

MASTER'S THESIS ACEX30

Closing the Loop —Exploring Circular Business Models for Kitchen Household Appliances

*Master's Thesis in the Master's Programme Quality and
Operations Management*

NISHA DELLI BASKARAN



DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING
CHALMERS UNIVERSITY OF TECHNOLOGY
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NISHA DELLI BASKARAN

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Department of Architecture and Civil Engineering
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Department of Architecture and Civil Engineering
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ABSTRACT

Replacing household appliances very often results in wastage of raw materials and natural resources involved. Circular economy could be a great solution to minimize such wastage in household industry and there are more ways to implement it. Interestingly, the recently trending product service systems seems like a promising enabler of circular economy by enabling multiple users to utilize the complete lifecycle of the product through reuse, refurbishment, remanufacturing and recycling. Although, circular economy is most extensively researched domain, practical aspects are neglected. Hence, this thesis aims to bridge the research gap by exploring and designing a suitable circular business model for the focal company in order to close the loop. Further, it explores new B2B and B2C customer segments for focal company to enable such business model which extends the market share of the organization as well.

The research was initiated by doing a literature study on circular economy business models which highlighted servitization to be a successful enabler of circular economy. Later, an interview study was conducted to provide qualitative data for the research which helped in exploring various dimensions like possibilities, benefits and challenges associated with developing a servitized circular economy business model. Based on the empirical findings and emanated results, three preliminary subscription models were developed for three identified customer segments in order to slow down the resource loop.

Later, a workshop was conducted to gain expert opinions on the developed preliminary models which necessitated customization and hence scenario analysis was conducted for focal B2B customer segments. For further validation on profitability aspect, an economic analysis is done. These lay the groundwork for the upcoming discussion which probe deeper into the various aspects of the proposed business model.

In the conclusion, this thesis successfully developed a new business model for the focal company to keep their first big step towards the path of circular economy. The below mentioned parameters were used as keywords to shortlist literatures and also, the interview questions were framed by keeping these parameters as a base.

Keywords: Product service systems, servitization, circular economy, servitized business models, dishwashers, household appliances industry, closing the loop

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Contents

- ACKNOWLEDGEMENTS..... IV**
- List of Figures VIII**
- List of tables IX**
- List of abbreviations.....X**
- 1. INTRODUCTION.....1**
 - 1.1 Focal company’s background.....2
 - 1.2 Aim3
 - 1.3 Scope and Limitations3
 - 1.4 Research Question.....3
- 2. LITERATURE REVIEW.....4**
 - 2.1 Circular Economy.....4
 - 2.1.1 Basic principles of circular economy6
 - 2.2 Product-service systems6
 - 2.2.1 Servitized Business models7
 - 2.2.2 Usage focused business models9
 - 2.3 Strategy of circular economy business models10
- 3.METHODOLOGY12**
 - 3.1 Research Process12
 - 3.2 Research strategy14
 - 3.2.1 Design research14
 - 3.2.2 Research Approach.....15
 - 3.2.3 Research design15
 - 3.3 Data collection.....15
 - 3.3.1 Literature study.....16
 - 3.3.2 Interview study16
 - 3.3.3 Workshop18

3.4 Data analysis.....	19
3.5 Research Quality	20
3.6 Ethical Considerations.....	21
4. FINDINGS FROM INTERVIEWS	22
4.1 CIK team’s perspectives.....	22
4.1.1 CIK team’s view on circularity in kitchen	22
4.1.2 CIK team’s view on circularity in dishwashers.....	24
4.2 ASKO/ATAG’s Perspectives	24
4.2.1 Introduction of ATAG.....	25
4.2.2 ASKO’s opinion on dishwashers, production and life span.....	25
4.2.3 Interest for circular economy from design perspectives	26
4.2.4 Circularity in household appliance industry.....	26
4.2.5 Incentives for circular economy business model	28
4.2.6 Challenges involved in circular economy	29
4.3 Jemmett’s perspective	31
4.3.1 Significance of circularity in general and business	31
4.3.2 Procurement of dishwashers.....	32
4.3.3 Interest in circular solution for dishwashers.....	32
4.4 Poseidon’s perspectives.....	33
4.4.1 Significance of circularity in business.....	33
4.4.2 Significance of circularity in dishwashers.....	33
4.4.3 Procurement of dishwashers.....	33
4.4.4 Interest in circular solution of dishwashers	34
5. DESIGNING CIRCULAR BUSINESS MODELS.....	35
5.1 Designing a business model	35
5.1.1 Classification of model.....	35
5.1.2 Findings from workshop	36
5.1.3 Existing Customer segments	37
5.1.4 Shortlisting focal customer segments.....	37
5.2 Scenario analysis	37
5.2.1 Pricing.....	38

