for the collection of primary data.

Methodical delivery of the contents with Project Based Learning was found useful for capacity development of the first-generation rural entrepreneurs for the adoption of Lean Startup Methodology with Lean Critical Tools (LCT) and Lean Research Framework. Holistic approach of these three is found useful to improve livelihood of rural entrepreneurs with sustainability of the startups.

Keywords: Lean Startup Methodology, Learning School, Strategy, Effectuation, Business model validation, Critical Lean Tools, and Lean Research Framework.

Introduction

Startup operates on an engine known as the "engine of growth." Every new product version, feature, and marketing campaign is an effort to strengthen this engine of development to ensure the long-term viability of entrepreneurial activity. Much of a startup's existence is spent fine-tuning the engine by improving the marketing, goods, and other aspects of the business.

The startups fail for a variety of reasons. The attraction of a solid strategy, a good plan, as well as in-depth market research, is the initial problem. Previously, these factors were used to predict market success. Entrepreneurs have a strong desire to apply these principles to startups as well, but this is ineffective because startups operate in an uncertain environment since they are still unsure of their target market and the nature of their goods. As the entire world grows more unclear due to the rapidly changing environment, it becomes increasingly difficult to anticipate the future. In an ever-changing environment, traditional management practices are inadequate. Reliable planning and forecasting are only possible in an environment that is largely constant and has a long, consistent working history.

The second reason for failing startup is that the traditional management fails to solve the problem with investors who have thrown up their resources as well as adopted the “Just Do It” an academic approach. According to this method, chaos is the solution if management is the issue (Anthony, S. D. 2014). Lean startup's theoretically based assumptions and boundary constraints are becoming more widely accepted, which should strengthen the method's theory-practice understanding and enable future iterations of similar approaches (Leatherbee, M., & Katila, R. 2020).

The goal of the LSM (Lean Startup Methodology) is to teach businesspeople how to drive their businesses. Startups With a Build-Measure-Learn feedback loop may make continuous improvements rather than creating intricate plans that are heavily predicated on assumptions. The LCT are ten in number. These tools focus more on process comprehension, waste detection, error prevention, and act documentation (Minitab, 2023). In the context of international development and humanitarian work, the Lean Research Framework (LRF) is helpful in directing and enhancing the practice of conducting field research with individuals and communities (Root Capital & McCreless, M., 2015). According to Tyagi, S., Cai, X., Yang, K., & Chambers, T., (2015), A collection of 10 lean tools and approaches are provided to help increase the effectiveness of the knowledge generation method. The methodology begins by establishing a framework for knowledge creation in the product development environment, followed by a methodical demonstration of how these 10 lean tools and methodologies conceptually fit into and play an important part in that process.

This article addresses the Vision, Steer, and Accelerate parts of the LSM, as well as the LCT and LRF, which are important for startup sustainability. "Vision" presents a case for a novel type of entrepreneurial management. Validated learning (VL) requires an entrepreneur to explain a new method for his company in order to assess

whether it is progressing. To obtain such learning, we'll examine how a startup, whether in a garage or inside an organization, may utilize scientific experimentation to figure out how to develop a viable firm. "Steer" delves into the Lean Startup technique in depth, demonstrating one significant step of the Learn feedback loop, the basic Build, and Measure. Here, we'll look at how to create a minimal viable product and how to decide whether to pivot (change direction with 1 foot planted to the ground) or continue. We'll examine strategies under "Accelerate," which enable Lean Startups to continue to develop while completing the Build-Measure-Learn feedback cycle as rapidly as feasible. The value of small batches is one of the lean manufacturing concepts we shall examine that may also be applied to startups (Baker, T., & Nelson, R. E., 2005).

Objectives of the study:

- To explore practices of Lean Startup Methodology.
- To study awareness about LSM with Vision, Steer, and Accelerate.
- To explore Lean Critical Tools and its application.
- To explore Lean Research Framework.
- To know awareness about LSM, LCT, and LRF and identify gaps for the holistic approach.
- To explore opportunities for enhancing Awareness for the first generation of Startup entrepreneurs.
- To conclude about the holistic approach to LSM, LCT and LRF.

Research Design and Methodology:

In this exploratory research study, the design is trying to focus on the current problem instead of conclusive answers to the stated questions. To explore the deep understanding the LSM, LCT, and LRF, this study is carried out and annoying to emphasize the implementation of a holistic approach for well-established and new startups and through a literature survey with research paper mapping on Litmaps. LSM, LCT, and LRF are the keywords used to explore the related papers and their mapping. The paper reviews on LEAN are available in fewer numbers on these three aspects in various database and hence primary data was collected to see the awareness about these lean aspects and its adoption in the startup. The sample consisted of 126 first generation trained startup founders-entrepreneur youths from rural area with Project Based Learning (PBL) methodology. The purpose of the research questions of this study is to explore the learning of start-ups and its measurement of progress with LSM, LCT, and LRF and to see its holistic adoption with awareness for the sustainability of the startups as the reviews on these three LEAN aspects are available in less number on various database.

Literature Review:

We utilized Google Scholar and the SCOPUS database to conduct a literature study on the holistic approach of LSM, LCT, and LRF. Out of 36 publications, 20 research papers were cited to discover the gap after mapping the other 20 research papers with Litmaps. Figure 1 shows research paper mapping.

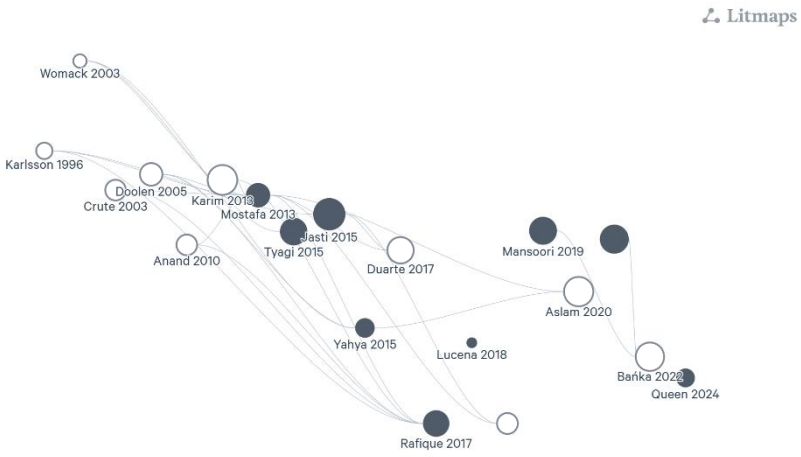

Figure 1: Research Paper Mapping using Litmaps

In an increasingly international market, first-generation well-trained entrepreneurs frequently generate distinctive concepts for start-ups. Other entrepreneurs frequently start new enterprises with very rudimentary notions and insufficient resources. A transitory company founded to find a scalable and replicable business concept is commonly referred to as a startup. In light of this, academics agree that a startup company lacks a viable and cohesive business plan that can support the long-term goals of the organization (Chesbrough and Rosenbloom 2002; Chrisman et al. 2005; Teece 2010). Chesbrough and Rosenbloom (2002) suggested that an original model

of business of the company is the hypothesis or unclear understanding of how to provide the client with value. Complements by pointing out that the best model of the business rarely emerges in a startup's early stages. In today's worldwide market, first-generation well-trained entrepreneurs frequently generate distinctive concepts for start-ups. Other entrepreneurs often launch new businesses with little more than a few simple concepts and little funding. A startup is sometimes defined as a short-term firm established to find a scalable and replicable business plan.

Accordingly, academics agree that a new company in its early stages lacks a viable and cohesive business plan that can support the long-term goals of the organization (Chesbrough and Rosenbloom 2002; Chrisman et al. 2005; Teece 2010). Chesbrough and Rosenbloom (2002) suggested that the original model of the business of the company is the hypothesis or unclear understanding of how to provide the client with value. Adds that it is uncommon for the best business plan to appear in the early phases of a firm.

Many experts think that the capacity of an organization to conduct tests along with experiments, learn from its business model, and grow is what determines its success amid situations and conditions of significant ambiguity, complexity, as well as speed of change, specifically for novel business ventures or startups. As a result, the drafting of a company Plan with a Model has become a top priority in a few company sectors. Most specially, Internet-based businesses are thought to be the most example of a situation where the speed of commerce demands that business models be continuously tested and modified.

In the era of a globalized market, many times first-generation well-trained entrepreneur develops specific concepts for the start-ups. Other entrepreneurs frequently launch new companies with little more than basic ideas and a little amount of available capital. A transitory organization created to look for a repeatable as well as scalable business model is one definition of a startup that is frequently used.

Accordingly, scholars generally concur that a startup company in its early stages of operation usually does not have a coherent & long-lasting business strategy that may support the long-term objectives of the company (Chesbrough & Rosenbloom 2002; Chrisman et al. 2005; Teece 2010). According to Chesbrough and Rosenbloom (2002), the original model of the business of the company is a hazy theory or hypothesis about how to give value to the client. complements, pointing out that the best business plan is rarely present in the initial phases of a startup.

In highly uncertain, complicated, and rapidly changing contexts and situations—particularly for startups or new company ventures—many academics think that an organization's ability to test, experiment, learn, and adapt from its business model is what determines its success. Hence preparation of Business Plan with Model has become top priority in few sectors of the business areas. It is believed that Internet-based companies are the best example of a situation where the speed of commerce demands that business models be continuously tested and adjusted.

Entrepreneurs must use lightweight, adaptable, and straightforward approaches, tools, and processes to accomplish this cycle of development from their business model. This will enable them to progress from simple product prototypes based on ongoing customer feedback. In this context, the phrase "Lean Startup" has been developed and defined to represent a technique engineered to assist firms in conducting tests, iterations, and pilots in search of a viable business model. His work has had a wide-ranging commercial impact and attracted the attention of new businesses.

Lean Startup Methodology:

The Lean Start-up Methodology can foster smart innovation in start-ups. It has the potential to reduce risk while also improving collaboration. It also helps the startup's commercial viability. LSM, LCT, and LRF must all be implemented in conjunction.

Vision with Lean Thinking:

The revolution in lean manufacturing gave rise to the Lean Startup. Shingo and Taiichi Ohno are credited with its development at Toyota. Supply chains and production systems can be improved with the help of lean thinking. It allows for just-in-time manufacturing and inventory control, batch size reduction, cycle time acceleration, and the expertise and inventiveness of individual workers (Blank, S., 2013). It draws attention to the difference between waste and activities that add value. It also showed how excellence can be infused into things from the inside out. The Lean Startup extends these principles to the context of entrepreneurial enterprises, arguing that entrepreneurs evaluate their success distinctly than other types of businesses do. Manufacturing progress is often judged by the creation of high-quality physical products. VL is a separate unit of progress used by the LSM. Using scientific learning as a guide, we may identify and reduce the causes of waste that plague entrepreneurship.

All elements of an early-stage company, such as the concept and idea, product development, organizational structure and design, marketing & sales, collaborations, scaling up, and distribution, should be covered in a comprehensive theory of entrepreneurship. It must set up a framework for evaluating advancement in the face of significant ambiguity. It provides entrepreneurs with precise instructions on how to make the many trade-off choices they encounter, such as whether and when to invest in process, formulation, and planning, as well as specific infrastructure; when to work alone and when to collaborate with others; when to react to criticism and when to

remain true to the vision; and how and when to make investments in business scaling. Above importantly, it should enable entrepreneurs to make predictions that can be tested (Blank, S. & Dorf, B., 2012).

Validated Learning:

The vision component of the LSM also takes into account learning. The essential purpose of entrepreneurship is to develop an organization in the face of severe uncertainty. Its most important role is learning. We must understand which components of our plan are effective in achieving our objective. Instead of focusing on what customers say they want or what we think they ought to want, we need to find and understand what they actually want. We need to assess if we are headed toward creating a long-lasting company. The Lean Startup paradigm rehabilitates learning through a concept known as VL. VL is neither an after-the-fact justification nor a nice narrative used to conceal failure. As companies grow, VL is a strict method of demonstrating progress in an atmosphere of extreme uncertainty. VL is the empirical demonstration of a team's discovery of important facts regarding a startup's current and upcoming commercial potential in the market. It is more specific, precise, and timely than market forecasting or traditional business planning.

Value Vs. Waste:

Which of our effectiveness provide value, and which are wasteful? The lean manufacturing revolution's most urgent question is this one. Every follower of lean manufacturing is instructed to ask this question first. VL must identify waste and then eradicate it systematically, as it has done with lean firms. According to lean thinking, value is anything that benefits the client; anything else is waste. Customers at a manufacturing company are more concerned with the product's functionality than its assembly (Brinckmann, J., Grichnik, D. & Kapsa, D., 2010). In a company, it must be understood that who the client is and what the consumer could find useful are unknowns, which is part of the ambiguity that defines a business.

Customers rarely know exactly what they want ahead of time. In this instance, we must experiment, allowing customers to test something and then measure their behavior. Learning is a crucial component of the work that is not required to advance companies. This is verified learning since it consistently results in positive changes in the startup's main KPIs. It is simple to deceive yourself regardinh what you believe your clients want. It is also simple to learn information that is entirely unrelated. Thus, verified learning is supported by actual information gathered from real consumers.

Experiment:

Many entrepreneurs struggle to solve issues such as what they should work on next. What may be altered safely, and what could irritate customers? Which consumer opinions, if any, should we consider? How should we prioritize among the several features we may develop? Which features are critical to the product's progress, and which are optional? What would satisfy today's customers at the expense of tomorrow's?

The startup can use the LSM to test its plan and determine which aspects are great and which are crazy. A real experiment follows the scientific process and it starts with a well-defined hypothesis that forecasts what is expected to occur (Chang, S.J., 2004). It then conducts empirical testing to validate these predictions. While startup testing is driven by the startup's objective, scientific experimentation is grounded on theory. Every startup experiment aims to determine how to develop that idea into a long-term business. Experimentation yields significantly more corporate insights for strategic decision-making.

Task into Components:

The first step would be to deconstruct the big vision into its constituents. To derive conclusions, entrepreneurs use two key assumptions: the value hypothesis as well as the growth hypothesis. The value hypothesis establishes whether a good or facility actually adds value for consumers once they utilize it. What is a decent indication of whether individuals value contributing their time? It could be answered via a poll, but it would be inaccurate because most individuals struggle to objectively judge their emotions.

Tests offer a more precise choice. What could we observe in real time that would be a stand-in for the benefits that volunteers were receiving? Opportunities for a limited number of individuals to volunteer may be identified, and their retention rate could then be examined (Chesbrough, H. & Rosenbloom, R.S., 2002). How many of them agreed to volunteer again? When individuals actively spend their time and attention in a program, it is a good indication that they think it worthwhile. We may do a similar study for the growth hypothesis, which examines how new buyers find a good or facilities. How will the program expand once it is up and operating, from early adopters to broad adoption?

Viral growth is a possible avenue for this program's expansion. If that is the fact, the most critical thing to measure is behavior: would the early participants actively spread the word to other people? A straightforward experiment in this situation would entail selecting a relatively small number of people and possibly offering them a unique volunteer opportunity (Eisenmann, T., Ries, E. & Dillard, S., 2011). The goal is to identify early adopters rather

than the ordinary client. Customers who have the most acute demand for the goods. Those clients are more forgiving of faults and quick to provide feedback.
An experiment, according to the Lean Startup concept, is both a theoretical investigation and an initial product. The manager may begin his/her campaign by enlisting early adopters, adding people to all subsequent experiments or iteration, as well as eventually starting for manufacturing a product if this or any other trial proves successful. During this stage, the good is prepared for widespread distribution and will have existing clients. It will have addressed real-world issues and other thorough specifications for what must be built. Instead of anticipating what could work tomorrow, this specification will be based on input on what is working today, as opposed to a standard strategic planning or market research procedure. This is the main factor that has to be considered while using LSM.

Steer:
Startups act as catalysts, turning concepts into completed goods. Customers create data and feedback when they use such goods. Both qualitative as well as quantitative comments are provided, including the number of users and their perceptions of its value. A startup's goods are essentially experiments, as we saw in part one, and the results of those trials are lessons learned about how to create a viable firm. Since it has the power to shape and impact the next generation of ideas, such information is far more significant for startups than money, accolades, or media attention (Furr, N., & Ahlstrom, P. 2011). LSM can visualize with these three-step processes (Figure No. 2). The foundation of the Lean Startup method is this Build-Measure-Learn feedback loop.

