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Abstract: Metal cylinders are being phased out in favour of composite LPG cylinders. These cylinders are light, have a pleasing colour and shape, are rust and corrosion resistant, UV resistant, and also 100% explosion proof. The aim of this study is to understand consumer's awareness level and likeliness to shift to composite LPG cylinders. The paper studies the relative strength and weaknesses of composite LPG cylinders in comparison with traditional metal cylinders. This paper provides the opportunity to identify the consumer's needs and to bridge by suggesting technological applications, thus giving an idea to streamline the value chain of LPG cylinder distribution. This study also provides a holistic study of both B2B and B2C segments in the LPG cylinder value chain and thus provides a scope of improving the existing system. The paper will help the business leaders in composite LPG cylinder manufacturing along with cost saving opportunities to the distributors in the long run.

Keywords: type IV composite cylinders; metal LPG cylinder; composite LPG cylinder; composite cylinder pricing; market feasibility; LPG cylinder safety; India.

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1 Introduction

In last few years, there have been a rapid increase in the usage of liquefied petroleum gas (LPG) as a fuel. LPG is a colourless and odourless volatile liquid which can readily evaporate into gas. To keep them in liquefied form, LPG is delivered in pressurised cylinders that are conventionally made up of metallic element like steel. As compared to other lightweight materials, steel makes the cylinder weigh more comparatively. Thus, with advancement of low-density materials material like composites, it is possible to reduce the weight of LPG cylinders.

In contrast to aerospace applications, where component weight reduction is a top priority, reliability/safety, as well as component weight are prioritised in commercial and household applications. So, high-end composite material technology can very well be utilised in the design of residential LPG cylinders, keeping the issue of dependability and weight in mind (Reddy and Prasad, 2016). In case of fire, any pressure vessel constructed of metallic materials may suffer from devastating bursts and can be also hazardous.

Composite LPG cylinders are generally made from helically woven fibres mixed with resin. Their characteristics represent a significant transition to a new generation of technology, moving interesting characteristics such as being 100% recyclable and UV resistant (Wu et al., 2017). The composite cylinder's lighter weight comes in handy in places with weak infrastructure and no public transportation.

The composite LPG cylinder can be used in a variety of settings, including residential, industrial, institutional, and commercial applications. They are used in a variety of industries, including boating, hot air balloons, manufacturing, recreation,

hospitality, agriculture, calefaction, and fishing. However, the most common use of a composite LPG cylinder remains in the kitchen and at home (MarketWatch Inc., 2021).

LPG will replace firewood or kerosene in a number of emerging markets, either as part of a program to avoid deforestation or to minimise illness and deaths caused by pollution and fire accidents. As a result, the new generation of composite cylinders focuses on families, allowing them to work, cook, and sleep in a space where the product's high quality eliminates any chance of explosion (Sharma et al., 2019). In the past few years, the industry has seen LPG consumption declining in developing countries. Effort related to promote the use of LPG gas in other areas through its exceptional energy initiative are being made at different levels of government and industry (Aburi Composites, 2020).

Bandhavi and Rao (2012) conducted a finite element analysis of a composite cylinder and a steel cylinder subjected to internal pressure, concluding that utilising fibre reinforced plastic (FRP) composites, the weight of an LPG cylinder may be reduced by seven times, and the stress values are well within the material's capability. Thus, establishing superiority of composites over conventional steel cylinders. This provides compelling evidence for its usage in domestic settings.

In the process of developing alternative materials for LPG, Ashok and Harikrishna (2013)] conducted elemental analysis of LPG made of steel and FRP composite. The study also gave an insight on how the weight of an LPG cylinder may be significantly reduced by using FRP composites, and the stress values are well within the material's capacity.

Further, for domestic cooking gas cylinder the use of lighter and transparent fibre glass was introduced. Aside from providing maximum strength and safety, composite gas cylinders also provide additional benefits such as non-corrosive construction, high strength weight ratio, low weight, and explosion proof fabrication, making this an obvious alternative cooking gas cylinder. Studies were performed to improve upon this design and thus the multi-layered fibre reinforced composite which withheld optimum fibre orientation were developed (Tripathi et al., 2017).