5.2.2 Subscription rate for new appliances.....	38
5.2.3 Customer segments considered for the scenario analysis	40
Scenario analysis	46
5.3 Economic analysis based on scenarios.....	48
6. DISCUSSION.....	51
6.1 Circular design of dishwashers.....	51
6.2 Development of business models	52
6.3 Scope of refurbished appliances.....	53
6.4 Economic analysis of business models under different scenarios	53
7. CONCLUSION	55
7.1 Managerial Recommendations	56
7.1.1 Short term recommendations.....	56
7.1.2 Long term recommendations.....	57
7.2 Future Research	57
REFERENCES	58
Appendices	i
Appendix 1	i
Appendix 2	iii
Appendix 3	vii

List of Figures

Figure 3.1	Flowchart of research process	13
Figure 3.2	Data analysis process	20
Figure 4.1	SWOT Analysis for ASKO	30

List of tables

Table 2.1	Classification of product-service systems adapted from Tukker (2004)	8
Table 3.1	Details of Interviewees	17
Table 3.2	Details of workshop participants	18
Table 5.1	Classification of models	35
Table 5.2	Expenses for owning 100 new ASKO dishwashers under scenario 1	41
Table 5.3	Cumulative subscription rate for 100 new ASKO dishwashers under scenario 2	43
Table 5.4	Expenses for owning 100 refurbished ASKO dishwashers under scenario 3	44
Table 5.5	Cumulative subscription rate for 100 refurbished dishwashers under scenario	44
Table 5.6	Savings obtained in all scenarios for 100 years	47
Table 5.7	Expenses incurred in all scenarios for 100 years	48
Table 5.8	Least expensive variant and business model	49
Table 5.9	Most profitable variant and business model	49

List of abbreviations

CE	–	Circular economy
CEBM	–	Circular Economy Business model
EU	–	European Union
CEAP	–	Circular Economy Action plan
UN	–	United Nations
SDG	–	Sustainability Development Goals
PSS	–	Product-Service Systems

1. INTRODUCTION

In the recent times, circular economy paradigm is becoming popular among the academic researchers and industry experts all over the world in order to overcome the drawbacks of linear business model (Dokter et al., 2021). Sweden, being an EU country is more attuned to innovation and digitalization, and hence it is a necessity for Sweden to pursue the transition process from a linear to circular economy abiding to achieve EU's sustainable development goals by the year of 2030.

This is in line with European Union's "The 7th Environment Action programme" (EAP). The key objective of EAP is to promote a resource efficient economy by protecting the natural capital through reduced consumption of natural resources (European Commission, n.d.).

As mentioned in Government Offices of Sweden (n.d.), "Two-thirds of Swedes' emissions come from households, while investments and public consumption account for the remaining third" clearly highlights the significance of reducing emissions from households in order to accomplish the climate objectives of EU. Thus, realizing the potential of resource effectiveness and circular economy in contributing a prosperous future for the planet, Sweden has initiated several research projects to introduce circularity in various industrial sectors (Royal Swedish Academy of Engineering Sciences, n.d.).

Bressanelli et al. (2020) accentuates the effectiveness of circular economy in decoupling economic growth from detrimental environmental impact made by the current business. Though circular economy is oriented towards having a "preventive and regenerative eco- industrial development" with broad spectrum of triple bottom line demanding radical design alternatives enabled by innovative concepts with innovative actors but it is limited to pure waste management techniques in reality which might not be suitable for all contexts (Ghisellini et al., 2016).

Hence, Hagejard et al. (2020) emphasizes the need for combining several design strategies in order to develop a suitable circular business model for industries to overcome the negative environmental impact of linear business model. As the traditional business models are linear in nature and predominantly follows a "take, make and dispose" approach resulting in more wastage of raw materials and natural resources (Ness, 2008). Three strategies identified by Bocken et al. (2019) for developing a circular economy deals with slowing, narrowing and closing the resource loops.