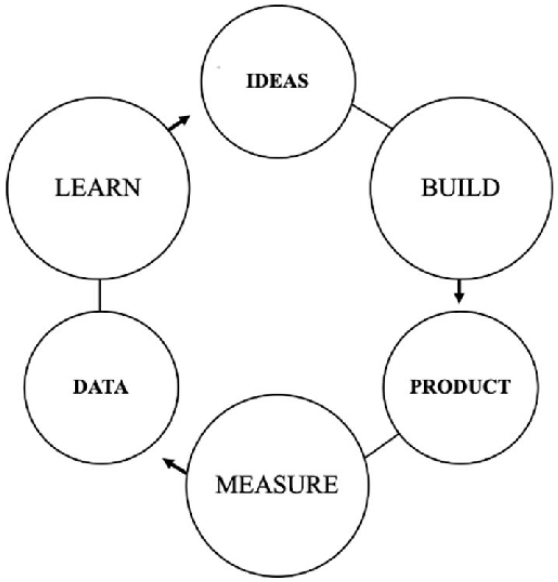

Figure 2: Build-Measure-Learn Feedback Loop
Source: (P. Brecht, R. Kerres and et all 2020)

One aspect of this feedback loop is emphasized in the professional training of many persons. For engineers, it often means understanding how to construct things as effectively as feasible. Some managers are quite skilled at brainstorming and learning at the whiteboard. Many entrepreneurs concentrate their efforts on the people who have the greatest first product design, the best product concept, or who are obsessed with statistics and metrics. In actuality, none of these pursuits are really significant on their own. Rather, we must concentrate on reducing the overall amount of time spent in this feedback loop. This is the section that involves leading a startup.
Exploring the significance of learning as a gauge of a startup's growth was the aim of the earlier concepts. We can steer clear of a lot of the waste that now befalls startups by concentrating our efforts on proven learning. Similar to lean manufacturing, knowing when and where to invest energy saves both money and time. We must decide which hypotheses to test in order to apply the scientific procedures to a startup. These components—a leap of faith assumptions—are the most dangerous in a startup's plan as they are the ones that depend on everything else. The value hypothesis as well as the growth hypothesis are the 2 most crucial presumptions. They result in tuning variables that govern the development engine of a startup (Allen, K. R. 2015). Every startup integration is an effort to spin this engine and see if it will turn. The procedure repeats once it is operating, moving into higher gears for improved performance.
The initial stage is to launch the Minimum Viable Product (MVP) into the Build phase as soon as possible after these leap-of-faith assumptions are established. According to Blank (2005), the MVP is the version of the good that allows for a complete cycle of the Build Measure Learn loop including the small quantity of work as well as time

of development. Many elements that might later prove crucial are absent from the minimal viable product. In other respects, though, developing an MVP necessitates additional effort since we need to be able to gauge its effectiveness. For instance, engineers' and designers' internal quality. Additionally, we must expose it to prospective clients to assess their responses. As we will soon see, we might even have to attempt selling them the prototype.
Assessing whether the efforts being made to develop the product are producing tangible success will be the largest hurdle during the Measure phase. Whether we were doing it on schedule and within our budget. We must employ a quantitative technique known as "innovating accounting," which enables us to determine if our engine-tuning efforts are paying off. As an alternative to conventional business and product milestones, it also enables us to establish learning milestones. Entrepreneurs may utilize learning milestones to correctly and impartially evaluate their development, and managers and investors who have to hold entrepreneurs accountable can also benefit greatly from them. The pivot is the most crucial element. After finishing the Build-Measure-Learn cycle, we are faced with the most challenging decision an entrepreneur must make: should we stick with the original plan or change it? A significant shift to a new strategic hypothesis should be made if we have found that one of our assumptions is incorrect (eMarketer 2012).
It enables startups to realize when it's time to pivot sooner, the LSM reduces time and money waste and helps create capital-efficient businesses. Even yet, we represent the feedback loop as Measuring, Learn, and Building due to the inverse sequence. We determine what we require to learn, determine what we require to measure to determine whether we are gaining VL, and then determine what product we require to develop to conduct the experiment & obtain the measurement using innovation accounting (Ries, E. 2009). By using the Build, Measure, and Learn feedback loop with the LSM, all of the methods are intended to reduce the overall time.

Accelerate:
The majority of the decisions made by startups are not definitive. How frequently should a product be released? From an efficiency perspective, product releases frequently leave less time for product development since they come with overhead. On the other hand, waiting or taking very long to release might result in the ultimate waste—something that no one wants. How much time and effort should businesses put into early planning and infrastructure to succeed? If you overspend, you lose valuable time that might be used for education.
If you don't put in enough time, you can miss out on early success as well as market leadership to a quick follower. What should workers do during the day? How can we, as an organization, hold individuals responsible for learning? Conventional departments establish incentive programs to help employees stay committed to achieving excellence in their fields, such as product development, marketing, and sales. If cross-functional cooperation is in the best interests of the business, startups require organizational structures that counteract the excessive unpredictability that is their worst opponent. On the production floor, the lean manufacturing movement encountered comparable issues. With a few adjustments, their responses also apply to startups.
The important main question for any lean transformation is, which activities create value and which are a form of waste? After you comprehend this difference, you may start applying lean methods to eliminate waste and boost the effectiveness of the value-creating processes. These strategies need to be modified to fit the particulars of entrepreneurship to be applied in a startup (Ries, E. 2011). Validated knowledge on how to create a sustainable firm is more valuable in a startup than producing goods. What goods do consumers desire? Who is our client? Which clients should we pay attention to, and which should we overlook? How will our company expand? To increase a startup's chances of success, these are the issues that must be addressed as soon as possible because it is what adds value to a startup's success.
As businesses mature, bureaucracy and lethargy are not their inevitable fate. As a starting point, lean startups may develop into lean businesses while retaining their adaptability, focus on learning, and innovative culture. Lean startups use just-in-time for scalability, experimenting with goods without making significant upfront expenditures in planning and design, much like lean manufacturing has aimed for a just-in-time strategy for product development, minimizing the requirement for in-process inventory. A startup may focus its efforts where it will have the greatest impact on expanding the firm by determining the growth engine it is employing. To select new experiments and assess the performance of new products, each engine has to concentrate on certain criteria. These metrics enable companies to determine when their growth is about to run out and make the necessary adjustments when combined with the previously discussed innovation accounting method (Startup Lean, 2015).
The same forces that force today's businesses to discover new methods to invest in disruptive innovation also affect startups as they develop into established businesses. Businesses now need to become proficient in managing a portfolio of disruptive and sustainable innovation. The idea that businesses move through distinct stages and abandon prior types of labor, including invention, is out of date. Instead, contemporary businesses need to be adept at handling several types of tasks concurrently. Companies should foster innovation teams inside the framework of an established business to achieve this.

Lean Critical Tools (LCT):

The LCT is 10 in number. It contains the following: Quick Changeover, Standard Work Combination Chart, Line Balancing, Kaizen Event, Value Stream Map, Gemba Walk Interview Sheet, A3 structured template, 5S Audit, and Waste Analysis by operation (Minitab Engage). Understanding the process, identifying waste, avoiding errors, and recording your actions are all made easier using LCT. Lean aims to make doing things correctly simple and doing them incorrectly difficult.

The Lean Suite claims that there are 10 LCTs. There are several real-world instances of how Lean adoption has benefited various industries. Significant cost, lead time, and inventory reductions, along with several other enhancements, have been observed globally. The first LCT tool, both value-added as well as non-value-added, that follows goods or facilities from start to finish to the consumer is a Value Stream Map (VSM).

- The goal of Gemba Walk is to watch, comprehend, and eventually enhance a process. It may be used to verify reality using the Gemba Walk Interview Sheet. It includes several inquiries, different types of information, and observables. The interview sheet offers a structure for ongoing communication and reliable feedback.
- The practice of equalizing for the amount of time needed to achieve these goals is known as line balancing.
- A3 is for ongoing improvement and problem-solving. It became an excellent Lean tool because it provides a straightforward, organized method, and visual communication, and encourages cross-team cooperation.
- 5S is a collection of tools that help teams arrange their workspace in a methodical and systematic way. To adhere to the numerous acts consists of 5 steps: Set in Order, Sort, Sustain, Standardize, and Shine.
- Kaizen is a committed and targeted event that promotes process improvements. The project's goals are clearly stated and properly organized. Workers are dragged away from their regular tasks to take part.
- Manufacturers may establish accurate estimations for upcoming scheduled activities and upgrades by using the Work Element Time Study (WETS), which helps them understand how long a task takes to complete.
- Waste Analysis by Operation quantifies and color-codes the degree of waste at each process stage by documenting the categories of waste. When carried out by several observers, both inside and outside the process, the Waste Analysis exercise is most successful.
- A method for analyzing your present processes and contrasting them with future states is called Quick Changeover (AC).
- Another LCT tool is the Standard Work Combination Chart (SWcC). The process is made clearer, consistency is guaranteed, staff training is accelerated, and a benchmark for future progress is established by the definition of "standard work."

Under the guidance of LCT practitioners, the startup can adopt LCT as it entails comprehending precise concepts and appropriate methods for implementing its many components.

Lean Research Framework:

In the modern period of the fourth and fifth industrial revolutions, it serves as a framework for directing and enhancing the practice of doing field investigations with individuals and communities in the background of humanitarian work and international development. According to J. Aker, L. Budzyna, et al. (2015), research in these settings is frequently carried out to comprehend and enhance the effects of different project activity interventions on the lives of communities dealing with poverty, vulnerability, and other issues. Rigor, Respect, Relevance, and Right Size are the “4R” principles of the LRF.

Rigor: The integrity of the research process and its findings are always guaranteed by high levels of rigor. Research ought to be useful to stakeholders and considerate of participants' time. Lean research is carried out in accordance with research methodological standards and pragmatic considerations that are most appropriate for the particular activity being studied. It provides findings while safeguarding sensitive subject data and overcomes problems with both internal and external validity.

Respect: All ethical considerations are covered in respectful research, together with the enjoyment and dignity of the human research subject. The research briefing, discusses a transparent, informed consent procedure where stakeholders are genuinely free to decline involvement without worrying about the repercussions. Subjects find the study experience interesting and useful for drawing conclusions if they want to participate.

Relevance: All parties involved may clearly and significantly benefit from relevant research. For research participants, study communities, investors, and decision-makers, it tackles the most important problems and queries. All stakeholders, including study participants, practitioners, and policymakers, may easily comprehend and obtain the research findings.

Proper Size: Research is appropriately sized when its techniques and scope align with its goals and the importance of its questions to stakeholders. Because it must be and because all superfluous questions, actions, and processes are eliminated, properly scaled research can occasionally be time-consuming, difficult, and expensive. Appropriate research size yields appropriate solutions to the problems.

There are few such other LRFs for the specific context. Working in a lean startup might be difficult for a variety of reasons, but since quality and speed are crucial, we developed a flexible framework to assist you in establishing the methodology of a research project (Oriol Banus, 2020). In order to identify and reduce apparent wastes, J. Wanitwattanakosol and S. Noamna (2018) state that their research framework consists of five steps that primarily followed processes of the action research cycle. Interviews and an examination of operational manuals are used to gather preliminary data. The IDEF family is chosen to document activities and investigate component relationships. To talk about a root cause, a cross-level, cross-functional focus group is used. In a case study, a Necessary Condition Analysis is used to determine the degree of lean hurdle. Critical wastes are eliminated with the use of developed lean technologies. Lean IT tool modifications are a result of the action evaluation stage's findings.

Data Collection and Analysis:
First Generation-trained Start-up Founders-Entrepreneurs are the population for the primary data. The sample size for the data collection is 126. Collection of the data is done through the multiple-option questionnaire with two point and five-point scales.

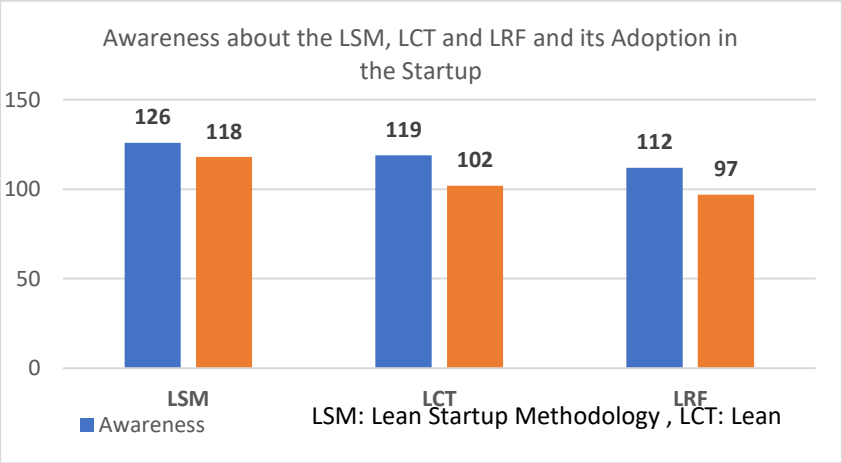

Figure 3 Awareness about the LSM, LCT and LRF & its adoption in the Startup

Awareness and adoption of LSM, LCT, and LRF by the startup entrepreneurs for sustainability of startup-enterprise is shown in the Figure 3. It shows that highest number of entrepreneurs are aware about LSM than LCT and LRF. Research framework component is less popular as compared to the others two.

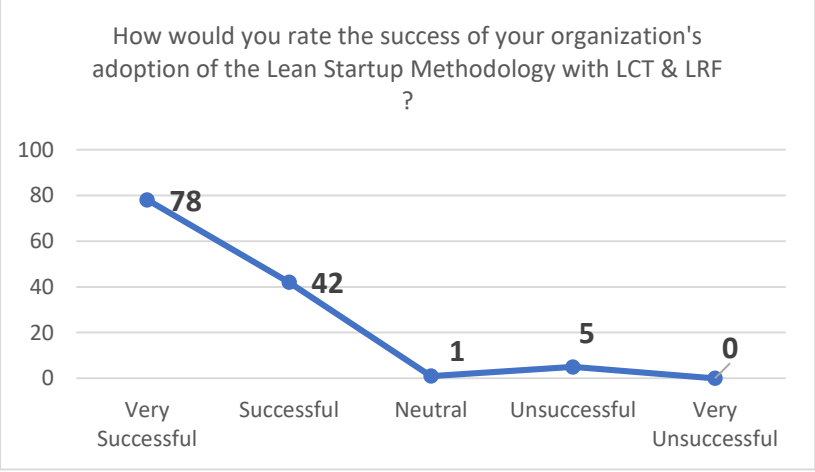

Figure 4 Rate of Success on adoption of LSM, LCT, and LRF

Figure 4 shows success rate with adoption of LSM, LCT and LRF in organisation was 95.23% as 120 out of 126. The unsuccessful rate was 3.96 % as 5 out of 126. One remains neutral.

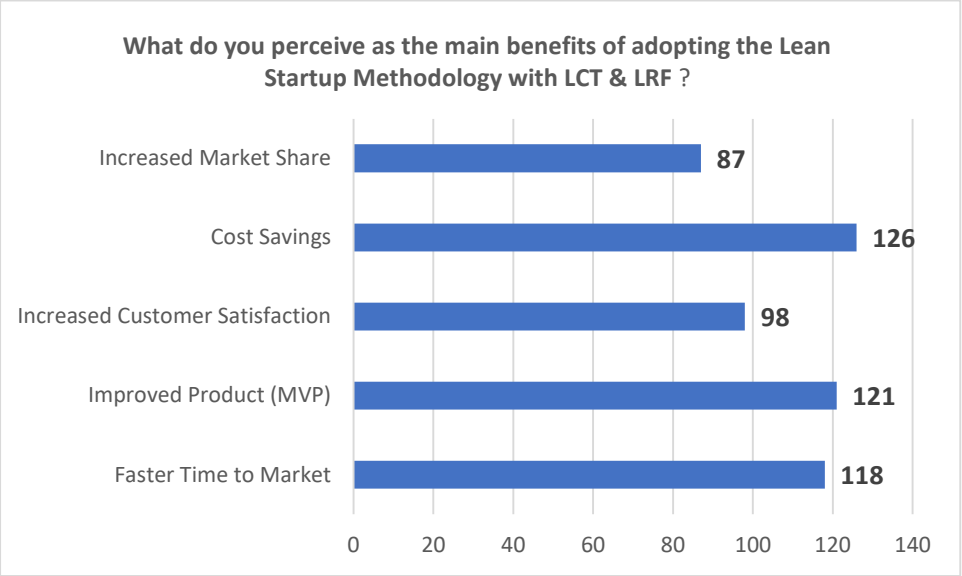

Figure 5 Benefits of adopting LSM, LCT, and LRF

Figure 5 shows the data on the benefits with adopting LSM, LCT, and LRF on the five aspects of Increased Market Share (69%), Cost Saving (100%), Increased Customer Satisfaction (77.77%), Improved Product MVP (96%), and Faster Time to Market (93.6%).

Analysis shows that the Holistic approach of LSM, LCT, and LRF was found useful for the sustainability of the startup with various identified Lean parameters. Project Based Learning Methodology for understanding Lean concepts to apply for field practice was found 100% successful in the one of the other questions answered during the survey.

Conclusions:

We recognized and synthesized the professional and scientific underpinnings that precede, support, and enhance the key ideas, procedures, and techniques promoted by the Lean methodology with LSM, LCT, and LRF because of the LSM's significance and popularity, particularly among practitioners.

Furthermore, by placing the Lean methodology in the context of other strategic and entrepreneurial tools that have been studied in recent decades, we discovered a group of related and preemptive approaches that can help the Lean methodology be implemented by giving the entrepreneur new tools and supporting procedures for sustainability.

Awareness among the first-generation entrepreneurs needs to be rebuilt with capacity development programs for sustainable startups to improve the livelihood of the rural youths. Lean methodology process implementations aspects should be under the lean practitioners for effectuation. Holistic approach of the LSM, LCT, and LRF with “Project Based Learning” methodology improves sustainability concern of the startups.

According to our review, the core ideas of the Lean methodology with a holistic approach are strongly aligned including the foundations and tenets of the Learning School of Strategy & the Effectuation and Bricolage schools of Entrepreneurship. They are also explicitly supported by the Lean philosophy's techniques and principles, which originated in the manufacturing context.

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An Analysis of Online Reviews: How Positive and Negative Reviews Influence Purchase Intentions

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Abstract

Introduction: Online reviews are increasingly becoming the key drivers of consumer purchase decisions in the digital age. Due to the increasing popularity of e-commerce websites and social media, consumers are relying more and more on the views and experiences of others before buying. Understanding the impact of online reviews, particularly their opinions, on consumers is crucial for firms that want to enhance their marketing strategy and customer satisfaction.

Purpose of Study: The aim of this study is to examine the impact of positive and negative online reviews on consumers' purchasing intentions. The aim of this study is to examine a database of online reviews of varied product categories in an attempt to determine how different types of reviews affect consumers' decision-making.

Objective of the study: The purpose of this study is to investigate the influence of positive online reviews on consumers' purchase intention across various product categories. Investigate the effect of negative online reviews on consumers' propensity to buy and determine if the effect is moderated by the product category.

Methodology: Individuals who use the internet to purchase goods from various e-commerce websites and review websites are the subject of this primary research. The questionnaire is based on variables like dependent (purchase intentions) and independent (online review valence—positive reviews and negative reviews).

Results: The findings indicate that although positive reviews will enhance purchase intentions, negative reviews can impact consumers' attitudes in different ways. In some product categories, negative reviews can convey authenticity and honesty and hence have a positive influence on purchase intentions. Nevertheless, the extent to which these effects occur differs based on considerations such as product nature and the credibility of the reviewer.

Keywords: consumer purchase intention, negative reviews, online reviews, positive reviews, purchase intentions, review valence.