1.1 Problems faced by consumers with metallic cylinder

The customer faced problem with LPG cylinders due to the following factors:

- *Window for fuel level* – Existing steel cylinders have no reliable way of displaying the rate of fuel consumption.
- *Weight* – The traditional LPG cylinders weigh more and it is difficult to carry from one place to another.
- *Rustiness* – Traditional steel cylinders on being exposed to moisture over time may develop rust and can thus affect the sturdiness of the material of the outer body of the LPG cylinder.
- *Safety* – Traditional cylinders, due to the nature of their material, have higher chances of suffering bursts in case of adverse conditions, which can be hazardous to people and property.

The current LPG active domestic customers in India (as on April 1st 2021) are 2,895 lakhs, which has a significant growth of 3.9% from the previous year and the estimated LPG coverage is 99.8% which growing eventually. The total number of bottling stations of LPG cylinders are 200, which is increased by 2% comparing to the previous year (Petroleum Planning and Analysis Cell, 2021b). The current numbers of LPG distributors are 25,083 which has seen an increase of 1.7% from previous year. Since the inception of LPG and its wide variety of usage, the LPG cylinder took different forms in terms of weight and shape, including the different types of net weight of LPG along with the standard 14.2 kg domestic LPG (Petroleum Planning and Analysis Cell, 2021a). In India, around 14% people consider size of the cylinder as a barrier and the around 30% of households in Odisha and Tripura consider size of the cylinder as a barrier. The other most important factor, irrespective of the end-user nature is the pricing of the LPG cylinders, the composite cylinder costs significantly more compared to the conventional steel LPG cylinders (*Live Mint*, 2016; *Financial Express*, 2017).

1.2 Success stories of composite cylinder in Bangladesh and the Philippines

1.2.1 Bringing innovative LPG solutions to Bangladesh

Beximco LPG Ltd. is a private LPG marketer owned by the Beximco Group, Bangladesh's largest private sector firm with annual revenue in excess of $1 billion (Hexagon Ragasco, 2020). Beximco LPG was charged with creating a fully integrated operational infrastructure to fulfil the country's growing LPG demand. The first firm in Bangladesh to produce composite LPG cylinders for domestic and commercial use in 2016. Beximco termed the new cylinders as Smart CylindersTM. Beximco LPG has established a position in a highly competitive industry with over 25 operators and a network of 300 distributors ensuring retail coverage of over 30,000 outlets serving around 500,000 households per month.

Beximco LPG is the only 100% composite cylinder marketer in Bangladesh. The success is attributed in part to targeted advertising initiatives in print, digital, and television media that preceded the debut and sustained cylinder users' interest. Other activities devised by the corporation to ensure a successful launch include dealer promotions and special authorised dealer conferences, which have increased understanding of the cylinder's user-focused features, such as enhanced safety and lightweight, but most significantly, they improved their technical understanding of the cylinders, which will allow them to manage the items appropriately throughout the logistical chain and deliver exceptional customer support to end users. Furthermore, prior to the COVID-19, Beximco LPG held frequent community events to educate and instruct local LPG consumers about the smart cylinder's benefits and usage requirements. This will remain when the pandemic limitations are lifted. The cylinders are strategically distributed through a dedicated dealer network and all the way down to the end consumers via bicycles with customised mounts, rickshaws, and tuck tucks.

Mrinal Roy, CEO of Beximco LPG, comments: "Since our inception, Hexagon Ragasco, the pioneer in LPG composite cylinder technology, has been our primary strategic supplier. They have allowed us to quickly and securely introduce a paradigm shift in cooking to the Bangladeshi community as a whole. Because of their professionalism, service-oriented attitude, and exceptional product quality, Hexagon Ragasco has become our trusted partner."

Beximco LPG's goal is to improve the life of every LPG user in Bangladesh by providing the safest, smartest, and most convenient LPG solution at all times. They also prioritise environmental protection by promoting LPG as a cleaner energy source for cleaner air and houses, thus conserving the nation's valuable natural resources, such as forests, which would otherwise be depleted due to wood collecting for a growing population.