This is aligned with 3R's principles namely Reduction, Reuse and Recycling as highlighted by Ghisellini et al. (2016). Reduction is intended to reduce the consumption of raw materials and waste generation by achieving "eco-efficiency" in the production process as explained by Feng and Yan (2007) and Su et al.(2013).

Reduction concerns economic and environmental aspects without focusing on social perspectives. The second principle of reuse is intended to use the products and materials multiple times before sending it to trash and hence reusable products are designed with durability to contribute to longer lifespan (Stahel, 2014) and (Ghisellini et al., 2016).

The first two principles of reduction and reuse minimizes and postpones the waste generation whereas the last principle of recycling involves converting the waste back into the raw materials

and intended to be reused for production. But this should be the last resort for industries as recycling is least feasible and sustainable solution with its due limitations according to Stahel (2013). To attain climate neutrality with long term competitive advantage for industries, European Union promotes a “deep, systemic and transformative” approach of circular economy underlining the triple bottom line of sustainability (European Union, 2022).

From social perspective, circular economy has increased the employment rate by 5% globally which would be 4 million jobs providing necessary skills for global green transition. From economic and environmental perspective, circularity contributes to more value through material savings and effective waste management impacting different industries to focus on developing sustainable value chains.

Various guidelines have been designed by EU to enhance circularity in industries from all possible aspects like improving resource efficiency, increasing recyclable content of materials, reducing carbon footprints, reducing the products intended for single use, promoting product-service systems and rewarding the sustainability performance.

Though many key actors are interested in pursuing circular approach, there are certain technical and market barriers concerning the design of circular product which limits the current industries to initiate a circular business model as highlighted by Ghisellini et al. (2016). Further, a non-modular product design limits the possibilities of refurbishing and recycling products. In addition, poor quality of materials used in production, less preference on reusing products, less infrastructure and high costs of repair services contributes to more challenges which prevents industries from transitioning to circular business models (European Environmental Bureau, 2017).

Ollar et al. (2022) explains the impact of linear operations of multi-residential construction towards the rise in carbon footprints and waste production and proposed certain spatial key characteristics to improve adaptive capacity and propose circular design of kitchens. Notably, Kitchen appliances and furniture bear a great impact on environment and climate due to their high energy consumption, user behavior and premature alterations and renovations as put forth by Hagejard et al. (2020). These factors necessitate the increasing demand for circular business models for kitchen and household appliances industry.

Lewandowski (2016) presents a detailed classification of circular business models under two major themes of regeneration and sharing, which covers upstream and downstream of the product. Regeneration focuses on upstream concerning utilizing renewable energy and recovery in production, choosing sustainable product locations and circular supplies through sharing chemicals whereas sharing focus predominantly on downstream by introducing product-service systems at the customer end.

Product-service systems could be a key enabler in developing a circular business model as highlighted by Tukker (2004) in household appliance industry and hence this research focus on enabling a circular business model via product-service systems.

1.1 Focal company's background

Focal entity here is ASKO, a globally recognized Scandinavian household appliance brand established in 1950. ASKO has its Research and development team based in Lidköping, Sweden. Their production facilities are located in Slovenia and distribution is done from Denmark. ASKO has their markets in 50 plus countries in Europe, North America, South America, Australia,

Asia, and Middle east. ASKO appliances is currently owned by a Slovenian company Gorenje group, a part of Chinese brand Hisense. ASKO is known for their first-class, high-quality products which were tested 20 years of household consumption. Their mission is to develop sustainable, environmentally friendly, and long-lasting products and hence ASKO is one among the water and energy saving white goods in Europe (ASKO, 2022).

1.2 Aim

This thesis aims to explore various circular business models and design a suitable business model for the kitchen and household appliances industry and specifically for ASKO in order to facilitate their transition from linear to circular economy. Further, it will explore the potential of refurbished products in promoting circular economy.

1.3 Scope and Limitations

The scope of this research is narrowed down to design a suitable circular economy business model for focal product dishwasher with selected customer segments. Considering the time frame of the research, this project is limited to dishwasher as focal product and other white goods were not considered for the research. Supply chain was also not considered. Further, closed loop supply chains will not be the prime focus of the study since slowing down the resource loop is considered more appropriate for the focal entity's product.