Introduction

In today's digital economy, online reviews have become a key driver of consumer purchasing behavior. As e-commerce has grown and user-generated content has become more important, consumers increasingly look to online reviews to guide their purchasing decisions. Positive online reviews, in fact, are thought to enhance consumer trust in a product or service, tending to drive higher purchase intentions. Existing literature shows that consumers view good reviews as social proof, legitimizing their purchase decision and fostering brand or product confidence (Chevalier & Mayzlin, 2006). Such an effect illustrates the power of positive reviews in potentially making a huge difference to the sales and overall market performance of a firm. Negative reviews, on the other hand, may have a sizeable and even detrimental impact on consumer sentiments and actions. Negative reviews are more likely to evoke stronger emotional responses, because consumers will tend to perceive them as signals of the quality of the product or the reliability of the service. Decision-making, according to studies, is more likely to be led by negative than positive information, a phenomenon called the "negativity bias" (Baumeister et al., 2001). This leads to deterrence among prospective buyers, causing decreased purchase intention and consumer loyalty shift.

Given these opposing impacts, it is important to understand the relative impact of positive and negative online reviews on purchasing behavior for businesses looking to optimize their online presence. While both reviews have an impact on consumer behavior, it is unclear which has a stronger impact in some cases. Therefore, in the current research work, the researcher seeks to analyze the influence of positive consumer online reviews on the purchase intention among consumers, examine the effect of negative reviews on consumer purchase decision, and compare the relative significance of positive versus negative reviews' influence on the consumer choice decision. By exploring these dimensions, this study aims to provide practical insights for marketers and companies on how to manage online reviews in a way that will influence consumer purchasing behavior in a competitive online market.

Literature Review

The growing body of literature on the role of online reviews highlights their pivotal function in shaping consumer behavior and purchasing decisions. Online reviews, often regarded as an electronic word-of-mouth (eWOM), provide consumers with valuable information about products and services, which influences their attitudes and guides purchasing choices (Dellarocas, 2003). In recent years, empirical studies have moved to both the positive

and negative aspects of online review, trying to gain more insight into differential impacts on purchase intentions and consumption behavior. This literature review examines current research in three broad objectives: the effect of positive online reviews on consumers' purchase intention, the effect of negative reviews on purchasing behavior, and a comparison of the relative influence of positive and negative reviews on purchase intention.

The Influence of Positive Online Review valence on Consumer Purchase Intentions

Evidence always indicates that positive reviews posted online increase consumer purchase intentions by building consumer trust, lowering perceived risk, and acting as a kind of social endorsement. In accordance with Chevalier and Mayzlin (2006), consumers who are exposed to positive reviews are likely to be more confident with their buying decisions since positive reviews act as a kind of word-of-mouth endorsement by fellow users. This social evidence not only establishes the value of the product but also eliminates uncertainty that is normally associated with online shopping. For instance, in online shopping, Pavlou and Dimoka (2006) found that positive comments tend to contribute considerably towards establishing consumers' confidence in the vendor, which ultimately gives rise to purchase intent.

Positive reviews also play a significant role in creating positive dispositions toward the brand and establishing brand perception. Lee et al. (2008) showed that positive criticism on the web can have a positive influence on the evaluation of a product, especially if the criticism is straightforward and credible. Additional studies verify that preferred feedback enhances the product's desirability, and therefore directly impacts consumers' intentions to buy (Park et al., 2007). Notably, studies have shown that vast volumes of positive feedback even more reinforce consumer confidence (Duan, Gu, & Whinston, 2008).

The Impact of Negative Online Review valence on Consumer Purchase Behaviour

Whereas favorable reviews can engender trust and encourage buying, unfavorable reviews have a more complex and, in many cases, a greater influence on the shaping of consumer behavior. Unfavorable web reviews typically instill fears of product quality and thus cause consumers to reconsider purchasing or, in the majority of cases, avoid the product. This is also due to the "negativity bias," a psychological tendency in which individuals place more significance on bad information than good information when judging or deciding (Baumeister et al., 2001). Several studies have found that negative feedback has the ability to significantly reduce purchase intentions. For instance, Park and Lee (2009) found that consumers who were exposed to negative comments were likely to avoid a product since the comments generated doubt regarding its reliability. Similarly, a study by Lee and Youn (2009) found that negative comments heighten perceived risk and uncertainty, leading consumers to reconsider their purchase intentions. These findings are consistent with the hypothesis that threats of possible product failure or inferior service tend to deter consumers, leading them to assign higher priority to giving negative feedback while making decisions.

Moreover, the severity and genuineness of negative reviews have a significant impact on their influence. Negative reviews highlighting substantial issues, such as defects or poor customer service, tend to have more influence in undermining consumers than those mentioning trivial annoyances (Sen & Lerman, 2007). In addition, lengthier or credible negative reviews are more likely to have a stronger negative effect.

The research on online reviews indicates that positive and negative reviews both have important, but different, roles to play in shaping consumer buying behavior. Positive reviews enhance purchase intentions by offering social proof and minimizing perceived risk, whereas negative reviews tend to generate avoidance behaviors by creating concerns regarding product quality and reliability. Nevertheless, negative reviews typically impact more intensely on account of the negativity bias, although relative influences of positive versus negative reviews would differ on parameters like product type, credibility of reviews, and number of reviews. Based on these insights merged together, organizations can ascertain their approach towards controlling online reviews better to influence buyers' decisions optimally.

Objectives:

- To study and analyze the demographic variables with respect to online reviews on purchase intention towards consumer durable goods
- To examine the impact of positive online reviews on the purchase intentions of consumers.
- To evaluate the impact of negative online reviews on customer purchase intentions.

Theoretical framework:

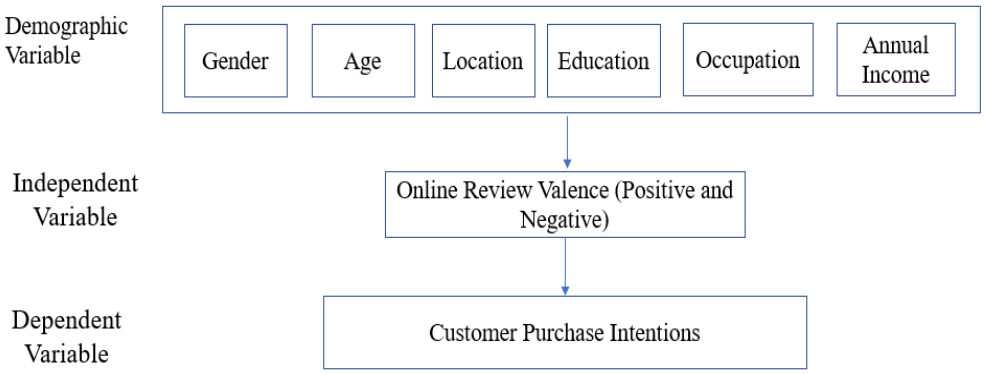

Figure 1 Theoretical framework

The figure illustrates the theoretical model that emphasizes the interaction between demographic variables, online review valence, and purchase intentions by customers. Demographic factors, including gender, age, location, education, occupation, and yearly income, affect how people feel and react to online reviews. Online review valence, characterized by its polarity, either positive or negative, is used as the independent variable and mediates the influence of consumer demographics on purchasing decisions. This is consistent with the elaboration likelihood model (Petty & Cacioppo, 1986), which highlights that information processing depends on individual differences and the persuasive content of messages. Positive reviews have been found to increase purchase intentions by building trust and lowering perceived risk (Cheung et al., 2008), while negative reviews may discourage purchase behaviors by inducing skepticism regarding product quality. As a result, this model emphasizes the interaction between consumer characteristics and review sentiment in determining purchasing intentions.

Methodology:

Research Design

Primary and secondary data are the two forms of data employed in research studies. Secondary data assist in the identification of variables. Primary data include pilot studies and factor analysis. The pilot study is done first to validate and ascertain the reliability of the questionnaire. Pilot study, which comprises 104 individuals, is followed by a comprehensive primary research or study. We undertook the study to evaluate the validity of a questionnaire containing independent, moderate, and dependent variables, and thereafter finalized the same.

Sample Design

We carry out face-to-face interviews with the respondents by appointment, employing a random sampling strategy. We shall utilize Google Forms in areas where it is impossible to hold face-to-face interviews because of the pandemic and other logistical reasons. We will use a structured questionnaire to gather information and used 104 respondents for this research. We looked at the product knowledge of the customer, the authenticity of the online review source, and their probability of buying the product.

Questionnaire Design

It is pilot exploratory study. Pilot testing was performed in order to justify the questions and measure validity and reliability of the questionnaire. The questionnaire tackled the demographic factors which drive purchase intention of the customers. Customer purchase intentions are driven by factors that include online reviews of the consumer durable goods. We've applied these tools to measure, forever, what do customers know, how much do they like it, if they will purchase and what do they do.

A systematic questionnaire is designed by integrating demographics such as age, gender, educational qualification, marital status, occupation, and annual income, which are quantified in terms of percentage analysis. There are different sets of questions for each variable, namely online positive review valence and online negative review valence. They are quantified on a 1–5 scale (strongly disagree, disagree, neutral, agree, strongly agree) by Sutanto and Aprianingsih (2016).

Results

We segregated the identified variables into independent and dependent variables based on the secondary research. Our independent variables in our study are online positive review valence and online negative review valence. The dependent variable is customer purchase intentions.

Table-1: Descriptive summary of Demographic data

	Characteristics	Frequency	%
Gender	Male	64	61.54%
	Female	40	38.46%
Age group	20-30 Years	56	53.85%
	30-45 Years	32	30.77%
	45-60 Years	16	15.38%
Place	Pune	70	67.31%
	Mumbai	34	32.69%
Education	Doctorate	16	15.38%
	Post Graduate	72	69.23%
	Graduate	16	15.38%
Occupation	Student	48	46.15%
	Business	16	15.38%
	Service	40	38.46%
Annual income	Less than 5L	32	30.77%
	Rs.5L-Rs.10L	64	61.54%
	More than 10L	8	7.69%

The demographic information in this research gives us an idea about the respondents who took part in the study of the effect of online reviews on consumer purchase intention for durable products. Out of the participants, 61.54% were male and 38.46% were female, reflecting a minor male dominance in the sample. Age-wise distribution had the majority (53.85%) falling in the 20–30 years group, followed by 30.77% in the 30–45 years group, and 15.38% in the 45–60 years group. Geographically, 67.31% of the respondents belonged to Pune, and 32.69% were from Mumbai. Educational qualification-wise, the majority (69.23%) were postgraduates with an equal number of doctorate holders and graduates at 15.38% each. By occupation, students dominated the category with 46.15%, followed by service professionals at 38.46%, and business professionals at 15.38%. On the basis of annual income, 61.54% of the respondents belonged to the Rs. 5L–10L bracket, 30.77% had less than Rs. 5L income, and just 7.69% earned more than Rs. 10L. This demographic information gives a better picture of the participant pool within the study that is representative in its diversity for consumer views concerning online reviews and their impact on buying behavior.

Hypotheses 1:

H01: There is no impact of the online positive review valence on customer purchase intention.

H1: There is an impact of the online positive review valence on customer purchase intention.

Table-2: Kruskal-Wallis-Test for hypotheses 1

Ranks			
Groups	n	Median	Mean Rank
Positive online reviews increase my trust in a product/service.	104	4	251.96
The number of positive reviews influences my perception of a product's quality.	104	4	242.67
I am more likely to purchase a product that has many positive reviews.	104	4	251.96
Positive reviews from verified buyers impact my purchasing decisions.	104	4	251.96
Customer Purchase Intention	104	5	303.94
Total	520	4	
Kruskal-Wallis-Test			
Chi^2	df	p	
13.8	4	0.008	
Dunn-Bonferroni-Tests			

	Test Statistic	Std. Error	Std. Test Statistic	p	Adj. p
Positive online reviews increase my trust in a product/service. - The number of positive reviews influences my perception of a product's quality.	9.29	18.74	0.5	0.62	1
Positive online reviews increase my trust in a product/service. - I am more likely to purchase a product that has many positive reviews.	0	18.74	0	1	1
Positive online reviews increase my trust in a product/service. - Positive reviews from verified buyers impact my purchasing decisions.	0	18.74	0	1	1
Positive online reviews increase my trust in a product/service. - Customer Purchase Intention	-51.98	18.74	-2.77	0.006	0.055
The number of positive reviews influences my perception of a product's quality. - I am more likely to purchase a product that has many positive reviews.	-9.29	18.74	-0.5	0.62	1
The number of positive reviews influences my perception of a product's quality. - Positive reviews from verified buyers impact my purchasing decisions.	-9.29	18.74	-0.5	0.62	1
The number of positive reviews influences my perception of a product's quality. - Customer Purchase Intention	-61.27	18.74	-3.27	0.001	0.011
I am more likely to purchase a product that has many positive reviews. - Positive reviews from verified buyers impact my purchasing decisions.	0	18.74	0	1	1
I am more likely to purchase a product that has many positive reviews. - Customer Purchase Intention	-51.98	18.74	-2.77	0.006	0.055
Positive reviews from verified buyers impact my purchasing decisions. - Customer Purchase Intention	-51.98	18.74	-2.77	0.006	0.055
Adj. p: Values adjusted with Bonferroni correction.					

Hypothesis 1 (H01) in this research examines whether positive online reviews influence customer purchase intentions. The null hypothesis (H01) states that there is no impact of positive online review valence on customer purchase intention, while the alternative hypothesis (H1) posits that positive online reviews do affect customer purchase intention. To test this, the study employed the Kruskal-Wallis test, which yielded a statistically significant result ($Chi^2 = 13.8$, $p = 0.008$), indicating that positive online reviews play a crucial role in shaping consumer perceptions. The analysis also found that customers are more likely to believe in a product if it carries many positive reviews, especially those of verified purchasers, and would be more willing to buy it. The Dunn-Bonferroni post-hoc test also verified the correlation and exhibited strong correlations between customer intention to buy and belief in the product's quality from the volume of positive reviews ($p = 0.011$). Against these findings, the null hypothesis (H01) is rejected in favor of the conclusion that positive online reviews have a significant impact on customer purchasing behavior. This reinforces the need for online reputation management as companies are able to use positive reviews to build consumer confidence and boost sales.

Hypothesis 2

H02: There is no impact of the online negative review valence on customer purchasing behavior.
H2: There is an impact of the online negative review valence on customer purchasing behavior.

Table-3: Kruskal-Wallis-Test for hypotheses 2

Ranks			
Groups	n	Median	Mean Rank
Negative online reviews make me doubt the quality of a product/service.	104	4	197.31
I am less likely to purchase a product if it has several negative reviews.	104	4	204.73
A single negative review can impact my perception of a product.	104	4	187.46
Customer Purchase Intention	104	5	244.5
Total	416	4	

Kruskal-Wallis-Test					
Chi^2	df	p			
16.13	3	0.001			
Dunn-Bonferroni-Tests					
	Test Statistic	Std. Error	Std. Test Statistic	p	Adj. p
Negative online reviews make me doubt the quality of a product/service. - I am less likely to purchase a product if it has several negative reviews.	-7.42	15.26	-0.49	0.627	1
Negative online reviews make me doubt the quality of a product/service. - A single negative review can impact my perception of a product.	9.85	15.26	0.65	0.519	1
Negative online reviews make me doubt the quality of a product/service. - Customer Purchase Intention	-47.2	15.26	-3.09	0.002	0.012
I am less likely to purchase a product if it has several negative reviews. - A single negative review can impact my perception of a product.	17.26	15.26	1.13	0.258	1
I am less likely to purchase a product if it has several negative reviews. - Customer Purchase Intention	-39.78	15.26	-2.61	0.009	0.055
A single negative review can impact my perception of a product. - Customer Purchase Intention	-57.04	15.26	-3.74	<.001	0.001
Adj. p: Values adjusted with Bonferroni correction.					

Hypothesis 2 (H02) in this research investigates whether negative online reviews impact customer purchasing behavior. The null hypothesis (H02) states that there is no impact of negative online review valence on customer purchasing behavior, whereas the alternative hypothesis (H2) suggests that negative online reviews do influence consumer purchasing decisions. The Kruskal-Wallis test results ($Chi^2 = 16.13$, $p = 0.001$) indicate a statistically significant effect, demonstrating that negative reviews contribute to doubts about product quality and decrease the likelihood of purchase. The analysis further reveals that customers are less inclined to buy a product when it has multiple negative reviews, and even a single negative review can impact their perception. The Dunn-Bonferroni post-hoc test confirms this, showing significant associations between negative reviews and purchase intention ($p = 0.012$ for general negative reviews, $p < 0.001$ for a single negative review affecting perception). Given these findings, the null hypothesis (H02) is rejected, confirming that negative online reviews significantly influence consumer hesitation and reduce purchase confidence. Overall, the findings highlight the substantial role that online reviews play in shaping consumer purchase intentions, with positive reviews enhancing trust and likelihood of purchase, while negative reviews create hesitation and decrease purchase confidence.

Discussion:

The account of this research, framed around its general objectives, provides a methodical description of online reviews' contribution to influencing consumer purchasing intent on durable products. Considering the demographic attributes in relation to online reviews and purchasing intent—the research highlights that the majority of the respondents are young working professionals aged 20–30 possessing postgraduate degrees. Such population demographics mean that well-educated, technology-empowered consumers rely on online reviews to make purchasing decisions. The findings suggest that companies must aim their online marketing campaigns at this consumer segment by making it convenient, interactive, and trustworthy in their online review management practices. Examing the effect of positive online reviews—the research determines that positive reviews indeed lead to greater consumer trust and product perception, influencing buying behavior. The Kruskal-Wallis test results confirm a high correlation between review valence and buying intention, with customers likely to trust and purchase the product if there are a huge number of reviews, particularly by verified purchasers. The results further reiterate the need for businesses to source satisfaction from customers as positive word of mouth to promote brand confidence and strategically present reviews to create credibility in their brands. Measuring the effect of negative word of mouth online—the study finds that negative feedback has a notable deterrence effect on consumer

purchasing behavior. Statistical testing shows that multiple negative feedback as well as even one negative comment can lead to hesitation on the part of consumers and less purchase intention. This shows that firms need to employ active reputation management strategies, such as a positive reply to negative feedback, resolution of customer complaints, and transparency to avoid potential damage to brand image.