1.2.2 Safer homes in the Philippines with EC gas

Eastern Petroleum is a Philippine-based privately owned fuel and LPG distributor (Hexagon Ragasco, 2013). The company began in the gasoline market before expanding into wholesale LPG and, eventually, setting foot in retailing LPG to industrial and domestic users. With 20 years of expertise and 20 gas stations throughout the country, the company has concentrated on delivering environmental solutions and expanding entrepreneurial opportunities. Eastern Petroleum debuted Hexagon Ragasco's composite LPG cylinders under the brand name Eastern Composite Gas (EC Gas) in September 2013. Its one-of-a-kind franchise concept aided expansion into domestic LPG distribution with a new product category, bringing safety into Filipino homes. The cylinder supplied to homeowners has a water capacity of 24.5 litres and comes with a choice of two different regulators. The end-user benefits from composite cylinders include safety, lightweight, translucency, and corrosion-free construction. Eastern petroleum's image as an innovative and socially responsible corporation has also been promoted through the EC Gas brand. The cylinders were introduced with a nationwide B2C campaign that included promotions at hand-selected venues, cooking events, a strong presence on social media platforms such as Facebook and YouTube, and television advertisements starring celebrity chefs and the users themselves. The success stories of the EC Gas franchise business are extensively publicised. EC Gas also supply a marketing materials kit to help promote new business in the area. End consumers pay a deposit of around US$91 to obtain their first composite cylinder. They are given a filled cylinder of LPG. Once the gas has been used and the cylinder is empty, the end-user dials a hotline and a new cylinder full of gas is brought directly to their home for a price, usually by a motorbike messenger. EC Gas has approximately 130 stations and distributors in less than two years since its start. EC Gas has become a household name in Filipino kitchens and has transformed the way Filipinos deal with LPG.

1.3 Background and need for research

For composite cylinders different sizes are available for the domestic, commercial and industrial usage as per demand. A scouring of Indian LPG brand 'GoGas' that stepped into composite cylinder business in 2017 gave us an insight of the different sizes of these cylinders available for the market. The size availability of composite LPG cylinders ranges from 2 kg, 5 kg and 10 kg for domestic usage, 20 kg for commercial usage, and composite cylinders weighing 33 kg and 49 kg for industrial purpose usage.

However, there is need to study pricing of composite LPG cylinders which are expected to grow significantly and replace steel cylinders in the market and also study market feasibility of the composite cylinder.

1.4 The decision problem

This study is undertaken to answer the following research questions:

1 How to increase the market share of composite cylinders and to better position itself as a solution to the problems created by the existing metal cylinder?

2 Should the type 4 composite LPG cylinder be introduced in all parts of India?

3 How the product has to be positioned so that the higher pricing can be justified?

2 Methodology

During the research, the primary approach were survey research and focused group approach. In this study stratified random used where various strata is domestic, industrial and commercial segments. To conduct this study, 150 respondents were selected. Questionnaire is used to collect primary data and understand product's market research, people's conception towards LPG usage and composite LPG cylinders. We are concentrating on Indian market we targeted Indian population and framed questions which can be relatable to the people's awareness towards composite LPG cylinder and its development. The questionnaire exclusively made on forms.office.com, focused more on the people's perception towards composite LPG cylinder. The questionnaire was divided into three categories where questions are related to product based, business perspective and market based. The questions that we framed based on the aspects of the LPG cylinders, has been provided to the customers, preceding with the brief visual explanation of composite LPG cylinders.

In this study qualitative data has been collected through focus group method. Under focus group approach used in-depth discussion among the group members, effective data extraction, and devil's advocacy and finally different perspectives were shared for choosing best alternative. In this study feasibility analysis is done using capital budgeting.