Further, this research will not delve deeper into the life cycle assessment of focal products. This research is based upon an organization located in Scandinavia and hence it might not address other geographical areas. Further, two potential customer segments were focused and remaining customer segments were not considered. One other constraint could be due to case study research design which limits the researcher's ability to generalize to other contexts without further research.

1.4 Research Question

- 1) *What could be the suitable business model for dishwashers to enable a circular economy?*
- 2) *What would be the stakeholder's general perspective on circular economy?*

2. LITERATURE REVIEW

This section on literature review provides the theoretical background of the key concepts highlighted in this research. First, an overview of circular economy is provided. Then, the concept of product-service systems is introduced in relation to the strategies used to devise circular economy business models. This lays down the foundation for the upcoming empirical study.

Bell et al. (2019) explain that the purpose of literature review is to enhance the reliability of the research study by gaining understanding on the previous finding through reviewing relevant literature articles and generating knowledge.

2.1 Circular Economy

This section entails the origin and principles of circular economy and plots the journey on how it gained such phenomenal significance over the years. Further, this section focuses on approach of key actors in implementing circular economy by analyzing the multiple dimensions associated with circularity.

Though the concept of circular economy has different schools of thought, it emanated from ecological economism and environmental economism as per Boulding (1966) and Pearce and Turner (1989). Around the 1960's with the improved globalization in industries, popular economists associated environmental pollution and resource scarcity as a consequence of economic growth centered around some specific industries and decided to counteract the depletion of natural resources with a technocentric approach (Pearce and Turner, 1989).

Frishammar and Parida (2019) agrees that the paramount focus of industries on their financial returns has been a major cause of various environmental problems and hence many incumbent firms started emphasizing sustainability in their business objectives. According to Ghisellini et al. (2016) the goal of circular economy is to evoke an effective decoupling between economic progress and resource consumption and thus Ellen MacArthur Foundation (2012) promotes industries to analyze the benefits of circular economy from diverse economic, environmental, technological political, social and business perspectives.

Circular economy has gained more importance in recent years especially after 2015 when the European Union devised its circular economy action plan in order to create a sustainable economy and adopted CEAP in 2020 which has become a prime focus in the European green deal, and this is further linked to the EU's goal of climate neutrality within the year 2050 (European Commission, 2020).

This is in line with the sustainable development goals developed by the United Nations for climate action and specifically goal 13 necessitates that post COVID- 19 could be the perfect time to initiate the systemic change in order to enable green transition after witnessing the sharp decrease in the level of greenhouse gases during the COVID times in 2020 than 2019 (United Nations, 2022).

Further, UN's Sustainable development goal called "sustainable production and consumption" promotes dematerialization by minimizing the consumption of natural resources to reduce carbon

emissions and thereby boosting economic growth (United Nations, 2022).

Though globalization and industrialization are imposing exploitation of limited natural resources, policy makers like the European Union and United Nations are interested in implementing circular economy as an enabler for sustainable economic and environmental progress. According to Ghissellini et al. (2016), though circular economic practices are said to be worldwide, most of them lies in their initial phases assuming circular economy as an equivalent to sustainability and spend their efforts towards recycling and waste management rather than to reuse the product in order to close the resource loop (Sallerström et al., 2022).

Although, EU's circular economy embrace has created a boost for recycling industry through its policies and actions, Friant and Vermeulen (2021) asserts that they are interpreted with different perspectives by industries with varying degrees of social, ecological, and political transformations and consequently provided a critical analysis of EU's circularity discourse and further suggest industries to take up a more holistic approach in order to get a tangible change which is agreed by most CE practitioners.

Meanwhile, Kirchherr et al. (2017) defines circular economy as an economic system that replaces the 'end-of-life' concept with techniques like reduction, reuse, recycle to recover materials from consumption and use it back in production. It operates at three levels with the aim to accomplish sustainable development, thus simultaneously boosting the quality of environment, financial and social conditions thereby developing opportunistic future with propitious current circumstances.