Managerial implications:

The manager implications of this study are beneficial insights for companies in terms of the effect of online reviews on consumer purchase intentions, consistent with the primary aims of the study. The evidence indicates that companies should engage in encouraging satisfied consumers to post positive reviews, especially verified buyers, since their endorsements greatly promote consumer trust and buy likelihood. Firms can adopt review solicitation tactics, including post-purchase follow-ups and rewards, to maintain a constant stream of positive feedback. Moreover, placing positive reviews in prominent positions on online platforms can also help support product credibility. This highlights the importance of businesses adopting proactive reputation management. Managers need to respond to negative reviews immediately through active customer service, problem resolution, and open communication. By realizing the concerns of their customers and presenting efforts to rectify, companies can reduce the adverse impact and gain back the confidence of consumers. As a whole, the study underlines the need for companies to incorporate online review management into their overall marketing and customer relationship frameworks. Positive reviews can be harnessed and the impact of negative reviews offset to affect consumer choice markedly, enhancing brand reputation and boosting sales.

Limitations:

The limitations of this study, offer essential feedback on the study's limitations and scope for future development. Firstly, in regards to the aim of examining demographic variables with regard to online reviews and purchasing intentions, the study is limited by sample size and geographical focus. Since the respondents were mostly from Pune and Mumbai, the results might not be entirely generalizable to wider consumer groups in other regions or nations with different digital habits and buying behaviors. Future studies can increase the sample size to a more representative demographic base for a more complete analysis. Consumers might overreport or underreport their dependence on positive reviews based on personal taste or previous experiences. Besides, the research fails to vary across product categories or industries, which may affect how positive reviews shape purchase intentions. Future studies may investigate whether review effects differ across product categories. The research verifies that negative reviews have a strong effect on consumer choice, but it does not consider other controlling factors like brand loyalty, word-of-mouth communications, or offers that may mitigate against negative reviews. In addition, the research does not take into account the intensity of negative reviews (e.g., minor issues vs. severe product defects), which may affect consumer responses differently. Future studies may further investigate the subtleties of negative review influence and examine how companies can effectively counteract them. Overall, though this study sheds important light on the influence of online reviews on consumer purchasing behavior, these constraints indicate areas where subsequent studies may improve and extend these findings by including wider demographics, industry-specific data, and other factors influencing purchasing behavior.

Conclusion:

The finding of this study, brings to the limelight the overwhelming influence of internet reviews on durable goods purchase decisions of consumers. The research confirms that young working professionals, specifically those belonging to the 20–30 years age group and postgraduate degree holders, are a predominant category among the respondents. This demographic understanding advises companies to put emphasis on digital engagement methods designed for technologically advanced customers who actively make smart buying choices through online reviews. The good feedback greatly reinforces the consumer confidence, product quality impression, and intention to purchase. Consumers are more affected by reviewed buyer reviews and the quantity of positive reviews in general. Consequently, companies should focus on getting happy customers to post reviews, making positive feedback visible, and using it for promotional purposes in order to build consumer trust and boost sales. The study sets up that negative feedback will discourage prospective buyers and raise questions regarding a product's quality. One negative review alone will have a serious effect on consumer sentiment. This highlights the importance of proactive reputation management, where businesses must address customer concerns promptly, resolve complaints effectively, and maintain transparency to mitigate the adverse effects of negative reviews.

Future direction:

The direction of this future research, offers various paths for further investigation to increase the knowledge base on how online reviews impact consumer purchase intentions of durable products. Future research may increase the sample size and gather participants from various geographic areas and cultural affiliations. As this research addressed mainly the consumers of Pune and Mumbai, by bringing in a more diverse demographic sample pool, one would be able to make a larger generalization of results. Moreover, future studies may look at how other

factors like gender, income level, and digital literacy further shape consumer dependence on online reviews. It may study the efficacy of various forms of positive reviews, including video testimonials, influencer reviews, and expert reviews, in building consumer trust and influencing purchasing decisions. Furthermore, longitudinal research would be conducted to analyze how consumer sentiment shifts over time due to repeated positive feedback or product rating fluctuations. Companies would also benefit from research on the impact of sentiment analysis and AI review suggestions in enhancing consumer choice-making. It could study the various degrees of negative review impact. For instance, studies might differentiate between smaller problems and larger product defects to test whether customers are assigning varying degrees of weight to different types of criticism. And the efficacy of a set of responses by the brand—public apology, refund, and individual customer service—might inform researchers how to respond to bad criticism most effectively.

Overall, future studies would need to analyze industry differences in the impact of online reviews depending on how these types of factors like brand loyalty, price competition, and product category influence responses from consumers to reviews. Through the use of sophisticated data analysis, sentiment analysis, and AI-powered review moderation, future studies can provide deeper insights into the ever-changing realm of online consumer behavior and allow businesses to optimize their digital marketing and reputation management efforts.

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Sustainable Textiles: Antimicrobial Finishes Using Natural Resources

S. V. Chavan & P. V. Kadole

Abstract
Textile materials whether natural or synthetic are prone to attack of microoraganisms like bacteia, fungi, algae, dust mites etc. These microorganism grow on textile substrates under specific conditions of storage as well atmosphere. In rainy season the problem is more accute as drying of clothing takes long time due to which unwanted odour is imparted to the colthes and surface staining also occurs. Such clothes can cause problems to the skin of wearer which generally results in etching of skin, irritation, skin allergies etc. The problem is severe in case of textile materials used for sanitaion purpose such as sanitary napkin, diapers which are directly in contact with skin and the area is humid and warm which is prone to get attacked easily by microbes. Hence tretament with antimicrobial agents play an important role in case of textile substrates. Considering sustainable processing, this work deals with treatment of textile substrates with natural antimicrobial agents like Tulsi (Ocimum Sanctum) and Neem (Azadirachta Indica) extracts. The ethanolic extraction process is adopted to get the antimicrobial agent from Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) These natural antimicrobials agents are applied by Pad - Dry
Cure technique and the antimicrobial perfromance is tetsted by test method AATCC 147. It is found that these agents exhibited good antimicrobial properties against gram positive and gram negative bacteria.

Keywords: Antimicrobial finish; Sanitary napkin; Neem (Azadirachta Indica); Tulsi (Ocimum Sanctum); Sustainable processing

Introduction

The use of antimicrobial finishing on fabric is aimed at preventing the growth of various microorganisms such as bacteria, viruses, fungi, algae, mold, and mildew. Different antimicrobial agents are applied to fabrics using various processes, and their effectiveness can vary. Some antimicrobials work by leaching or moving from the surface they are applied on, poisoning microorganisms in the process. However, a bound unconventional antimicrobial technology, specifically an organo-functional silane, works differently. It remains affixed to the substrate, killing microorganisms upon contact and maintaining its effectiveness over time without leaching or diminishing. This technology polymerizes with the substrate upon application, creating an antimicrobial surface. It is particularly useful in textiles that come into contact with humans or require durability. The antimicrobial finishing of textiles is generally done for antimicrobial treatment for fabric is done to control microorganisms, to reduce odour from perspiration, stains and other soil on textile material, to reduce the risk of cross infection being carried by feet from ward to ward in hospital, to control spread of disease and danger of infection following injury, to control the deterioration of textiles particularly fabrics made from natural fibres caused by mildew.
Textile materials, especially garments, are prone to wear and tear, necessitating consideration of stress, strain, thermal, and mechanical effects on finished substrates. To maximize the benefits of finishing treatments, several requirements must be met which are durability to washing, dry cleaning and hot pressing, activity to undesirable microorganisms, no harm to manufacturer, fabric quality, user and environment, compatibility with chemical processes, ease of application, resistivity to sterilization and disinfection etc.

Material and Methodology*:*
Following materials were used for the work

- Selection of Raw material: Wool, cotton (Woven and Knitted), Viscose Woven and Nonwoven, Bamboo (Woven and Knitted) etc
- Processing of Fabrics: Above fabrics were given treatments like desizing for removal of size, Scouring to impart absorbency and Bleaching to improve whiteness by standard processing formulations.
- Extraction of Antimicrobial agent: Natural antimicrobial agents like Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) were selected for this study and the extraction of natural antimicrobial agents was done by ethanolic extraction method.
- Ethanolic extraction of Neem (Azadirachta Indica): 250 grams of mature, fresh Neem (Azadirachta Indica) leaves were collected and washed in distilled water. The leaves were dried using autoclave. Then the leaves were ground into fine powder and packed in muslin cloth bag for the process of extraction.100ml of 99.9% of ethanol were used as a solvent. The extraction was done using Soxhlet apparatus as shown in Fig.1a and Fig.1b. The samples were macerated in ethanol for 3 to 4 hours at temp of 50℃ matching the boiling point of solvent. The extraction was followed by re-flux method. Water was supplied continuously to the condenser to cool the solvent in order to

prevent the evaporation and facilitate the process of extraction. The procedure was continued till the crude Neem (Azadirachta Indica) extract was obtained. The extract was distilled to remove the solvent in order to get a concentrated extract. Solvent thus extracted was evaporated by hot water bath and the extract was stored in refrigerator.

Figure.1a Dried Neem Leaves

Figure. 1b Ethanolic extraction of Neem

- Ethanolic extraction of Tulsi (Ocimum Sanctum): Take 500 grams of dry rhizomes Tulsi were collected and thoroughly washed with water to remove the soil particles and chopped in to small pieces, powdered using a grinder. The samples were weighed and transferred to a cylinder which is attached to the Soxhlet apparatus. 100ml of 99.99% of ethanol were used as a solvent. The samples were soaked in ethanol for 3 to 4 hours at temp of 50°C matching the boiling point of solvent as shown in Fig 2a and Fig. 2b. The extraction was followed by re-flux method. Water was supplied continuously to the condenser to cool the solvent in order to prevent the evaporation and facilitate the process of extraction. The procedure was continued till the crude turmeric extract was obtained. The extract was distilled to remove the solvent in order to get a concentrated extract. Solvent thus extracted was evaporated by hot water bath and the extract was stored in refrigerator.
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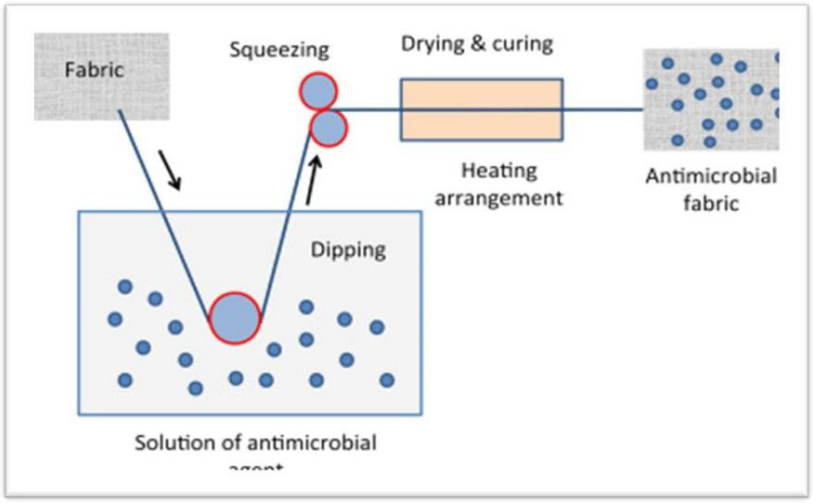
Figure. 2a Tulsi Dry Leaves

Figure 2b Ethanolic extraction of Tulsi

- Application of antimicrobial agent: The applcation of antimicrobial agent was done using 10gpl concentration of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) (Ocimum Sanctum) each on above fabrics by pad- dry- cure method. Padding was carried out with 70% expression on laboratory padding mangle followed by drying the fabric at 80^0C and curing at 140^0C as shown in Fig 3.

Fig 3 Pad-Dry-Cure Process for application of Antimicrobial Finish



- Testing :

The antimicrobial activity of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) on wool, cotton, bamboo, viscose fabrics was tested by Agar diffusion test at BIOCYTE Institute of Research and Development, Sangli. The inoculum of the microorganism was prepared from the bacterial cultures. 15ml of nutrient agar (Hi media) medium was poured in clean sterilized Petri plates and allowed to cool and solidify. 100 µl of broth of bacterial strain was pipette out and spread over the medium evenly with a spreading rod till it dried properly. Wells of 6mm in diameter were bored using a sterile cork borer. Solutions of all the compounds (100µl/ml) inDMSO were prepared. 100µl of plant extracts solutions was added to the wells. The petri plates incubated at 37^0C for 24 h. streptomycin (1mg/ml) was prepared as a positive control DMSO was taken as negative control. Antibacterial activity was evaluated by measuring the diameters of the zone of inhibitions (ZI) all the determination were performed in triplicates.

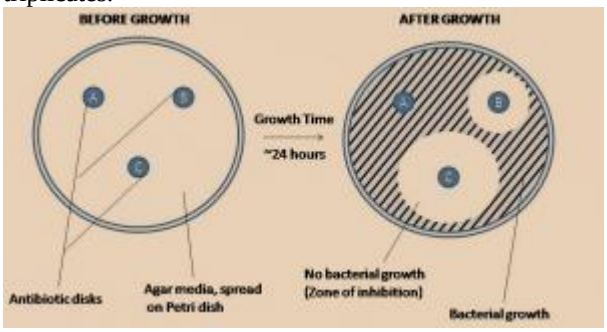
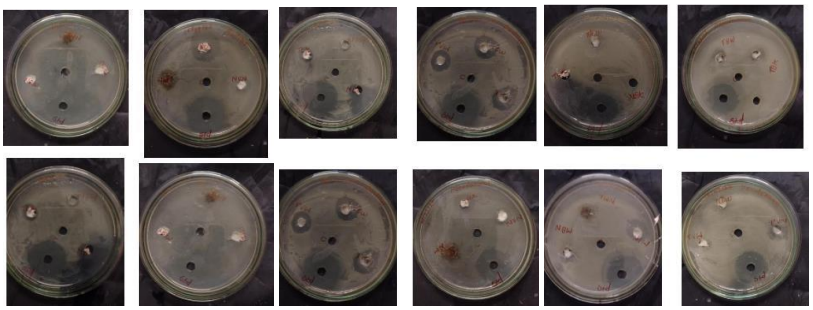


Fig. 4 Agar Diffusion Test

Result And Discussion

The antimicrobial activity of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) on cotton woven and knitted, Bamboo woven and knitted, viscose nonwoven, wool nonwoven was evaluated by measuring the diameters of zone of inhibition as shown in Fig 5.

Fig 5: Agar diffusion test – Zone of inhibition on the textile substrates.



The results of diameters of zone of inhibition are as follows.

Table 1: Antimicrobial Activity of Textiles against Bacillus subtilis

Sr. No	**Samples**	**Concentration ((µg/ml)**	**Zone in Diameter (mm)**
1	Control	--	0
2	Standard (Streptomycin)	10	28
3	Cotton Woven	10	10
4	Cotton Knitted	10	22
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	8
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	16
9	ViscoseWoven	10	13

Table 1 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Neem (Azadirachta Indica) on above textile substrates against Bacillus subtilis which reveals that at the concentration 10µg/ml, the samples treated using Neem (Azadirachta Indica) extract show good activity against Bacillus subtilis.

Table 2: Antimicrobial Activity of textiles against Pseudomonas aeruginosa

Sr. No	**Samples**	**Concentration ((µg/ml)**	**Zone in Diameter (mm)**
1	Control	--	0
2	Standard (Streptomycin)	10	26
3	Cotton Woven	10	8
4	Cotton Knitted	10	21
5	Bamboo Woven	10	5
6	Bamboo Knitted	10	7
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	16
9	ViscoseWoven	10	13

Table 2 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Neem (Azadirachta Indica) on the textile substrates against Pseudomonas aeruginosa which show that at the concentration 10µg/ml, the samples treated using Neem (Azadirachta Indica) extract show good activity against Pseudomonas aeruginosa.

Table 3: Antimicrobial Activity of Textiles against Bacillus subtilis

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	28
3	Cotton Woven	10	20
4	Cotton Knitted	10	4
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	12
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	18
9	ViscoseWoven	10	15

Table 3 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Tulsi (Ocimum Sanctum) on the textile substrates against Bacillus subtilis. From the results, it can be stated that at the concentration 10µg/ml, the samples treated using Tulsi (Ocimum Sanctum) extract show good activity against Bacillus subtilis.

Table 4: Antimicrobial Activity of textiles against Pseudomonas aeruginosa

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	26
3	Cotton Woven	10	18
4	Cotton Knitted	10	4
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	11
7	Wool nonwoven	10	9
8	Viscose Nonwoven	10	15
9	ViscoseWoven	10	13

Table 4 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Tulsi (Ocimum Sanctum) on the textile substrates against Pseudomonas aeruginosa.which exhibits that at the concentration 10µg/ml, the samples treated using Tulsi (Ocimum Sanctum) extract show good activity against Pseudomonas aeruginosa.

Conclusion:

- Natural antimicrobial agents from Neem (Azadirachta Indica) (Azadirachta Indica) and Tulsi (Ocimum Sanctum) (Ocimum Sanctum) can be extracted by ethanolic extraction method.
- The extracted antmicrobial finihes can be applied by pad-dry-cure technique on natural textile substrates like cotton, wool and bamboo.
- The natural antimcrobial finishes can be applied on well regenrated substrates like viscose. The substrates can be in woven, knitted or nonwoven form.
- The antimicrobial efficieniency of both the antimicrobial finishes Tulsi (Ocimum Sanctum) and Neem (Azadirachta Indica) are found to be good against Bacillus subtilis and Pseudomonas aeruginosa bacterial.
- These natural antimicrobial finsh applied textile substrates can be used for various applicatios where antimicrobial property is essential such as daily wear garments, cloth based sanitary napkins, baby wear, appareals for patients.
- There is greater scope to produce textile substrates using natural antimicrobial finishes theryby contributing to sustainable processing practices.

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Overview of Issues, Challenges and Strategies for Effective Management of E -Waste in India

Dr. Varsha Rayanade

Abstract
The rapid growth of the electronics industry has led to a significant increase in generation of electronic waste i.e. e-waste in India, which mostly comes from electronic devices and appliances. Managing E-waste is more complex and challenging compared to other traditional waste. E-waste management is becoming a major cause of concern to public health and environment due to its hazardous nature. This paper attempts to review the current issues, challenges and management practices of e-waste in India.