3 Data analysis

In this study, questionnaire consists of sixteen questions, extensively framed to source out the information irrespective to nature of the customer. As the majority of population consumes LPG through metal cylinder, this questionnaire framed for the end-user. The end-users classified based on three parameters as domestic, commercial and industrial. To infer the likeness of this factor from the end-user and other types of consumers, the questions have been framed through Likert scale approach. Variables identified through literature. Questions framed based on variables to achieve each objective. To achieve the first objective questions are based on the variables such as customer buying intention, tracking intention, customer acceptance and effect of substitute for collecting data and then these data are being analysed.

Figure 1 Demography of respondents (see online version for colours)

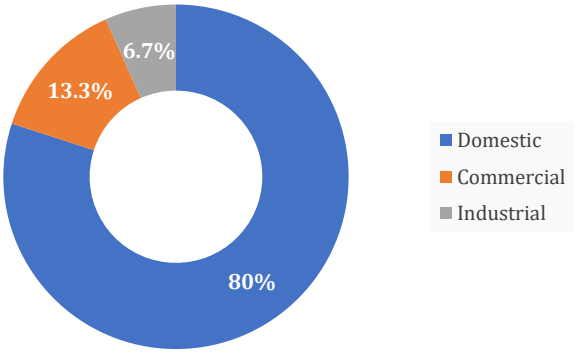
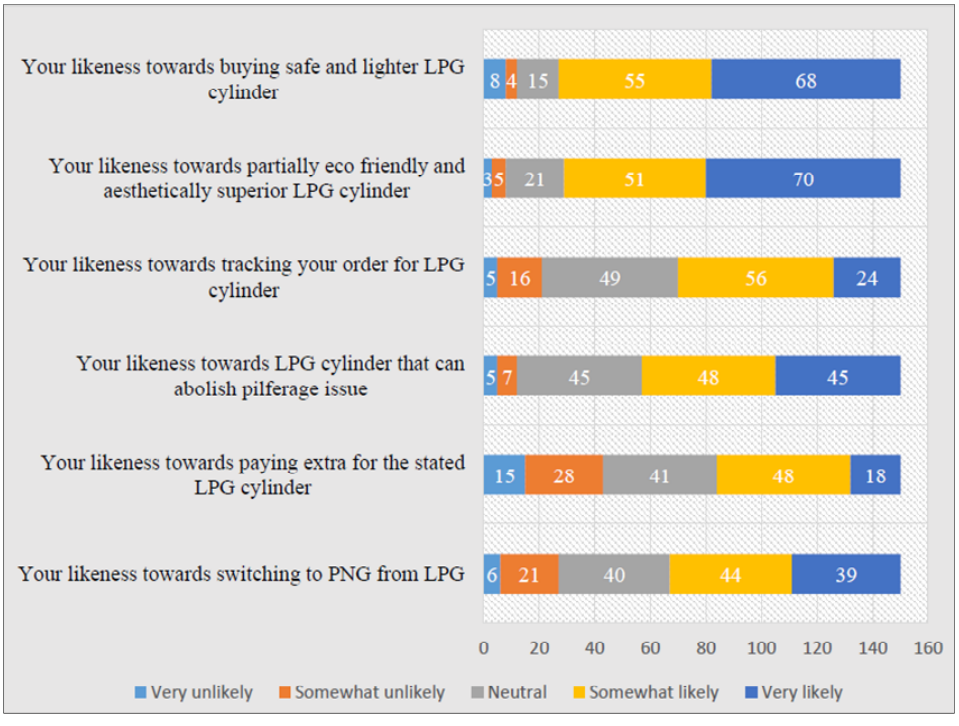


Figure 2 Stack bar graph showing consumer response (see online version for colours)



To achieve the second objective, variables such as safety perception and procurement difficulty used for frame questions.

To achieve the third objective, variables such as consumer acceptance and negative sentiment used for frame questions.

The study shows that out of 150 respondents, 71% are male, and 39% are female. Out of 150 responses, 80% respondents are domestic users, 13.3% are commercial users and rest are industrial users (see Figure 1).