This is in line with the classification of circular economy into three levels, proposed as indicators for measurement purpose as per Heidi & Mette (2019). Micro level focuses on circularity for either a product or single firm whereas meso level focuses on industrial level and finally macro level focuses on regional or national or global level. Since this thesis focuses upon circularity in dishwashers within a single company, it would come under micro level.

Bressanelli et al. (2018) states that CE can be implemented either top down where it is driven by regulations and legislations and bottom up where it is driven by gathering single economic actors towards economic benefits. Various studies have been made on the economic prospects of the circular economy to trigger industries to step into circularity.

One significant article by Lewandowski (2016) affirms that major global companies like Renault, Unilever, Google etc., from countries like Europe, Japan and US took the bottom-up approach and went forward in making a transition from the current linear economy to circular economy in order to unleash the immense financial, social and environmental benefits. Meanwhile, Ghisellini et al. (2016) illustrates that China could be the perfect example for initiating macro level circularity with the top-down approach.

There are various articles that highlight the relationship between sustainability and circular economy. Though circularity is seen as a subset of sustainability, most of the existing research on circularity focus only on the environmental aspects of sustainability rather than taking up a holistic approach ignoring the economic and social dimensions. Though few authors contributed to highlight the social dimension of circularity, it is limited to the employment perspectives and no clarity on social wellbeing through sharing resources is provided. With the economic perspectives, it mostly focuses upon the individual progress with short term results, but sustainability is oriented to long term effects (Geissdoerfer et al., 2017).

However, there are limitations associated with both strategies of sustainability and circularity, since they have only quantitative targets to increase recycling rates. But this increased recycling rate can cause the recirculation of micropollutants into the product cycle which can be hazardous to human health. One other notable limitation of circular economy in general could be its policy on zero waste since some materials cannot be recycled and reused many times due to its limited lifecycle. Meanwhile, slowing the resource loop by extending lifetime of products may adversely impact the market of replacement products. It can also impact innovation since reusing existing products can counteract new product development and digitalization involved (Energy & Utilities Alliance, n.d.).

2.1.1 Basic principles of circular economy

According to Ellen MacArthur Foundation (2022), circular product design is associated with three basic principles namely waste elimination, products and material circulation and regeneration of nature. The first principle highlights the drawbacks associated with the current linear economy based on “take-make-waste” system. This is in line with Lewandowski (2016) who affirms that the transition from linear to circular economy cannot only reduce the environmental degradation but can bring immense economic progress by saving a lot of money to EU especially.

In linear economy, valuable raw materials are utilized for product creation and those products ends up in landfill as waste at the end of life. Further, linear economy cannot work in long run since our planet has only finite resources. So, it necessitates circular design of products so that the materials used in the product can reenter the economy even after the product’s life. Various process like recycling, reuse, remanufacturing, and refurbishing can help the product become more circular and hence more focus on upstream is essential (Ellen Mac Arthur foundation, 2022).

The second principle demands the need for maximum circulation of products and materials through both technical and biodegradable cycle so that nothing ends up as waste. Technical cycle deals with extending the lifecycle of product whereas biodegradable cycle deals with reverse flow of material back to earth through composting and anaerobic digestion (Ellen Mac Arthur foundation, 2022).

Ellen MacArthur foundation (2022) ascertains that to enable effective technical cycle, servitized business models initiate lifecycle expansion through product sharing by multiple users. Sometimes, maintenance, repair and refurbishment are required to maximize the product life cycle during resale in order to enable reuse of product. Once the product cannot be used no longer, then components can be remanufactured which insists the need for modular design which enables effective decoupling between components.

Recycling is the last resort to extend the material life in the economy without being end up as waste. The third principle explains the regenerative ability of natural systems and affirms that benefits of circular economy is three-fold covering economic, health and environmental aspects. For example, if food industry practice circular economy, it can save up to 2.7 trillion USD annually and further reduce greenhouse emissions to half by 2050 (Ellen MacArthur foundation, 2022).

2.2 Product-service systems

This section on product-service systems highlighted the significance it gained over the years and compares product-service systems with servitization to know the actual difference between these two commonly used terms by defining and explaining both concepts.

McAloone et al. (2017) highlighted the significance of product-service systems for companies to enable a transition towards circular economy which helps in addressing the environmental issues concerning product development. In one way or other, companies are forced to take up more efforts towards sustainability and in the process of becoming more sustainable, the company might be required to change its entire business model (Seroka-stolka et al., 2017).