With the growing economy and rise in demand for electronic devices, India today has become one of the largest generators of e-waste. Approximately 2 million tons of e-waste is generated annually that keeps piling up, with a growth rate of almost 15-20% per annum. The present system of e-waste management in India is facing many issues and challenges such as difficulty in inventorization, ineffective regulations, unsafe and informal recycling practices, lack of awareness among consumers, etc. Failure in proper disposal of e-waste thus leads to significant environmental and health concerns, including soil and water pollution, air pollution and health problems. This paper presents an overview of various issues, challenges related to e-waste and the strategies for effective e-waste management in India. It also highlights the need for effective e-waste management strategies, including legislation, infrastructure development, public awareness and emphasizes the need for infrastructure development, including e-waste recycling and disposal facilities.
The paper concludes that e-waste management is a significant concern in India due to its hazardous impact on the environment and human health. Effective e-waste management strategies, including legislation, infrastructure development, and public awareness, are needed to address this issue.

Keywords: E-Waste, E-Waste Management, Environment, Pollution, Infrastructure Development, Public Health.

Background
India is one of the fastest growing economies in the world. During the past decade, there has been significant growth in Indian's IT and communication sector, as result of which use of electronic products such as computers, laptops, tablets, smartphones, Bluetooth devices, etc. have also increased rapidly. Further, technological advancements have shortened the useable life cycle of such electronic products as new models with better features are constantly being launched, which induce the consumers to exchange their existing gadgets and appliances for new models. Thus, it can be said that the electronic waste stream is one of the fastest-growing waste streams in India. E-waste is a popular, informal name for electronic products whose "useful life" period has ended and have become obsolete and un-useable. When any electrical or electronic equipment is no longer fit for use, it turns into electronic waste (e-waste).

Definition of Electronic Waste (E-Waste)
E-Waste (Management) Rules, 2016 defines e-waste as "any electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes"

United Nations Environment Program (UNEP) defines 'E-waste' as "any electrically powered appliance that fails to satisfy the current owner for its originally intended purpose"

Organization for Economic Cooperation and Development (OECD) defines 'E-waste' as "any household appliance consuming electricity that has reached its end of life is E-waste."

Introduction
The rapid growth of the electronics industry has led to a significant increase in electronic waste (e-waste) generation worldwide. Electronic waste refers to discarded electronic devices, including computers, mobile phones, televisions, and other electronic equipment. The growth of the electronics industry has been driven by the increasing demand for electronic devices, particularly in developing countries like India.

India has become one of the largest generators of e-waste due to its growing economy and increasing demand for electronic devices. India is the "Third largest electronic waste producer in the world"; approximately 2 million tons of e-waste are generated annually and an undisclosed amount of e-waste is imported from other countries around the world. According to United Nations Trade and Development (Unctad) report, India witnessed an

highest 163 per cent growth globally in generating electronic waste from screens, computers, and small IT and telecommunication equipment (SCSIT) between 2010 and 2022. As per the '2024 Digital Economy Report: Shaping an environmentally sustainable and inclusive digital future' India has doubled its share in SCSIT waste generation in the world from 3.1 per cent in 2010 to 6.4 per cent in 2022. Over the year, the E-waste garbage list is getting updated that includes gadgets like smartphones, tablets, laptops, video game consoles, cameras, e-bikes, and many more.

E-waste is a repository of numerous hazardous substances such as lead, mercury, cadmium, and chromium that pose significant risks to both human health and the environment. These materials can contaminate soil, water, and air, and can have serious health impacts, including cancer, neurological damage, and reproductive problems. E Waste is emerging as a serious public health and environmental issue in India. *(Joon, Veenu, et.al, 2017).*

Though, E-waste, is an emerging problem, it also a business opportunity of increasing significance, given the volumes of E-waste being generated and the content of both toxic and valuable materials in them. E- waste includes fractions of iron, copper, aluminum, gold and other metals in E-waste which constitute to over 60%, while the pollutants material comprise of only 2.70% (Widmer et al., 2005). Therefore, recycling of E-waste is an important subject not only from the point of waste treatment but also from the recovery aspect of valuable materials. However the process of take-back and disposal of E-waste is very complex, involving various kinds of products, many people and enterprises, extensive areas, and long time span.

The current e-waste disposal techniques in India are been operated mostly in an informal manner due to the lack of enforcement laws and regulations and unfortunately, it is frequently disposed of without adequate safety measures in place. This is largely because a substantial portion of e-waste is processed illegally by workers operating outside of formal, regulated systems. These informal laborers often employ unregulated and perilous recycling methods, leading to potentially severe health consequences. *(Park, Miles 2019).* Although it helps many make a living, those that are disposing of e-waste are usually not aware of the risks and health hazards that result from certain disposal techniques due to low literacy rate and limited awareness of the hazards associated with e-waste. These workers operate independently, outside of any formal organization which makes enforcing e-waste regulations difficult-to-impossible. Further, these recyclers often rely on rudimentary recycling techniques that can release toxic pollutants into the surrounding area. The release of toxic pollutants associated with crude e-waste recycling can have far reaching, irreversible consequences. *(Pandit, Virendra, 2016).*
E-waste management in India continues to follow similar pattern used for other waste products. An informal e-waste recycling sector employs thousands of workers in urban areas to collect, sort, repair, refurbish, and dismantle disused electrical and electronic products. However, there is a different situation in advanced countries, and there is no such concept in India of consumers voluntarily donating the useless electrical and electronic equipment at formal e-waste recycling centers. Also, there is no concept of consumers paying for disposal of the e-waste they generate. According to Toxic Link (2004), there is no large-scale organized e-waste management in India. The unorganized sector dominates and manages 95% of e-waste in India (Link, 2004). Also, the volume of e-waste generated is high in India with ineffective legislation, the involvement of child labor, lack of proper infrastructure, poor awareness, and the reluctance of authorities involved (Lundgren,2012). Without proper disposal of e-waste in India, in the coming years these problems will get more serious and a matter of concern in India's handling of e-waste.
The management of e-waste is thus a complex issue that requires a multi-faceted approach. It involves the development of effective policies and regulations, the creation of infrastructure for e-waste collection and recycling, and the raising of public awareness about the importance of proper e-waste disposal. The management of e-waste in India is still in its infancy stage. The country lacks a comprehensive legislation to regulate e-waste management, and the existing infrastructure for e-waste collection and recycling is inadequate. There is also a lack of public awareness about the importance of proper e-waste disposal.

This paper reviews the current issues, challenges, and management practices of e-waste in India. It highlights the need for effective e-waste management strategies, including legislation, infrastructure development, and public awareness.

Research Methodology
This paper follows an exploratory methodology based on a qualitative review of the environmental and social aspects in the area of e-waste sector. An exploratory methodology was adopted due to non-availability of ample information on e-waste. Data were collected through comprehensive analysis of qualitative data related to the topics that have been published in various sources mainly from various Government and NGOs' published reports, news articles, websites etc. This paper focus to limelight the issues, challenges and strategies for effective management of e-waste in India

Issues and Challenges Related To E-Waste In India

Volume of E-waste Generated – As per Thomas Reuters, India stands fifth in e-waste generation producing around 1.7 lakhs metric tonnes per annum

Involvement of Child Labor – ASSOCHAM estimates that in India, around 4.5 lakh child laborers in the age group of 10-14 are engaged in various E-waste activities. These child laborers do not adequate protection and safeguards in various dumping yards or at recycling units. Today, the need of the hour is prevention of child labour entry in E waste activities - be it collection, segregation or recycling.

Ineffective Legislation- Most of the websites of State Pollution Control Board's do not provide adequate information related to E-waste. Even the basic E-waste Rules and guidelines have not been uploaded of their websites. Due to the absence of any such information the recyclers and collectors of E-waste, citizens and institutional generators of E- waste are totally at a loss to deal with their waste and do not know how to fulfill their responsibility. (Sinha & Rambha,2013). Hence, there is failure in successful implementation of E- waste management and handling rules, 2012.

Lack of Infrastructure – There is very limited infrastructure capacity for large-scale management of e-waste in India. Further, very few governments approved e-waste recycling centers exist in the country, which constitutes only about 1/5th of the total amount of e-waste generated each year. Therefore, there is a huge gap between present recycling and collection facilities and quantum of E-waste that is being generated and this gap is growing at an alarming speed of 15% per annum.

Health Hazards - E-waste contains various toxic materials, such as lead, mercury, cadmium, chromium that pose significant risks to both human health and the environment. These materials can contaminate soil, water, and air, and can have serious health impacts, including cancer, neurological damage, and reproductive problems. E Waste is emerging as a serious public health and environmental issue in India. Due to lack of awareness, many people are risking their health as well as contaminating the environment as well.

Lack of Incentive Schemes- Several cities have very few dedicated collection depots or formal recycling centers where consumers can voluntarily drop-off the e-waste. Due to lack of proper incentive schemes, the majority of people and urban household consumers are used to sell e-waste or get some discount in exchange when they purchase any new electrical or electronic products from small-scale retail shops. A few financial incentives could help consumers for responsibly disposing of their e-waste.

E-waste Imports – Along with the huge generation of E – Waste in the country, nearly 80% of E-waste generated in developed countries is sent to developing countries such as India, China, Ghana and Nigeria for recycling (Lundgren, 2012)

Mismanagement in Market for the End-of-Life Products - The inability to reliably source e-waste quantities create economies of scale and restricts the entry of private players to set up e-waste management systems in a formal sector. For instance, employing effective recycling technologies for e-waste management in India may require significant upfront capital expenditures. Further, absence of certainty about sourcing enough quantities of e-waste acts as a barrier to interested private entities.

Inadequate Regulations –At present the mandatory take-back system for producers has induced little improvements in e-waste management practices as there are no accompanying collection targets nor any incentives for taking responsibility. Certain amendments were proposed, which provided more regulatory certainty by specifying gradual and increasingly stricter collection targets. However, the regulatory design places a significant burden on the already ill-equipped regulatory agencies. The regulators therefore, need to review the Extended Producer Responsibility (EPR) plan submitted by the producers, grant authorization, and enforce the EPR plan's provisions.

Lack of research- Government needs to encourage research into the development and standardization of hazardous waste management, environmental monitoring and the regulation of hazardous waste-disposal. (Karishma & Vrat, 2015). As of now limited research is underway in E –Waste sector.

Strategies For Effective Management of E_Waste In India

There are various ways of improving e-waste management in India. However, there are certain key components mentioned below that can be linked together to form strategies for improving e-waste management in India.

- Providing Market Information About E-waste Prices - The prices for e-waste and its components are not widely known or publicized among urban consumers. A consolidated price list must be updated on a weekly

basis as it would be a powerful market signal for customers who sell the e-waste to local vendors. Such information must be displayed at websites of state Pollution Control Board, local Municipal Corporations as well as advertised in local newspapers similar to commodity price listings or foreign exchange rates. The price list must reflect the prevailing market demand for e-waste components and enable informal sector collectors to buy and sell e-waste at the fair market prices to private processors or government-approved recycling and dismantling centers.

- Incentive Schemes for Formal E Waste Recycling - The Indian Government has introduced a point-based reward system of E-waste Recycling Credits (ERCs) for formal organizations to incentivize them to channel their e-waste through government-approved recycling centers. Further, depending on the type of e-waste supplied, organizations should be given the requisite ERCs which they can use to offset their energy utility bills. Such an initiative will also provide a strong incentive for informal sector e-waste businesses to formalize the operations and establish supply chain links with approved recycling centers.
- Training and Up-skilling Informal Sector Players - The majority of an informal e-waste recycling workforce needs up-skilling, particularly for handling and dismantling hazardous materials. Short term courses and training programs can be specially designed for e-waste collectors, handlers, and dismantlers by the Electronics Sector Skill Council's combined expertise, the Green Jobs Sector Skill Council, and regulatory agencies like the Central and State Pollution Control Boards.
- Developing Innovative Methods and Technologies for Processing of E-waste - The composition of e-waste is changing rapidly due to the new electronic devices entering in the market. It therefore, requires significant investment in research and development for innovative recycling methods and technologies for future-proofing India's e-waste policies and management. For example, e-bikes and e-cars usage has expanded dramatically in India over the past five years, but any e-waste recycling rules do not yet cover the lithium-ion batteries that power the devices.
- Develop and Strengthen the Informal Sector- Addressing the problem of informal sector e-waste practices requires a greater understanding of the sector itself in terms of its incentives and challenges. Engagement with informal sector workers and the groups, in a manner that recognizes the right of their livelihoods, builds trust, and develops an understanding of the problems along with potential solutions, can be an initial step. The government must institute a platform that facilitates consultations among various stakeholders like informal sector workers, NGOs working with the informal sector, third parties, private entities, and registered recyclers, and manufacturers which will strengthen the informal sector.
- Implementation of EPR Policy - The government needs to rethink about the policy instruments under the EPR approach. A mandatory take back with collection targets cannot be the ideal instrument. Producer responsibility comes in many varieties other than mandatory take-back. The economic instruments like advanced recycling fee or advanced disposal fee on every unit of the product sold in the market will relieve the producers of the physical responsibility of collection, and the revenues generated can be used to develop markets for the end-of-the-life or useless products, such as Subsidize consumers to deposit their e-waste at designated centers, Directly fund recyclers, Assist informal sector workers in training or skill development or provide a greater social security net to the workers. Regulatory Enforcement
- Ban on E-waste Imports – as per the existing regulations, e-wastes are not allowed to be imported for final disposal but can be imported for reuse and recycling. However, in the absence of adequate infrastructure in the country for recycling, ban should be imposed on all kinds of e –waste imports.
- Public Awareness about E-waste Management – the producers are required to provide information about the impact of e-waste, appropriate disposal practices, etc. on their websites as per current e-waste regulations. However, it is observed that in spite of many producers providing such information on their websites, the overall awareness levels remain low among bulk consumers. Hence, the government must consider integrating e-waste awareness campaigns and the overall, public awareness generation initiatives should be based on partnerships and collaboration among various stakeholders. Stricter guidelines/regulations to the producers on these awareness campaigns' frequency and mode might also help in improving the present situation.
- Implementation of Effective Reverse Supply Chain Management – legislation or regulations need to be made for proper Implementation of Effective Reverse Supply Chain Management for E –Waste. In the Reverse Supply Chain Management, the E-waste would be collected from all kinds of resources and it would be delivered to a processor that can recycle valuable parts from E-waste and dispose the rest hazardous components in proper environmental friendly manner. The producer may also buy such recycled valuable parts as raw material from the processor; therefore a close loop supply chain would be formed. In the process, companies can become more environmentally efficient through reusing and reducing the amount of materials used,

Conclusion

Over the past ten years, e-waste has become a more prominent global issue. India, a significant participant in the electronics sector, has not been an exception to this trend. There are serious risks to the environment and public health as a result of improper e-waste disposal procedures and a lack of general knowledge. E-waste is becoming a huge public health issue and is exponentially increasing by the day. Hence, the competent authorities in developing countries like India need to establish mechanisms for handling and treating e-waste safely and sustainable manner. In India, there is dominance of informal sector in e-waste management. It is essential to integrate the informal sector with the formal sector by taking necessary steps to formalize the informal sector by strict implementation of rules and levy heavy penalties on defaulters. To conclude, it can be said that India's e-waste problem presents a range of challenges, from a lack of infrastructure and recycling capacity to limited public awareness. However, with comprehensive research, innovative recycling technologies, improved infrastructure, and increased public awareness, India can develop a more sustainable and effective approach to managing e-waste, protecting both the environment and public health while promoting responsible consumer behavior.

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Understanding ESG: A Conceptual Framework

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Abstract
This conceptual research looks at how Environmental, Social, and Governance (ESG) aspects are evolving in contemporary corporate operations. Using recognized theoretical frameworks like as institutional theory, legitimacy theory, and stakeholder theory, this research aims to combine and critically evaluate the many aspects of ESG. It examines the theoretical underpinnings that underpin companies' implementation of ESG principles, highlighting the interplay between public expectations, regulatory requirements, and organizational strategic imperatives. The conceptual challenges of defining and evaluating ESG performance are also examined in this study, with a focus on the challenges of integrating diverse sustainability standards into cohesive frameworks. This paper adds to a better understanding of ESG's role in promoting sustainable and ethical corporate practices by clarifying its theoretical underpinnings and conceptual nuances. It also suggests possible directions for further research and theoretical development.

Keywords: ESG Framework, theories of ESG, Sustainability reporting

Introduction

In an era where sustainability and ethical accountability increasingly shape corporate landscapes, Environmental, Social, and Governance (ESG) principles have emerged as pivotal frameworks guiding modern business practices (Eccles & Serafeim, 2013). This conceptual paper explores the changing role of ESG in corporate operations, exploring into its theoretical fondations by using various the frameworks of well-known theories - institutional theory (DiMaggio & Powell, 1983), legitimacy theory (Suchman, 1995), and stakeholder theory (Freeman, 1984), Agency theory (Alchian and Demsetz (1972) and Jensen and Meckling (1976) and Signalling theory (Michael Spence). By studying these perspectives, the study aims to critically evaluate how public expectations (Lyon & Maxwell, 2011), regulatory mandates (Ioannou & Serafeim, 2012), and strategic organizational imperatives (Porter & Kramer, 2011) all come together to drive ESG adoption. Additionally, it addresses the conceptual complexities of defining and assessing ESG performance, particularly the challenge of unifying the diverse standards of sustainability into unified a framework (Dillard, Dillard, & Miller, 2010). Through this analysis, the paper seeks to enhance an understanding of ESG's contribution to in order to foster sustainable and ethical corporate behaviour while identifying methods for theoretical advancement.

ESG can be defined as the impact environmental, social, and governance related impacts an organisation can have on its stakeholders. This concept originated from the 2004 report from the United Nations – titled "Who Cares Wins" – which has focused on the concept of ESG. (Maria, 2023) states that ESG stands for Environmental, Social and Governance. The Environmental pillar includes measures like greenhouse gas emissions, pollution, and renewable energy, while the Social pillar looks at practices towards employees, human rights, and equal opportunities, whereas the Governance pillar focuses on the corporate governance structure of the company. (Konstanin, 2022) says that ESG refers to the environmental, social, and governance factors that are considered important for company performance and evaluation. They also include corporate practices and disclosure related to environmental impact, social responsibility, and corporate governance. (Ting-Ting Li et,al 2021) say that ESG is defined as a framework system that includes environmental (E), social (S), and governance (G) factors, which are used by investors to evaluate the sustainable development and social impact of enterprises.
Thus ESG can be understood as a comprehensive framework that integrates Environmental, Social, and Governance factors to assess and guide corporate behaviour, performance, and societal impact. The Environmental pillar encompasses a company's ecological footprint, including measures such as greenhouse gas emissions, pollution control, and the adoption of renewable energy. The Social pillar would evaluates a firm's responsibilities toward its stakeholders, including employee welfare, human rights, equal opportunities, and broader social responsibility initiatives. The Governance pillar would focus on the structures and practices that define corporate oversight, including transparency, accountability, and ethical management within the organization. Together, these dimensions serve as important indicators that help investors, stakeholders, and companies to evaluate sustainable development, ethical practices, and long-term value creation, focusing on both operational priorities and disclosure commitments.