4 Financial modelling

Financial aspects play a major factor in determining the feasibility of a project. To grab the market, the product should not be of superior quality but also cost competitive. Cost does not only involve the monetary cost paid for the product, but also involves time energy and psychic cost which the customer has to pay. Easy availability, quick service, lighter weight and safety features reduces the time, energy and psychic cost for composite LPG cylinders. Moreover, the extra nine years of shelf life makes it superior to the metal counterpart. A comparison is done between metal cylinder and composite cylinder based on selected parameters (see Table 1). The composite LPG cylinders does not only offer savings to the end users but also facilitates cost saving for the bottling and distribution agencies as more cylinders can be stored and transported at same time. This justifies the higher connection cost which the consumer has to bear only one time. To highlight the long-term savings initiated by composite LPG cylinders, the following parameter are taken into account.

Table 1 Parameters for evaluate cost of composite cylinder against metal cylinder

Parameters	*Metal cylinder*	*Composite cylinder*	*Savings per unit for composite cylinder*
Shelf life	16 years	25 years	9 years
Distribution cost for B2B (fuel, delivery man)	-	0.5 times of metal cylinder	50% of that of metal cylinder
Time, energy, psychic cost	-	0.25 times of metal cylinders	75% of that of metal cylinder
Connection cost for domestic use	-	1.25 times that of metal cylinder	–25% of that of metal cylinder

5 Project financial feasibility

The cost estimation reference has been taken from the pre-feasibility report for setting up a LPG bottling plant of 60TMTPA capacity at Jhansi location (Uttar Pradesh for Hindustan Petroleum Corporation Limited, 2017). This estimation will provide an approximate investment required to set up bottling facility for composite LPG cylinder which is similar to that of its metal counterpart (http://www.forestsclearance.nic.in, 2011; http://www.entrepreneurindia.co, 2017). Considering the better shelf life and ease of distribution, the composite cylinders provide a sustainable profitability in the long run.

5.1 Financial modelling

Project at a glance

Capacity = 60 TMTPA (thousand metric tonnes per annum)

Table 2 Total project cost for setting a composite LPG cylinder bottling plant

Cost of project of composite LPG cylinder bottling plant			*In 'lacs INR*
Particulars	*Existing*	*Proposed*	*Total*
Land	0	750	750
Roads	0	835	835
Civil jobs (plant and non-plant buildings)	0	2,129	2,129
Filling/testing equipment	0	1,081	1,081
Equipment/pipe lines	0	749	749
Fire fighting system	0	913	913
Storage vessels	0	1,995	1,995
Electrification	0	833	833
Miscellaneous	0	675	675
Total (including land and land DVPT):	*0*	*9,960*	*9,960*
Owner management @3%	0	276	276
Contingency @3%	0	276	276
Total (incl. OM and contingency)	*0*	*10,512*	*10,512*
IDC cost	0	1,133	1,133
Total project cost	*0*	*11,645*	*11,645*

Note: Cost of investment = 116.45 Crore INR.

5.2 Internal rate of return

From PVIFA table, the corresponding values for 5 years to 19% and 20% rate of interests are 3.058 and 2.991, respectively.

Table 3 Calculation of IRR

Particulars	*In 'lacs INR*
Investment	11,645
Cash inflow for 5 years per annum	3,882
Annuity Factor	2.999742401

Using interpolation method

$$\text{LR} + \text{Difference in rate} \times \left[(\text{LRV} - \text{GV})/\text{LRV} - \text{HRV}\right] \quad \text{IRR} = 19.0115\%$$

6 Pay back period

Investment for the project = 11,645 lacs INR

Calculating depreciation using straight line method = $(11,645 - 0)/5$

$= 2,329$ lacs INR

Table 4 Calculation of payback period

In 'lacs INR

Year	*PBT*	*Depreciation*	*Taxable income (PBT-Dep)*	*Tax (@35%)*	*PAT*	*Cash flow after tax before depreciation (PAT + Dep)*	*Cumulative cash flow*
1	2,500	2,329	171	59.85	111.15	2,440.15	2,440.15
2	2,800	2,329	471	164.85	306.15	2,635.15	5,075.3
3	3,100	2,329	771	269.85	501.15	2,830.15	7,905.45
4	3,400	2,329	1,071	374.85	696.15	3,025.15	10,930.6
5	3,700	2,329	1,371	479.85	891.15	3,220.15	14,150.75