Batiles-dela Fuente et al. (2021) explained the evolution of product-service systems in sustainable product development has been analyzed for 3 decades from 1990 to 2020 to affirm that product-service systems can be a great way to achieve competitiveness and high environmental performance with the help of dematerialization and new business models. Very often, product-service systems is compared with servitization as they both have similar goals, drivers and motivation while they differ with the perception of results (Kryvinska et al., 2014).

Product-service systems can also be considered as a subset of servitization and to get a clear picture of both, it is vital to know the difference between products and services. Goedkoop et al. (1999) provides the following definitions for product, service, systems and for product-service systems.

Product is defined as “*a tangible commodity manufactured to be sold. It is capable of falling onto your toes and of fulfilling a user’s need*”. While service is defined as “*an activity done for others with an economic value and often done on a commercial basis*”. System is defined as “*a collection of elements including their relations*”. Hence, a Product-service system can be defined as “*a marketable set of products and services capable of jointly fulfilling a user’s need*”

This is in line with the interpretation of PSS as per Kryvinska et al. (2014) where products provide value and additional services adds up costs. And on adding up carefully chosen product related services to such combination provides unique and distinct value to the final offering and thereby gains competitive advantage. But PSS is evolved into servitization once when the product manufacturer transforms into a service provider and hence Baines et al. (2009a) defines servitization as “*the innovation of an organization’s capabilities and processes to better create mutual value through a shift from selling products to selling PSS*”.

In simple terms as per Baines et al. (2009b), Servitization refers to a process of value creation by adding services to products in order to gain competitiveness, companies use such value adding capabilities that are unique, sustainable, and inimitable. Vandermerwe and Rada (1988) define servitization as “*the increased offering of fuller market packages or “bundles” of customer focused combinations of goods, services, support, self-service, and knowledge in order to add value to core product offerings*”. Further, Wise and Baumgartner (1999) affirms that more western manufacturers focus on services to attain economic gains and are ready to go downstream i.e., towards customers. Rolls Royce’s business model of Total care is one significant example of PSS.

2.2.1 Servitized Business models

This section on servitized business model explains the classification of product-service systems business models and gives a special focus on usage focused business model as a potential enabler of circular economy in this subject area. Further, three value drivers of circular economy are presented and a framework has been conceptualized to map these value drivers with eight functionalities of product-service systems in order to show the potential results of integrating both concepts.

Tokarz et al. (2022) presented a holistic approach of methods and tools for developing a product-

service system by explaining the benefits associated such as competitive advantage, enhanced social and economic performance. According to Tukker A (2004), PSS Business models can be classified into three types. They are Product focused business models, usage focused business models and result focused business models. These 3 categories are further classified into eight archetypal PSS models which are explained in the table below.

Table 2.1 Classification of product-service systems adapted from Tukker (2004)

Product focused	Usage focused	Result focused
Product related services	Leasing	Activity management
Advice and consultancy	Renting or sharing	Pay per service unit
	Product pooling	Functional result

In product focused business models, the product is sold to the customer in a single event and hence the ownership is transferred to the customer. Hence, companies do not hold any responsibility for product lifecycle. The three CE drivers are rarely achieved here as the company generates revenue here in one-time sales of the product. Product related services like maintenance contract and consultancy services are examples of product focused business models (Tukker, 2004).

In usage focused business models, the product is of prime focus but unlike the product focused business models, the ownership of the product is not transferred to the customer instead he pays a fee to gain access to it. Further, the product is available in many different forms and can have multiple users. Leasing, renting, sharing, and pooling could be some examples of usage focused business models as per Tukker (2004). Whereas in result focused BMs, there is an agreement between the provider and the user to achieve a specific result without involving a particular product. Some examples could be activity management, outsourcing, pay per service, functional result. Though this is the most effective enabler of circular economy, there are some difficulties associated with performance measurement (Tukker, 2004).

The above classification by Tukker (2004) is widely cited and researched along with dynamic business trends. In addition to this, Bressanelli et al. (2018) states that digital technologies such as Internet of Things, Big Data and analytics possess high potential to introduce servitization in the business in order to implement circular economy. A framework has been suggested to integrate the servitized business models with circular economy. Eight functionalities have been presented that vary across the two dimensions. Those two dimensions are circular economy value drivers and servitized business model types.