The Growing Significance of ESG in Contemporary Corporate Operations
Environmental, Social, and Governance (ESG) principles have today become integral to modern corporate operations, driven by societal demands, economic benefits, and regulatory pressures. As climate change, social inequality, and governance failures gain attention, stakeholders—consumers, investors, and regulators—

increasingly expect transparency and accountability. ESG's environmental focus, addressing emissions, pollution, and renewable energy, helps firms reduce costs and risks while appealing to eco-conscious markets. The social pillar, covering employee welfare, diversity, and human rights, enhances reputation and stakeholder trust, while governance—emphasizing transparency and anti-corruption—bolsters investor confidence and long-term viability.

Frameworks like the European Union's Sustainable Finance Disclosure Regulation (SFDR) and the U.S. Securities and Exchange Commission's proposed climate disclosure rules exemplify this trend, compelling companies to formalize ESG strategies or face penalties. In India, ESG's significance is amplified by mandatory requirements. The Companies Act, 2013 (Section 135) mandates corporate social responsibility (CSR) spending for firms meeting specific financial thresholds, aligning with the social pillar. The Securities and Exchange Board of India (SEBI) further requires listed companies to submit Business Responsibility and Sustainability Reports (BRSR) as of 2022, enforcing ESG disclosures on environmental impact, social responsibility, and governance practices. These regulations, alongside global trends like the EU's Sustainable Finance Disclosure Regulation, push Indian firms to integrate ESG for compliance, competitiveness, and resilience. As a result, ESG is reshaping corporate success, blending profitability with purpose in India and beyond.

Research Aims and Objectives

This conceptual research seeks to deepen the understanding of how Environmental, Social, and Governance (ESG) principles are evolving within contemporary corporate operations by exploring their theoretical foundations and conceptual intricacies. The primary aim is to synthesize and critically evaluate the multifaceted dimensions of ESG using established frameworks—namely, institutional theory, legitimacy theory, and stakeholder theory—to elucidate the drivers and implications of its adoption.

Specifically, the study objectives include:

- Analysing the theoretical underpinnings that shape companies' integration of ESG practices.
- Examining the conceptual challenges in defining and measuring ESG performance, particularly the difficulties of unifying diverse sustainability standards.
- Contributing to the discourse on ESG's role in fostering sustainable and ethical corporate behaviour while identifying avenues for future theoretical development.

Theories Explaining ESG Adoption

In their study (Carla & Rab, 2024) reveal that five dominant theories stand out among the overall 32 they studied. These are stakeholder theory first, followed by legitimacy, institutional, agency and signalling theories.

Stakeholder Theory

The Stakeholder theory asserts that organizations must consider the interests of all groups affected by their actions—such as employees, customers, investors, communities, and regulators—not just shareholders. It views businesses as part of a broader network of relationships, where balancing stakeholder demands is key to long-term success.

ESG practices address diverse stakeholder needs: investors seek governance transparency, employees demand fair treatment, and communities expect environmental responsibility. For example, a company might adopt renewable energy to satisfy eco-conscious consumers or improve governance to attract ESG-focused investors. In India, stakeholder pressure is evident in firms responding to SEBI's BRSR requirements and public calls for social responsibility. Stakeholder theory frames ESG as a strategic tool to manage these relationships, enhancing trust and support.

This theory captures the multiplicity of influences on ESG but can be vague about prioritizing conflicting stakeholder interests.

Legitimacy Theory

Legitimacy theory argues that organizations seek to align their actions with societal values and expectations to maintain their "social license to operate." Legitimacy is achieved when a company's practices are perceived as desirable or appropriate by its stakeholders, reducing the risk of criticism or sanctions.

Firms implement ESG initiatives to enhance their legitimacy in the eyes of the public, regulators, and investors. For instance, reducing carbon emissions or ensuring fair labour practices aligns with societal demands for sustainability and equity, mitigating reputational risks. In India, mandatory CSR spending under the Companies Act, 2013, reflects a legitimacy-driven response to legal and social expectations. Companies use ESG disclosures to signal compliance and ethical commitment, reinforcing their standing in society.

This highlights the role of perception and external validation in ESG adoption but may underemphasize profit-driven motives or practical outcomes.

Institutional Theory

Institutional theory states that organizations conform to the norms, rules, and expectations of their institutional environment to gain legitimacy and ensure survival. It emphasizes three types of pressures: coercive (e.g., laws and regulations), mimetic (e.g., imitating successful peers), and normative (e.g., societal values or professional standards).

Companies therefore adopt ESG practices due to external pressures rather than solely internal motivations. For example, coercive pressures like India's SEBI Business Responsibility and Sustainability Reporting (BRSR) mandate compel firms to disclose ESG performance. Mimetic pressures arise when companies imitate industry leaders adopting sustainable practices, while normative pressures reflect growing societal expectations for environmental stewardship and ethical conduct. Institutional theory suggests ESG adoption is a response to these forces, leading to isomorphism—where firms in the same field increasingly resemble one another in their ESG approaches. This explains widespread ESG trends but may overlook internal strategic choices driving adoption.

Agency Theory Perspective

Perspective: Agency theory sees ESG adoption as influenced by the principal-agent relationship, where governance mechanisms align managers (agents) with shareholders' (principals) interests. ESG reflects efforts to reduce agency costs through accountability and incentives. Strong governance—e.g., tying executive pay to ESG goals or ensuring board oversight—encourages managers to pursue ESG, overcoming resistance to short-term costs for long-term gains. In India, BRSR mandates enhance governance, aligning managerial actions with shareholder sustainability goals. Weak governance, however, risks greenwashing.

Critical Evaluation: It provides a clear internal lens on ESG, emphasizing governance's role in execution. Yet, it focuses narrowly on shareholder-manager dynamics, potentially overlooking broader stakeholder or societal influences driving adoption.

Signaling Theory Perspective

Signaling theory views ESG adoption as a communication strategy to reduce information asymmetry, sending credible signals of a firm's quality, ethics, or sustainability to external parties like investors or consumers. Companies use ESG practices—e.g., renewable energy adoption or detailed BRSR disclosures in India—to signal responsibility and attract capital or customer loyalty. Transparent reporting differentiates them from less committed peers, enhancing market perception. This perspective excels at explaining ESG's role in reputation and trust-building, particularly in investor-driven contexts. However, it assumes stakeholders interpret signals accurately, which may not hold if disclosures lack substance or credibility.

Synthesis and Relevance to ESG

Together, these theories provide a comprehensive lens for understanding ESG adoption. Institutional theory explains the external structural pressures, legitimacy theory focuses on societal alignment, and stakeholder theory emphasizes relational dynamics. In practice, they overlap: regulatory mandates (institutional) reinforce legitimacy, while stakeholder demands shape both pressures and perceptions. For instance, a company in India might adopt ESG to comply with BRSR (institutional), gain public approval (legitimacy), and satisfy investors (stakeholder). Critically, these theories highlight that ESG is not merely a voluntary choice but a response to a complex interplay of forces, though they differ in their focus on structure, perception, or relationships.

Theoretical Perspectives on ESG Adoption

1. Institutional Theory Perspective

Perspective: Institutional theory views ESG adoption as a response to external pressures that shape organizational behavior. Companies conform to coercive (e.g., regulations), mimetic (e.g., industry norms), and normative (e.g., societal values) forces to fit within their institutional environment. Firms adopt ESG due to mandates like India's SEBI Business Responsibility and Sustainability Reporting (BRSR) (coercive), imitation of sustainability leaders like Tata or Reliance (mimetic), or societal expectations for climate action (normative). This leads to isomorphism, where ESG practices become standardized across industries.

Critical Evaluation: This perspective excels at explaining widespread ESG trends driven by structural forces, such as regulatory compliance or peer benchmarking. However, it may downplay internal motivations (e.g., strategic innovation) or variations in adoption depth, assuming uniformity over agency.

Legitimacy Theory Perspective

Perspective: Legitimacy theory posits that companies adopt ESG to align with societal expectations, securing their "social license to operate" and avoiding criticism or sanctions. ESG becomes a tool to maintain or enhance perceived appropriateness.

Critical Evaluation: Firms implement ESG to gain public approval—e.g., reducing emissions to meet climate expectations or fulfilling India's mandatory CSR requirements under the Companies Act, 2013, to demonstrate social responsibility. ESG reporting further reinforces legitimacy by showcasing ethical commitment.
It effectively captures the role of perception and societal pressure in driving ESG, especially in reputation-sensitive contexts. Yet, it may overemphasize external validation, neglecting cases where ESG is adopted for intrinsic benefits (e.g., cost savings) rather than legitimacy alone.

Stakeholder Theory Perspective

Perspective: Stakeholder theory frames ESG adoption as a strategy to balance the diverse interests of stakeholders—shareholders, employees, customers, communities, and regulators—beyond just profit maximization. ESG addresses their demands for sustainability and ethics. Companies adopt ESG to meet investor demands for governance transparency, employee calls for fair treatment, or consumer preferences for eco-friendly products. In India, stakeholder pressure is evident in firms responding to SEBI's BRSR and community expectations for CSR impact.

Critical Evaluation: This perspective highlights the relational dynamics of ESG, offering a broad view of its drivers. However, it struggles to resolve conflicts between stakeholder groups (e.g., investors vs. communities) and may lack precision in predicting specific ESG priorities.

Agency Theory Perspective

Perspective: Agency theory sees ESG adoption as influenced by the principal-agent relationship, where governance mechanisms align managers (agents) with shareholders' (principals) interests. ESG reflects efforts to reduce agency costs through accountability and incentives. Strong governance—e.g., tying executive pay to ESG goals or ensuring board oversight—encourages managers to pursue ESG, overcoming resistance to short-term costs for long-term gains. In India, BRSR mandates enhance governance, aligning managerial actions with shareholder sustainability goals. Weak governance, however, risks greenwashing.

Critical Evaluation: It provides a clear internal lens on ESG, emphasizing governance's role in execution. Yet, it focuses narrowly on shareholder-manager dynamics, potentially overlooking broader stakeholder or societal influences driving adoption.

Signalling Theory Perspective

Perspective: Signalling theory views ESG adoption as a communication strategy to reduce information asymmetry, sending credible signals of a firm's quality, ethics, or sustainability to external parties like investors or consumers. Companies use ESG practices—e.g., renewable energy adoption or detailed BRSR disclosures in India—to signal responsibility and attract capital or customer loyalty. Transparent reporting differentiates them from less committed peers, enhancing market perception.

Critical Evaluation: This perspective excels at explaining ESG's role in reputation and trust-building, particularly in investor-driven contexts. However, it assumes stakeholders interpret signals accurately, which may not hold if disclosures lack substance or credibility.

Synthesis and Critical Comparison
These five perspectives collectively illuminate ESG adoption from distinct angles: institutional theory emphasizes external structural pressures, legitimacy theory focuses on societal alignment, stakeholder theory highlights relational demands, agency theory underscores internal governance, and signaling theory stresses communication. In practice, they intersect—e.g., India's BRSR mandate (institutional) aligns managers with shareholder goals (agency), signals responsibility (signaling), meets public expectations (legitimacy), and satisfies investors (stakeholder). Critically, institutional and legitimacy theories excel at macro-level trends, while stakeholder, agency, and signaling theories offer micro-level insights into firm-specific dynamics. Their limitations—e.g., institutional theory's structural bias or agency theory's narrow focus—suggests a need for integration to fully capture ESG's complexity.

Conceptual Challenges in ESG
Difficulties in Defining ESG Performance
The absence of a universally accepted definition of ESG performance poses a significant conceptual challenge, complicating its adoption and evaluation across corporate contexts. ESG encompasses environmental (e.g., emissions reduction), social (e.g., labour practices), and governance (e.g., board transparency) dimensions, yet interpretations vary widely. The interpretation and operationalization of Environmental, Social, and Governance (ESG) principles vary significantly across stakeholders and jurisdictions. For instance, Maria (2023) prioritizes

tangible metrics such as greenhouse gas emissions and equal opportunities, emphasizing a performance-based approach. Conversely, Ting-Ting Li et al. (2021) conceptualize ESG as an investor-centric framework for sustainable development, highlighting the divergence in scope and purpose. This definitional ambiguity creates a fundamental challenge: what constitutes 'good' ESG performance is subjective, differing significantly based on stakeholder priorities. An investor, for example, may prioritize strong governance structures (e.g., Gillan, Hartzell, & Starks, 2021), while a local community may emphasize social impact and environmental stewardship (e.g., Aguinis & Glavas, 2012). This fragmentation is evident within specific jurisdictions as well. In India, the mandatory Corporate Social Responsibility (CSR) under the Companies Act, 2013, initially focused narrowly on expenditure-based social performance (e.g., Arora & Puranik, 2004), while the Securities and Exchange Board of India's (SEBI) Business Responsibility and Sustainability Reporting (BRSR) framework broadens the scope to encompass comprehensive environmental, social, and governance disclosures (SEBI, 2021). The implications of this lack of standardization are profound. Without a unified definition, companies struggle to establish clear ESG objectives, stakeholder's encounter difficulties in accurately assessing performance, and cross-firm or cross-regional comparability diminishes, thereby jeopardizing ESG's credibility as a consistent and reliable framework.

Challenges in Measuring and Evaluating ESG

The measurement and evaluation of Environmental, Social, and Governance (ESG) performance are fraught with complexities due to the inherent subjectivity, inconsistency, and variability of ESG metrics. Unlike standardized financial indicators (e.g., revenue, profit), ESG indicators—such as carbon footprint, employee satisfaction, or board diversity—lack universally accepted standards, resulting in divergent assessments (e.g., Chatterji, Levine, & Toffel, 2009). This is exemplified by the frequent discrepancies among ESG rating agencies like MSCI, Sustainalytics, and Refinitiv, which often produce conflicting scores for the same company. These differences stem from variations in methodology, weighting (e.g., the relative importance of emissions versus governance), and underlying data sources (Berg, Kölbel, & Rigobon, 2019). Consequently, a company may receive a high rating from MSCI for its robust environmental policies but a low rating from Sustainalytics due to perceived weaknesses in its governance structure, leading to confusion among investors and regulators (e.g., Christensen, Serafeim, & Sikochi, 2022). Furthermore, the subjectivity inherent in assessing "social impact," such as community welfare, introduces qualitative judgments that are susceptible to contextual variations and assessor biases (e.g., Margolis & Walsh, 2003). In India, despite the mandate for ESG reporting under the Business Responsibility and Sustainability Reporting (BRSR) framework, companies exhibit inconsistent reporting practices, with some emphasizing quantitative metrics (e.g., emissions) and others focusing on qualitative narratives (e.g., CSR stories), thereby impeding objective evaluation (SEBI, 2021). These challenges undermine trust in ESG as a reliable performance indicator, limit its effective integration into decision-making processes, and hinder accountability, as stakeholders struggle to differentiate genuine progress from mere compliance.

Issues with Integrating Diverse Sustainability Standards

Integrating diverse sustainability standards into a cohesive ESG framework is a formidable challenge, given the proliferation of global, regional, and industry-specific guidelines that often conflict or overlap. Globally, frameworks like the Global Reporting Initiative (GRI) emphasize detailed environmental and social disclosures, while the Task Force on Climate-related Financial Disclosures (TCFD) focuses narrowly on climate risks, creating tension in prioritization. Regionally, India's BRSR aligns with national priorities (e.g., CSR and governance transparency), yet differs from the European Union's Sustainable Finance Disclosure Regulation (SFDR), which mandates broader taxonomy-based reporting. Industry variations add complexity—energy firms prioritize emissions, while tech firms focus on data privacy under governance, making a one-size-fits-all ESG framework elusive. This fragmentation complicates implementation: a multinational operating in India and the EU must reconcile BRSR's qualitative social metrics with SFDR's quantitative environmental thresholds, increasing compliance costs and risking misalignment. The lack of harmonization also weakens ESG's global comparability, as stakeholders struggle to benchmark firms across jurisdictions. Ultimately, these integration issues hinder the development of a unified ESG standard, limiting its potential to drive consistent, scalable sustainability outcomes.

Broader Implications

These conceptual challenges—definitional ambiguity, measurement inconsistencies, and integration difficulties—interconnect to create a fragmented ESG landscape. The lack of a universal definition fuels measurement disparities, which in turn exacerbate integration struggles, collectively undermining ESG's effectiveness as a tool for sustainable corporate practice. For example, an Indian firm complying with BRSR might define ESG narrowly, use subjective metrics, and align only with local standards, missing broader global expectations. Addressing these issues requires theoretical and practical advancements, such as consensus-building on definitions, standardized metrics, and interoperable frameworks—areas your paper could explore as future research directions.

Discussion

Synthesis of Theoretical Insights and Conceptual Analyses

The confluence of institutional, legitimacy, stakeholder, agency, and signaling theories offers a comprehensive lens through which to examine ESG adoption and implementation. Institutional theory elucidates how external mandates, exemplified by India's SEBI's Business Responsibility and Sustainability Reporting (BRSR), compel firms to conform to ESG norms (DiMaggio & Powell, 1983). Legitimacy theory underscores the imperative for firms to align with societal expectations, evidenced by mandatory Corporate Social Responsibility (CSR) compliance under the Companies Act, 2013 (Suchman, 1995). Stakeholder theory expands this perspective by emphasizing the necessity of balancing diverse stakeholder interests, including investors and communities (Freeman, 1984). Agency theory focuses on aligning managerial actions with shareholder sustainability goals through robust internal governance mechanisms (Jensen & Meckling, 1976). Signaling theory posits ESG disclosures as credible signals to build trust with external stakeholders (Spence, 1973).