Pay back period = 4.2361536 years = 4 years 3 months

7 Results and discussion

As per the responses received, the majority of the LPG consumers are domestic with 80%, and commercial users holding 13.3% and least being the industrial consumer ranging 6.7%. Similarly, the highest used type of cylinder is 14.2 kg compared to other types of cylinders (i.e., 35 kg, 19 kg, 5 kg, etc.). Around 60% of respondents prefers for ordering monthly and 17% prefers fortnight, proving the high demand of LPG cylinders. The current steel LPG cylinders has significant safety issues, which has the potential of explosion. From the survey, the response is found to be neutral and a sense of dilemma is visible. The traceability of LPG cylinders in India is found to be difficult, as of 2016, in India 61% of unconnected houses are stated about the long duration taken to refill the LPG cylinders. Another important factor is the size and weight, which has shown has 'problem' for most of the respondents. Since the composite LPG cylinder comes with certain essential parameters such as its high in safety and light in weight, ecofriendly made and appealing in terms of visuals and efficient ordering and traceability through technology innovation the questions raised based on these parameters have been positive towards their likeness (Supreme, https://www.supreme.co.in/composite-cylinder.php#). The important factor which determines any sort of product is the price. Considering the vision of India to make the country heading towards gas-based economy, the investments in gas-based projects are increasing and preferably pipeline natural gas (PNG) will be prevailing in future (Mukundan, 2016). Critical infrastructure services face a paradoxical development: society demands higher levels of reliability as we become more reliant on them (De Bruijne et al., 2006), whenever there is a question raised based on this fact to the respondents by ensuring their likeness towards PNG, and 29% of the respondents favours towards PNG but remaining are in the state of puzzle.

Figure 3 Safety perception towards metal LPG cylinder (see online version for colours)

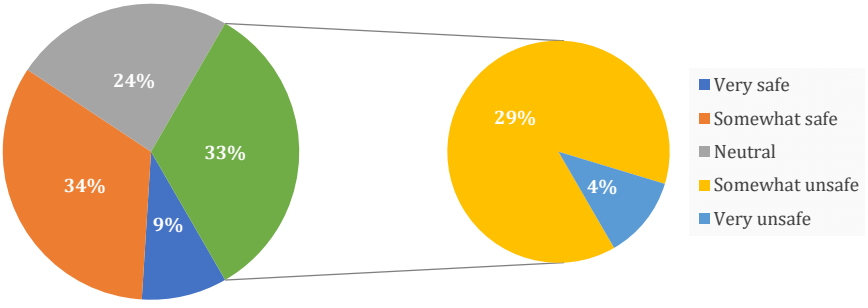


Figure 4 Procurement difficulty of LPG cylinder (see online version for colours)

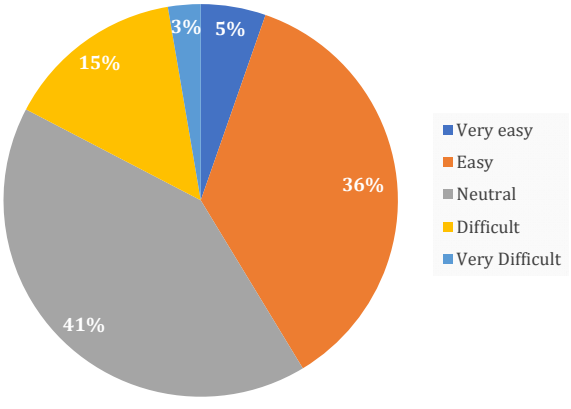
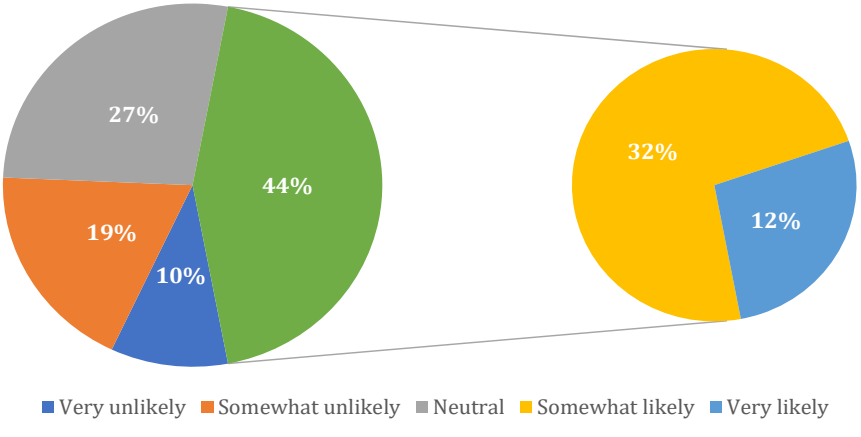


Figure 5 People's likeness towards paying extra for the stated (composite) LPG cylinder (see online version for colours)



It is clear from Figure 3 that the around 34% feels somewhat safe but similar level of response has been recorded under overall unsafety of the conventional cylinder. A sense of balance can be found through this response and showcases the opportunity to bring our product with an efficient counteract through marketing and value chain. As per Figure 4, maximum of 'neutral' option has been responded, which strikes a clear balance of difficulty level. It shows that an advancement in the procurement process will be added advantage both for distributor and customer. The question focuses on the customer's level of procurement in current LPG cylinders. Since the composite LPG cylinder has the capability to make procurement level in easy way due to its technology advancement and physical parameters. The nature of difficulty level of procurement of Current LPG cylinder for the customer or respondents is recorded here. Figure 5 infer a mixed response but maximum number of responses are favour to the payment of Composite LPG cylinder. The composite cylinder comes with an increment in price factor, which might be a deciding factor for the respondents. So, focused on the part whether the customer or respondent's readiness to pay for all the above-mentioned features. It is evident from Figure 6, the response that the people has faced a significant problem towards pilferage and showcases the need for solution through this problem irrespective of their purpose. This question gives an idea about the pilferage issues that has risen up in India. We would like to create an awareness yet to provide a solution through the Composite LPG product. In Figure 6, the question holds a strong response towards likeness of this feature of our product which proves the potential of the product in terms of aesthetic approach plus eco-friendly make. Since our product provides a significant concern towards eco-friendly and our product possess the potential of partial eco-friendly manufacturing along with appealing look. To proceed with this objective for future marketing prospects, we put a question to know the pulse of the people towards these objectives.

From Tables 4 and 5, the IRR of 19.0115% and payback period of four years three months for setting up a LPG bottling plant for composite cylinder makes the project a feasible one to invest in.

Figure 6 Consumer acceptance towards buying an eco-friendly and aesthetically superior LPG (see online version for colours)

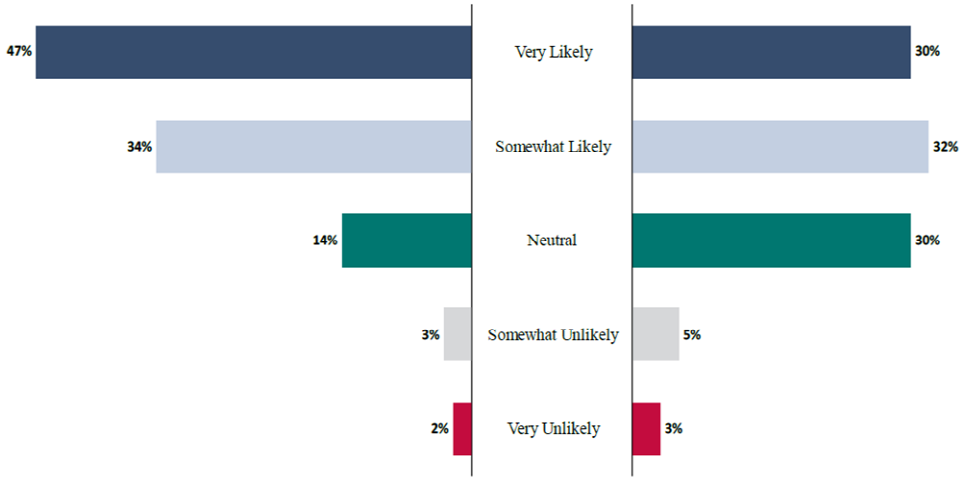


Figure 7 People's likeliness towards single day delivery of LPG cylinder (see online version for colours)