However, these theoretical insights are tempered by conceptual challenges. The lack of a universally accepted ESG definition, as highlighted by the divergent interpretations between Maria (2023) and Ting-Ting Li et al. (2021), complicates the application of these theories. Measurement inconsistencies, exemplified by the variability in ESG ratings across agencies (Berg, Kölbel, & Rigobon, 2019), and integration difficulties, such as the discrepancies between BRSR and the EU's Sustainable Finance Disclosure Regulation (SFDR), reveal practical limitations in operationalizing these frameworks. This synthesis underscores ESG as a dynamic interplay of external pressures, internal governance, stakeholder demands, and perception management, moderated by definitional ambiguity and operational fragmentation. ESG adoption, therefore, is neither purely strategic nor wholly coerced but a negotiated response to a complex ecosystem of forces.

Contributions to Understanding ESG's Role

This analysis contributes to a deeper understanding of ESG's role in promoting sustainable and ethical corporate practices by illuminating its dual nature as both a reactive and proactive mechanism. Theoretically, it demonstrates how ESG bridges structural (institutional), perceptual (legitimacy, signaling), relational (stakeholder), and governance (agency) dimensions, positioning it as a pivotal tool for aligning corporate behavior with societal goals. In India, ESG's function extends beyond mere compliance with BRSR reporting to fostering ethical practices such as equitable labor conditions and transparent governance, driven by stakeholder and legitimacy pressures (Aguinis & Glavas, 2012).

Conceptually, the identification of challenges, such as the subjectivity in ESG metrics (Chatterji, Levine, & Toffel, 2009) and the difficulty of integrating global and regional standards, highlights barriers to ESG's effectiveness, necessitating a re-evaluation of how sustainability is operationalized. This dual perspective reveals ESG not merely as a compliance tool but as a transformative framework that, when robustly defined and measured, can embed sustainability into corporate DNA. By elucidating these dynamics, the study underscores ESG's potential to shift firms from short-term profit motives to long-term ethical and sustainable value creation, particularly in contexts like India where regulatory and societal expectations are escalating.

Implications for Theory, Practice, and Policy

The findings carry significant implications across theoretical, practical, and policy domains. Theoretically, integrating the five perspectives suggests a need for a hybrid framework that synergizes institutional pressures, stakeholder dynamics, and governance mechanisms while addressing signaling's role in perception and agency's focus on internal alignment. Future research should empirically test this synthesis, refining theories to account for conceptual challenges such as measurement variability (Christensen, Serafeim, & Sikochi, 2022).

Practically, firms should transcend superficial ESG adoption (e.g., greenwashing) by developing standardized metrics and aligning strategies with both local (e.g., BRSR) and global standards (e.g., GRI). This necessitates training managers to prioritize ESG as a strategic asset, leveraging governance to align interests, and using credible signals to build stakeholder trust (Gillan, Hartzell, & Starks, 2021). In India, companies can leverage BRSR compliance as a competitive differentiator.

Policy-wise, policymakers, such as SEBI and global bodies like the IFRS Foundation (which oversees ISSB standards), should prioritize harmonizing ESG definitions and metrics to mitigate fragmentation. In India, aligning BRSR with international frameworks like the Task Force on Climate-related Financial Disclosures (TCFD) could enhance global comparability, while incentives (e.g., tax benefits for ESG leaders) could accelerate adoption. Collectively, these implications underscore that resolving ESG's conceptual challenges through theoretical refinement, strategic implementation, and policy coherence can amplify its role in driving sustainable and ethical corporate practices.

Conclusion

This conceptual study has elucidated the evolving role of ESG in contemporary corporate operations through rigorous theoretical evaluation, an analysis of influencing factors, and an exploration of conceptual challenges.

The theoretical perspectives—institutional, legitimacy, stakeholder, agency, and signaling theories—reveal ESG adoption as a multifaceted phenomenon: driven by external pressures (e.g., India's BRSR mandates), societal alignment, stakeholder demands, internal governance, and strategic communication. The interplay of public expectations, regulatory requirements (e.g., Companies Act, 2013), and organizational imperatives underscores ESG's integration into corporate strategy, balancing compliance with competitive advantage.
However, conceptual challenges temper this progress: the lack of a universal ESG definition creates ambiguity, inconsistent metrics (e.g., divergent ratings across agencies) hinder evaluation (Berg, Kölbel, & Rigobon, 2019), and fragmented sustainability standards (e.g., BRSR vs. SFDR) complicate global coherence. Together, these insights portray ESG as a transformative yet imperfect framework, poised to promote sustainable and ethical practices if its theoretical and practical gaps are addressed.

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Comparative Study of Use and Environmental Implications of Renewable and Non-Renewable Energy Resources in India

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Abstract

: Energy is a major driving force for country's economy. Today, we are standing at a point where we have to balance our energy demand with climate change mitigation goals by improving the energy efficiency. India's efforts to reduce emission of pollutants and promote use of clean energy are important steps for achieving sustainable development goals. Till 2024, India has installed 203 GW of renewable energy. "Viksit Bharat 2047" mission is committed to provide affordable and clean energy to all citizens. Now, we highly depend on non-renewable energy sources including coal, petroleum and natural gas for meeting our energy needs which cause emission of different pollutants including Sulphur dioxide, Nitrous oxide, Ozone and hydrocarbons. It can cause serious environmental damage including acid rain and photochemical smog. It can also have negative health effects like respiratory diseases and heavy metal toxicity. These energy sources are responsible for 75 percent of greenhouse gas emissions. So there is a urgent need to promote growth of renewable energy sector. More emphasis should be given on solar energy, biomass, wind energy and green hydrogen. In India, immense growth is observed in use of roof top solar panels since 2017-18, and the energy production has reached from 1.06 GW in 2017-18 to 14.45 GW in 2024-25. Along with this the use of wind energy and hydroelectric energy is increasing, which can proved to be environmentally feasible for the growth of Indian economy

Keywords: Energy, Economy, Pollution, Solar, Renewable etc.

Introduction

India is seventh-largest and most populous country in the world. So, the energy demand for various purposes including industries, residential areas and transportation is also very high. The energy sector has played a very significant role in the socio-economic growth of a country. India is the fourth largest producer of coal and it contributes to 61% of primary energy production. India is also the third largest consumer of oil and mainly relies on the import of crude oil to meet its manufacturing and transportation demands. The electricity demand of India is growing 5.8 percent annually. (BEE India, 2023-24) In order to meet this demand, the import of coal, crude oil and LPG is also increasing. Use of these conventional energy resources is a leading cause of overexploitation of natural energy resources and climate change. (Biswanth Behera et. al., 2023) Therefore, use of renewable energy is encouraged in order to attain sustainable development. The seventh Sustainable Development Goal also focusses on ensuring sustainable, reliable and modern energy for all in order to achieve environment friendly economic growth. (United Nations, 2015) India has set a target of producing 450 GW renewable energy by 2030. (Singh, 2021) India has high potential for producing renewable energy as it receives appreciable amount of sunlight due to its geographical location and has vast shoreline, hilly areas and huge network of rivers. All these factors can be helpful in the production of higher amounts of solar, wind, and hydroelectric energy.

India is a rapidly growing economy with increasing industrialization and urbanization. The demand for different electrical appliances and automobiles is increasing along with the rise in per capita income. (IEA, 2021) India is the third largest consumer of energy resources from which 80% of energy demand is met by coal, oil, and solid biomass. (IEA,2021) Due to this India has become the third largest carbon emitter in the world. According to UNEP, the greenhouse gas emission from fossil fuels was 37.5 GtCO2 in 2018 with an annual increase of 2 percent. (UNEP, 2019) The change in climatic conditions can be seen through increased temperature, changes in precipitation patterns, extreme weather conditions, and sea-level rise. Along with this the frequency and intensity of various climatic hazards like hurricanes, floods, heatwaves, wildfires and severe storms is increasing. (UNCCS 2019). Methane and Nitrous oxide are also major greenhouse gases that are released from agricultural and industrial areas. There is an urgent need for the energy sector to undergo a transition sector from fossil fuels to cleaner forms of energy and adopt innovative technologies to reduce emissions.

Distribution of Non-renewable Energy Resources in India:

Coal: Coal is a major source of electricity generation in India and its share in primary electricity generation is 61 percent. India stands at fifth rank in global coal reserve with 437 billion tonnes reserve. India's coal production has reached 998 million tonnes in year 2023-24.

Oil: The oil requirement in India is very high as India is third largest consumer of oil in world. India mainly relies on imported oil in order to meet energy demand for manufacturing, transportation and household consumption. The share of energy in primary energy supply in India is 29 percent. Domestic oil production in India is

continuously decreasing from 2016-17 at annual rate of 3 percent. (BEE, 2024) The import of oil is often connected to the trade balances, nation's economic health and nation's economic stability.

Natural Gas: It is considered as a clean fuel as compared to coal and oil as it helps to minimize greenhouse gas emission. Industrial sector is largest consumer of natural gas with 38 percent followed by transport and residential sector (20 percent), power generation (13 percent) and others (28 percent). Gas fields are also located in India at various locations including Mumbai high, Krishna-Godawari basin and Assam. India is a 4th largest importer of Liquified Natural Gas and it contributes to 7 percent of India's primary energy mix.

Effect of non-renewable energy resources on environment:

Non-renewable energy resources take thousands of years to form and replenish naturally and the dependence on these resources for energy production is very high. These fossil based resources are major contributor to climate change and the global temperature may rise by 2.6-4.8^{o}C till 2100 from pre-industrial levels. (World Energy Council, 2014) In 2010, the share of energy sector in greenhouse gas emission was 35 percent. SAARC nations have also highlighted that use of non-renewable energy resources cause higher carbon dioxide emissions, which is a major cause of global warming. (Akbar et al, 2024) In India, energy sector mainly relies on coal which has resulted in high carbon dioxide emissions. Expansion of coal based steel production may cause around 680 million metric tonnes of carbon dioxide emissions. Different types of natural resources emits carbon dioxide, but natural gas emits 50-60 percent less CO_2 as compared to coal. But extraction of natural gas from land results in leakage of methane which is also a potent green house gas. It is 34 times more potent than CO_2 in trapping heat. (MD Aslam Ansari et. al., 2017) Climate change can have adverse impact on different types of ecosystems resulting in loss of biodiversity and productivity. It is a major cause of rise in mean sea level and shift in global agricultural pattern. Along with this, combustion of these fossil fuels lead to emission of various air pollutants including nitrogen oxide, sulphur dioxide, particulate matter and some heavy metals which may have detrimental effects on air quality and human health. As Sulphur Dioxide is released from combustion of fossil fuel, it combines with rainfall and the pH of rainwater turns acidic which is corrosive and it also acidifies lakes and streams. (F. BARBI et al, 1990) It can be harmful to the aquatic organisms.

The mining activities conducted for fossil fuel extraction can cause various negative effects on local ecosystems including soil erosion, land degradation, habitat destruction, deforestation and water pollution. From the environmental perspective, these fossil fuel based energy resources are detrimental for both environment and living organisms. Thus its use should be discouraged.

Distribution of Renewable Energy Resources in India:

Renewable energy is playing significant role in energy supply of India and the share of wind and solar energy has been steadily increasing. This transition from non-renewable to renewable energy has been driven by government initiatives, substantial investment and technological advancement. From 2013-14 to 2023-24, the supply of energy from renewable energy resources has increased from 17.4 Mtoe to 31.1 Mtoe, increasing its share in total energy production to 3.4 percent. India is having high potential for energy generation from renewable energy resources from solar radiation and wind due to its geographical location and vast sea shore and hilly areas. According to the National Institute of Solar Energy (NISE), country's solar potential is 748 GW. National Institute of Wind Energy (NIWE) has stated that India's wind potential at 150 meters above ground level is 1164 GW. Along with this, additional 196 GW energy can be generated from hydropower plants and biomass. (BEE, 2024)

- Solar Energy: Total installed capacity of solar power in India is 102566.02 MW (Ministry of New and Renewable Energy, 2025). Government now aims to reach the target of generating 280 GW of solar energy by 2030. Solar parks are also established in India at various locations including Bhadla (Rajasthan), Pavagada (Karnataka) and Rewa (Madhya pradesh) in order to utilize solar radiations and reduce dependency on fossil fuels.
- Wind Energy: Total installed capacity of wind power in India is 48588.56 MW upto February, 2025. India aims to reach the target of generating 140 GW wind energy by 2030. Tamil Nadu, Gujarat and Maharashtra are leading states in installation of wind energy systems.
- Hydropower: India's installed hydropower capacity is around 46, 850 MW. India is having vast network of rivers and highest number of dams, which has been proved beneficial for increasing hydropower potential. India aims to increase hydropower capacity up to 70 GW by 2020.

Along with these resources biofuels, biomass and waste to energy approach are also used to generate renewable energy.

Effect of Renewable energy resources on environment:

Utilization of renewable energy resources by converting them into electricity, while ensuring environmental sustainability gives multiple benefits to renewable energy sources in terms of their use and environment protection. Renewable energy resources accounts for almost zero percent of greenhouse gas emissions. (UNEP, 2000). These energy resources generates electricity without emission of air pollutants like nitrogen oxides, sulphur dioxide and particulate matter. It also does not involve large scale mining, which prevents land degradation, water pollution and habitat destruction.

In life cycle of solar, wind or hydropower plant, it has insignificant amount of greenhouse gas emissions. (Dario Maradin, 2021). At the same time, these resources reduce dependence on import and use of fossil based energy resources. Thus it reduces carbon footprint, which in turn helps to combat climate change. Use of renewable energy resources also avoids overexploitation of other natural resources and provides source of sustainable form of energy. Thus it helps to achieve Sustainable Development Goal 7 which states about availability of reliable, affordable, sustainable and modern energy for all. Even waste material including biomass can be used to produce energy, which ensures environment friendly management of waste.

Conclusion:

From this study, it has been made clear that non-renewable energy resources are having several implications on environment as well as economy. The resources like crude oil and natural gas are mainly imported from middle East and other countries which can create economic instability due to volatility in their prices. At the same time it causes various environmental problems including global warming, sir pollution, land degradation and water pollution. Instead of these, use of renewable energy resources can be done in order to avoid these environmental issues. India is high potential of generating Energy from renewable energy resources including solar energy, wind energy, hydropower and biofuels. These resources can help to reduce carbon and methane emissions thus reduces the effect of global warming. They also helps to reduce air and water pollution and avoids overexploitation of natural resources . Along with this, the use renewable energy resources can be cost effective in long run. Government has taken various initiatives for promoting these resources. Due to awareness campaigns and several government initiatives, growth can be seen in use of these resources, especially in case of roof top solar panels which are growing at 45 percent annual rate. Some technological advancements and government initiatives should further encourage the energy production from renewable energy resources, so that energy production should become affordable and sustainable in long run.

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The Unaccounted Cost: Assessing the true Economic Impact of Environmental Damage

Dr. Dhanashree Kulkarni

Abstract
Global sustainability is seriously threatened by environmental deterioration, yet traditional financial and economic models do not fully account for its actual economic impact. Natural resource depletion, pollution, and biodiversity loss are not taken into account by traditional accounting systems and GDP estimates, which results in skewed economic metrics that ignore long-term environmental harm. Using natural capital accounting, carbon pricing, and sustainability reporting, this paper seeks to: (1) assess the economic impact of unrecorded environmental harm; (2) investigate the shortcomings of existing valuation models in capturing environmental costs; and (3) suggest ways to incorporate these costs into economic decision-making. The study uses a mixed-methods research strategy to accomplish these goals. To identify the gaps in environmental cost accounting, a qualitative analysis of the body of existing research and policy frameworks is carried out. To measure the hidden economic cost of environmental deterioration, case studies of sectors including industry, agriculture, and energy are also examined. In order to provide a more thorough accounting framework, the study also investigates other value methods, such as ecosystem service pricing and the Inclusive Wealth Index. This study emphasises the pressing need for a paradigm shift towards sustainable economic planning by including environmental costs into company plans and economic policy. By encouraging companies and politicians to take a more responsible and data-driven approach to environmental accountability, the results hope to add to the continuing conversation on sustainability.

Keywords: Sustainability, Hidden Economic Cost, Biodiversity

Introduction

Background and Rationale

The planet is facing serious environmental degradation such as deforestation, pollution, loss of biodiversity, and global warming. Although these issues have strong economic implications, they are generally overlooked in conventional financial analysis. Economic prosperity is generally quantified with the use of Gross Domestic Product (GDP), which takes into account only market activity without the depletion of natural resources. This creates a flawed image of economic prosperity as environmental degradation constitutes an "externality" and not a necessary component of economic study.

Why does this matter?

Inadequate environmental cost accounting results in unsustainable development. For instance, industries will keep polluting if the true economic cost of their environmental footprint is not accounted for in their balance sheets. Policymakers will emphasize short-term economic growth at the expense of long-term environmental sustainability because there is no stable system to include environmental costs in decision-making.
This research contends that the economic value of environmental destruction must be clearly quantified and incorporated into economic and financial models. Using tools like Natural Capital Accounting, Carbon Pricing, and the Inclusive Wealth Index, a truer picture of economic well-being can be developed.

Research Goals

The study seeks to correct the lapses of conventional economic models in depicting environmental destruction.
The central goals include:

Estimate the Economic Value of Unreported Environmental Harm:
This entails estimating the unobserved costs of pollution, deforestation, global warming, and loss of biodiversity. The study will examine the manner in which environmental degradation translates into economic losses for sectors like agriculture, energy, and medicine.

Discuss the Shortcomings of Current Valuation Models:
Traditional economic models like GDP and cost-benefit analysis are not capable of capturing the full extent of environmental damage.

This section discusses why such models are flawed and how they lead to unsustainable economic choices.
Suggest Ways of Incorporating Environmental Costs into Economic Decision-Making:
The paper proposes models such as Natural Capital Accounting, Carbon Pricing, and the Inclusive Wealth Index to make sure environmental costs are incorporated into business and policy-making decisions.

Suggestions will be given to governments, companies, and financial institutions regarding how to incorporate sustainability into financial decision-making.

Methodology

The research uses a mixed-methods approach that incorporates qualitative and quantitative research methods. The research methodology entails:

Qualitative Examination of Existing Policy and Research Frameworks:

Examination of available literature on environmental cost accounting, economic valuation models, and sustainability practices.