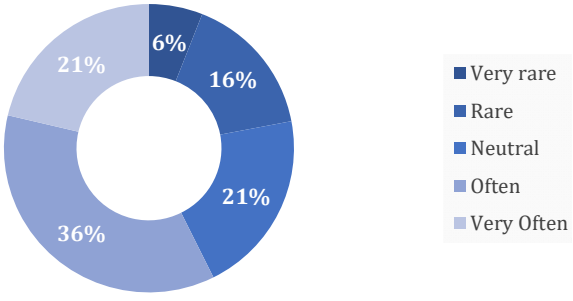


Figure 8 Negative sentiment about size and weight of metal cylinder (see online version for colours)

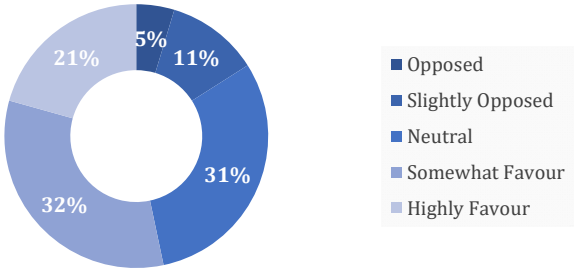
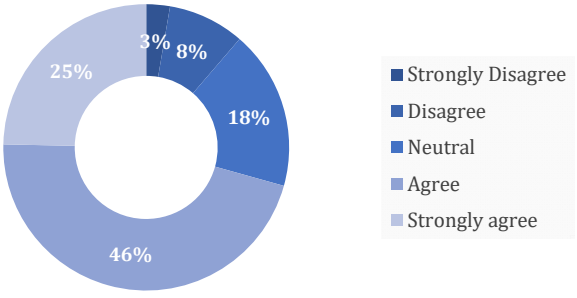


Figure 9 Negative sentiment tracking the LPG level (see online version for colours)



8 Conclusions

The financial modelling portrays the critical success factor for the feasibility and sustainability of setting a bottling plant for LPG composite cylinder. Higher shelf life with lower distribution cost makes composite LPG cylinder a viable product in the Indian market. Savings in terms of time, energy and psychic cost adds to the list of critical success factors of the composite LPG cylinders in Indian market. Seeing the payback and IRR, it is quite profitable to invest in a bottling plant of LPG composite cylinder. The primary goal of this study was to assess the market feasibility of LPG composite cylinder

in India, the short overview is given to understand its benefits, business tactics, and industry characteristics. LPG composite cylinder have the ability to be a viable alternative to conventional cylinders. Based on our market analysis, we believe that LPG composite cylinder will have a bright future in the Indian market due to its explosion aversion characteristics. Blast-proofing, simple processing, and advanced fiberglass technology can help the LPG composite cylinder take root in the Indian industry. In terms of one big issue, high price, we will address it with the assistance of a government subsidiary.

Composite cylinder is an advanced technology-enabled technologies which can also make a substantial contribution to increased protection in the long run and give distributors/consumers other advantages: Composite cylinders have higher mechanical resistance and often transparent (which make the gas level visible), are thinner, explosion-resistant, free of corrosion, can improve security and\ make cooking with LPG more comfortable and simpler for households. In some mature economies, they are being implemented more and more and are being deployed in major emerging markets. Also, government initiatives and schemes like PMUY can create a huge market in India as the government needs to increase the standard of service provided to LPG customers under this program.

9 Future scope

There is a huge opportunity in future to streamline the value chain of composite cylinder. Integration of block chain and radio frequency identification (RFID) will make the ordering and delivery system smarter and faster. This also provides a scope further research. Seeing the tough competition from PNG, it becomes an absolute necessity for LPG distributors to provide better facilities to their customers. So, further developing the composite cylinder can help in holding the market share.

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