Environmental policies from various nations are analyzed to determine the gaps in prevailing economic models.

Case Study Examination in Main Sectors:

Analyzing sectors like manufacturing, agriculture, and energy to determine the actual-world influence of environmental damage.

Analyzing the economic loss due to air and water contamination, global warming, and the depletion of natural resources.

Alternative Valuation Approaches Exploration:

Exploring Natural Capital Accounting, Carbon Pricing, and the Inclusive Wealth Index to create a holistic framework to incorporate environmental expense into economic strategy.

Determining best practices by organizations and governments that have implemented environmental responsibility successfully.

The Economic Impacts of Environmental Harm

Environmental harm has extensive economic implications that extend beyond tangible and immediate consequences. Conventional economic frameworks are unable to quantify the real costs of environmental degradation, resulting in policy loopholes and unsustainable choices. This section discusses three important dimensions of environmental harm: natural resource depletion, pollution, and loss of biodiversity, highlighting their economic impacts.

Natural Resource Depletion Costs

Natural resource depletion is the excessive consumption and exploitation of vital resources like forests, water, soil, and minerals. Natural depletion is caused by human activities like deforestation, over-extraction of groundwater, and intensive farming methods, which drain the resources faster than the natural rate of replenishment.

Economic Impacts:

Reduced Agricultural Productivity:

Soil nutrient overuse and deforestation cause soil nutrients to be degraded, decreasing agricultural output.

When forests are destroyed for agriculture or industry, topsoil and soil fertility loss heighten the dependence on chemical fertilizer, which increases the cost of production.

Agriculture-dependent nations like India and Brazil experience economic uncertainty because of reduced crop yields and increased food prices.

Heightened Disaster Vulnerability:

Deforestation and overuse of groundwater lead to droughts, floods, and landslides that cause billions of dollars of damage each year.

Coastal communities lose natural protection from mangroves and wetlands, leading to higher costs in disaster relief and recovery efforts.

Rising Commodity Prices:

Scarcity of natural resources increases costs for industries that rely on them.

Water-intensive industries, such as beverage manufacturing and textiles, face higher operational expenses due to water shortages.

The mining sector faces deteriorating ore quality that takes greater amounts of energy and investment to bring valuable minerals to the surface, increasing consumer electronics, car, and infrastructure development prices.

Example:

The Amazon rainforest is being cut down at an unprecedented rate in Brazil for cattle and soybean cultivation. The clearing of forests contributes to soil degradation, biodiversity loss, and unpredictable weather conditions, impacting agricultural exports and the regional economy directly.

Pollution and Its Economic Impact

Pollution takes place when harmful chemicals enter the environment and deteriorate the quality of air, water, and soil. Key causes of pollution are industrial discharges, motor vehicle emissions, chemical waste dumping, and plastic overuse.

Economic Consequences:

Increased Healthcare Costs:

Air pollution causes respiratory disorders, heart diseases, and lung cancer, which lead to rising healthcare costs.

Water pollution results in outbreaks of cholera and dysentery, which overwhelm public healthcare.

In highly polluted nations like China and India, billions of dollars are incurred every year on healthcare by pollution-related ailments.

Decreased Labor Productivity:

Pollution creates higher rates of absenteeism and decreased productivity among the labor force.

Pollution in the air induces drowsiness, headaches, and respiratory issues, decreasing the efficiency of employees.

Severe heat, which is augmented by pollution, restricts working hours outside for industries like construction and farming, lowering total economic output.

Costs of Environmental Restoration

Governments and businesses spend billions on restoring contaminated sites, reviving bodies of water, and replanting forests.

Cleaning up contaminated groundwater or reversing the effects of air pollution takes sophisticated technology and huge long-term investments.

The price tag for pollution control devices like air filters and water treatment facilities puts additional cost burdens on industries and regional economies.

Example

In Delhi, India, extreme air pollution causes the economy to lose almost $36 billion each year in healthcare expenditures, lost productivity, and lower life expectancy. Government measures like odd-even traffic regulations and green energy projects entail huge monetary expenditure but are vital to reduce economic losses.

Economic Disruptions Due to Biodiversity Loss

Biodiversity loss is a condition where ecosystems lose species and genetic diversity because of habitat destruction, climate change, pollution, and wildlife overexploitation. Biodiversity ensures ecosystem stability, food security, and climate regulation.

Economic Impacts:

Impacts on Food Security:

Pollinator losses such as bees and butterflies diminish crop production, influencing world food output.

Collapse of fisheries caused by overfishing and habitat loss affects millions relying on seafood as a source of protein and livelihood.

Decline in genetic diversity of crops leaves them more susceptible to disease and climate change, with greater dependence on costly genetically modified seeds.

Disturbances in Natural Resource-Based Industries:

The pharmaceutical sector, which depends on plant species for the discovery of new drugs, is affected when biodiversity reduces.

Economies based on ecotourism, like Costa Rica and Kenya, lose revenues as wildlife populations dwindle.

The forestry sector has chronic shortages in the supply of timber and non-timber forest products as a result of deforestation.

Loss of Climate Regulation Services:

Wetlands and forests provide carbon sinks that lower emissions of greenhouse gases. Their degradation contributes to rapid climate change, increased frequency of natural disasters, and increased costs of adaptation.

Coral reefs that host marine life and coastal defense are being destroyed by ocean acidification, and it results in financial losses for fisheries and tourism businesses.

Example:

Australia's Great Barrier Reef has been suffering from severe coral bleaching caused by increased ocean temperatures. The reef earns approximately $6.4 billion per year from tourism and fisheries but its decline poses a threat to thousands of jobs and economic stability in coastal areas.

Limitations of Current Valuation Models

Conventional economic models of valuation do not capture the real cost of environmental damage, producing erroneous measures of development and growth. Indicators such as Gross Domestic Product (GDP), cost-benefit analysis (CBA), and company sustainability reporting typically exclude the use of natural resources, the health costs of pollution, and the loss of biodiversity. This part discusses the inadequacies of these models and emphasizes the critical need for an enhanced valuation model for environmental effect.

Shortcomings of GDP in Measuring Sustainability

Gross Domestic Product (GDP) is the most common measure of economic performance. It is the sum of the value of all goods and services made in a country during a given period. Policymakers, investors, and governments utilize GDP growth as a sign of national well-being.

Why is GDP an Inadequate Measure of Sustainability?

It overlooks Natural Resource Depletion

GDP rises when sectors utilize natural resources (e.g., mining, forest cutting), but it doesn't capture long-term economic losses due to depleting resources.

Example: Logging in the Amazon adds to GDP but ignores the loss of species diversity, lowered carbon sequestration, or long-run climate effect.

Pollution-producing activities (e.g., fossil fuel mining, manufacturing) contribute to GDP without subtracting the economic costs of environmental degradation.

Example: Cleanup costs of oil spills are included in the calculation of GDP as economic activity while ignoring damage to ecosystems.

Does Not Distinguish Between Unhealthy and Healthy Growth:

GDP rises even when economic processes damage long-run economic sustainability, like groundwater pumping or fishing that is excessive.

Nations that experience fast industrialization might reflect high growth of GDP but encounter extreme environmental destruction, with concomitant long-run economic jeopardy.

Does Not Capture Well-being or Standard of Living:

GDP growth neither accounts for pollution in the air, green land loss, nor deteriorating public health caused by environmental degradation.

Highly polluted nations can have positive GDP growth even as life expectancy falls and healthcare expenses rise.

Alternative Methods:

Green GDP: Subtracts environmental costs, including pollution-related health costs and resource depletion, from GDP.

Genuine Progress Indicator (GPI): Adds social and environmental considerations to determine if economic growth enhances overall well-being.

Example:

China's development accelerated into double-digit growth of GDP for decades, but intense air pollution in urban areas such as Beijing resulted in economic losses through healthcare, lost productivity days, and clean-up costs. Conventional GDP statistics did not account for these costs, so the national economic well-being was left with an incomplete picture.

Defects in Cost-Benefit Analysis

Cost-benefit analysis is an economic appraisal technique employed to determine the worthiness of projects by evaluating the anticipated costs and benefits. CBA is employed by businesses and governments to guide investment and policy choices.

Underestimates Long-Term Environmental Costs:

CBA tends to use discounting, which diminishes the significance of future costs and benefits. This implies long-term environmental damages (e.g., climate change, loss of biodiversity) are underestimated in decision-making.

Example: A new highway development can stimulate economic activity in the short run, but if it results in deforestation, higher emissions, and loss of habitats, the long-run costs are much greater than the short-run gains.

Omits Non-Market Environmental Values:

Most environmental values, including clean air, biodiversity, and ecosystem services, lack a direct market price and are frequently omitted from CBA analysis.

Example: Natural flood protection and water filtration are offered by wetlands, but such services are hardly included in cost-benefit analysis.

Promotes Unsustainable Industrial Activities:

CBA favors projects with short-run profitability at the expense of neglecting irreversible environmental impacts.

Example: Groundwater extraction for business purposes can be profitable in terms of short-run economic returns, but it can cause serious water shortages, land subsidence, and agricultural loss in the long term.

Ignores Social and Health Impacts:

Most environmental costs, including higher respiratory illness due to pollution or community displacement due to forest cutting, are not included in CBA models.

Example: A coal power plant might be profitable in terms of energy generation, but the health expenses of air pollution (e.g., asthma, lung disease) render it a net loss when long-term health effects are taken into account.

Alternative Approaches:

Multi-Criteria Decision Analysis (MCDA): Considers social, environmental, and ethical considerations in decision-making instead of monetary valuation alone.

Ecosystem Services Valuation: Places value on natural services, including pollination, clean water, and carbon sequestration, to ensure they are included in project appraisals.

Example:

A highly debated hydroelectric dam project in Brazil's Amazon was supported by cost-benefit analysis, emphasizing electricity generation and economic development while disregarding long-term environmental damage, indigenous displacement, and loss of biological diversity. These unaccounted costs have contributed to continued disputes and financial losses.

Corporate Sustainability Reporting Gaps

Corporate sustainability reports (CSRs) are company disclosures regarding their environmental, social, and governance (ESG) activities. They are meant to demonstrate how companies are helping in sustainability while ensuring profitability.

Why Are These Reports Inadequate?

Superficial and Selective Disclosures:

Most companies report only good environmental actions while leaving out important negative impacts.

Example: A company that produces oil can release reports on investments in renewable energy while suppressing its contribution to deforestation and carbon emissions.

Lack of Standardized Metrics:

There is no standard system to measure environmental costs correctly, resulting in variable reporting.

Firms have the option to use different measures or methods, and hence, it is challenging to compare their true environmental performance.

Failure to Account for Full Environmental Costs:

Most reports fail to estimate the monetary effect of pollution, waste generation, or resource consumption.

Example: A fashion company can report on sustainability practices but leave out the environmental expenses of too much water used to grow cotton or microplastics from synthetic fibers.

Greenwashing and Misleading Claims:

There are some businesses that greenwash, as they overstate their environmental activities for the purpose of keeping a positive public perception.

Example: Some plastic manufacturers boast of promoting recycling but still continue to produce non-biodegradable packaging at a non-sustainable level.

Alternative Approaches:

True Cost Accounting: Adds environmental externalities, including emissions, deforestation, and water consumption, to company financial reports.

Mandatory ESG Regulations: Governments must introduce more stringent sustainability disclosure requirements to avoid deceptive reporting.

Example:

Major fashion brands often release sustainability reports claiming ethical sourcing and eco-friendly materials, yet investigations reveal continued reliance on fast fashion, poor labor conditions, and massive textile waste. These reports lack transparency about the true environmental and economic impact of their operations.

Alternative Economic Models for Environmental Accountability

As mainstream economic paradigms omit the true prices of environmental decay, new ones are being conceived to incorporate sustainability into financial investment decisions. Such models seek to monetize natural resources as an economic asset base, internalize environmental expenses, and redefine a nation's capital to encompass ecosystem health.

Natural Capital Accounting

Natural capital accounting (NCA) is a system that integrates ecosystem services, biodiversity, and natural assets into national and business economic frameworks. In contrast to traditional accounting, which monitors only

financial and physical assets, NCA puts an economic value on forests, water resources, air quality, and other natural resources.

It makes sure that environmental resources are valued as precious economic assets instead of free goods.

It assists governments and enterprises in determining the ultimate costs of resource depletion.

It aids in sustainable policy-making through data-driven information about environmental degradation.

Example:

The System of Environmental-Economic Accounting (SEEA) of the United Nations assists nations in measuring natural capital.

Costa Rica applied natural capital accounting to determine its economic value from forests, resulting in conservation-friendly policies that support eco-tourism.

Carbon Pricing and Environmental Taxation

Carbon pricing is a market instrument aimed at internalizing the cost of carbon emissions so that industries take into consideration their environment costs. There are two principal approaches:

Carbon Taxes – Governments set a tax on every unit of carbon dioxide released.

Illustrative Example: Sweden's carbon tax ($130 per ton of CO_2) has kept emissions low while economic growth has continued.

Cap-and-Trade Systems – The government establishes an emissions cap and permits companies to sell or purchase emission permits to emit CO_2.

Example: The European Union Emissions Trading System (EU ETS) has contributed to the reduction of emissions in sectors such as power generation and aviation.

Why Are These Policies Effective?

They encourage companies to use cleaner technologies.

They raise government revenue, which can be invested in renewable energy or climate adaptation initiatives.

They assist in redirecting economic activity towards low-carbon sectors.

The Inclusive Wealth Index (IWI)

What is the Inclusive Wealth Index?

In contrast to GDP, which concentrates on short-term economic production alone, the IWI looks at:

Produced capital (infrastructure, machinery)

Human capital (education, skills, health)

Natural capital (forests, water, biodiversity)

Why is IWI a Better Measure of Economic Progress?

It captures long-term economic sustainability.

It captures resource depletion and environmental degradation.

It offers policymakers a complete picture of national wealth.

Example:

A nation such as Indonesia might register GDP growth through the production of palm oil but have IWI falling because of forest clearing and biodiversity erosion.

Case Studies: The True Cost of Damaging the Environment

This part reviews actual situations where the environment is being destroyed, illustrating why standard economic valuation doesn't tell us the actual costs.

Economic Impact of Industrial Pollution:

Costs of rising healthcare bills owing to diseases resulting from pollution (such as respiratory ailments, cancer).

Reduced labor productivity as workers suffer from health problems.

Declining agricultural output due to soil and water contamination.

Example:

India's air pollution crisis: Delhi's poor air quality causes annual GDP losses of $95 billion due to health expenses and lost productivity.

Agricultural Practices and Environmental Degradation

Problems with Intensive Farming:

Overuse of pesticides and fertilizers contaminates water sources.

Soil erosion reduces long-term agricultural productivity.

Deforestation for agriculture contributes to climate change.

Example:

The Dust Bowl (1930s, USA) – Intensive farming without regulation resulted in extensive soil degradation, leading to economic meltdown in agricultural communities.

The Energy Sector and Climate Change Costs

How Fossil Fuels Contribute to Economic Losses:

Climate change adds to natural disaster expenditure (hurricanes, wildfires, flooding).

Temperature increases lower agricultural harvests and raise health risks.

Example:

The 2021 Texas Winter Storm – Collapse of fossil-fuel-powered energy infrastructure resulted in $195 billion damages.

Policy Recommendations

Governments and companies need to incorporate environmental costs into economic choices.

Incorporating Environmental Costs into National Accounting

Natural Capital Accounting (NCA) should be adopted by governments in order to monitor ecosystem losses.

Green GDP estimates should be complemented by the conventional GDP measures.

Example:

The United Kingdom's Office for National Statistics now incorporates natural capital accounts in economic reports.

Improving Environmental Rules

Enforce more stringent pollution control legislation and sanctions for environmental degradation.

Implement corporate environmental disclosers with standardized disclosure.

Example

The EU's Corporate Sustainability Reporting Directive (CSRD) requires firms to report on their environmental footprint.

Promoting Sustainable Business Practices

Environmental, Social, and Governance (ESG) considerations should be incorporated into business decision-making.

Tax breaks should promote low-carbon technologies and circular economy strategies.

Example:

Clothing retailer Patagonia invests profits in conservation of the environment instead of shareholder dividends.

Public Awareness and Stakeholder Engagement

Support education on sustainability to change consumer behavior.

Engage local communities in environmental policy-making.

Example

Plastic prohibitions in cities such as San Francisco were effective because of rigorous public consciousness campaigns.

Conclusion

The importance of incorporating environmental costs in economic models cannot be overstressed, as failing to account for environmental degradation leads to **misguided policy decisions and unsustainable economic growth**. Conventional GDP-based approaches focus solely on **short-term economic output**, overlooking critical factors such as **resource depletion, pollution, and climate harm**. As a result, these models present a **distorted and incomplete picture** of economic development.

Resource depletion, such as deforestation, water scarcity, and soil degradation, weakens long-term economic stability by reducing agricultural productivity, increasing disaster vulnerability, and driving up the costs of raw materials. Similarly, **pollution**, including air, water, and soil contamination, imposes **hidden economic burdens**, such as rising healthcare expenditures, loss of biodiversity, and decreased labor productivity. Additionally, **climate change-related damage**, such as extreme weather events, coastal erosion, and declining crop yields, further disrupts economies, yet these costs remain unaccounted for in traditional economic indicators.

By failing to factor in these environmental costs, GDP-based models create an **illusion of prosperity** while masking **long-term economic risks**. For example, an economy experiencing rapid industrialization may show **high GDP growth**, but if this growth is achieved at the cost of **deforestation, excessive carbon emissions, and pollution-related diseases**, the overall well-being of society deteriorates. This discrepancy highlights the need for **alternative economic frameworks** that integrate environmental sustainability into national and corporate accounting.

To ensure a **holistic and realistic** measurement of economic progress, policymakers and businesses must adopt **natural capital accounting, carbon pricing mechanisms, and sustainability metrics**. These approaches would enable decision-makers to recognize the true cost of environmental harm and promote policies that balance **economic growth with ecological preservation**, ensuring prosperity for future generations.

Future Research Directions:

Creating global accounting standards for environmental expenses.

Enhancing research on climate risk assessment in economic policy.

Encouraging collaborations between governments, corporations, and civil society to promote sustainable development.

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