The three value drivers of circular economy are increasing resource efficiency, extending lifespan and closing the loop. The eight functionalities mentioned were improving product design, attracting target customers, monitoring, and tracking product activity, providing technical support, providing preventive and predictive maintenance, optimizing the product usage, upgrading the product and enhancing renovation and end-of-life activities (Bressanelli et al., 2018).

Bressanelli et al. (2018) explains that product focused business models were not intended to increase resource efficiency and close the loop, but lifespan can be extended through attractive after sales services package which can include free maintenance and repair services throughout the period covered by warranties and guarantees. But the main demerit associated with this business model is it follows linear economy where the company’s intention is to maximize product sales

which leads to increased production of products thereby increased utilization of raw materials which results in more wastage of products and natural resources involved.

Whereas in usage focused business model, Bressanelli et al. (2018) highlights that it increases the resource efficiency by enabling product sharing among users. It extends the product lifespan by providing extra services such as extended warranties, predictive maintenance, and repair services. Further, it gives special focus on the design part to produce long lasting and easy to upgrade products. But the demerit could be that user may exhibit careless behavior while using the product as he doesn't own the product anymore which leads to quick wear and tear of products. Lat but not least, this closes the resource loop by take back agreement as the product is already designed for closing the loop. Result focused business model shares same features as the usage focused business models in contributing to three value drivers of circular economy, but the demerit associated with this could be difficulty in attaining agreement between customer and supplier as it would be complicated to measure results in case of product-service systems (Bressanelli et al., 2018).

Hence, according to Bressanelli et al. (2018), though each business model comes with its own demerit, usage focused and result focused business models seems to be great enablers of circular economy as they contribute to three value drivers of circular economy more than the traditional product focused business models.

2.2.2 Usage focused business models

This section on usage focused business models covers the challenges involved in usage focused business models in the perspective of economic aspects and comes up with a solution of integrating such usage focused business models with refurbishment to tackle economic problems and achieve environmental progress.

Tukker (2004) explains the environmental benefits of subscription models since the usage phase is more extensive but at the same time the challenges are associated with the production stage. Since the design of usage focused business models possess high intangible value and low tangible value, there could not be a major growth in market share commercially since it is offered towards the same population who prefers such usage models as desirable alternative options to owning the product.

Mont et al., (2006) acknowledges the darker side of PSS that it focuses too much on qualitative triple bottom line of sustainability and neglects the economic aspects of it. Further, there could be difficulties in tracking the profits in such business models which may complicate financial reporting require a major change in financial systems. It can bring more costs to the manufacturer since such models encompass reverse logistics, where the product has to be taken back by manufacturer at the end of life where the logistics cost can be more.

Though the levels of remanufacturing and refurbishments vary with the product and its usage, the process of manufacturing is technically feasible as it does require no new process and inputs. Therefore, all these considerations would pose great demand on designers to enable reduction in cost, time and effort required to recondition the products. To put simply, the designer has to invest in more durable raw materials which are expensive than highly available cheaper alternatives that are easily damaged with the usage. But this must be considered like one-time investment which improves the longevity of the product.

However, the concept of circular economy is gaining attention especially in energy consuming

products such as household appliances and hence refurbishments and servitized business models such as pay per use are seen as alternatives to the make-buy-discard approach of linear economy. Bressanelli et al. (2022) disclose that both pay per use and refurbishment models contribute to environmental savings significantly but only refurbishment generates economic savings for end users in case of washing machines. This article also suggests refurbished products can be targeted towards young consumers who are less affected by bias whereas for pay per use schemes should promote its environmental benefits.

2.3 Strategy of circular economy business models

This section covers the different strategic approach taken by industries to enable circular economy and highlights the significance of design phase in product development to create a circular product.

Several articles came up with different strategies to enable a circular business model in business. Bocken et al. (2021) illustrated two strategic choices. One is resource strategy, and the other is innovation strategy. Resource strategy is concerned with the flow of natural resources in the production and after usage of products and further classified into three strategies. They are narrowing the loop, closing the loop and slowing the loop.

Narrowing the resource loop refers to efficient utilization of natural resources through reducing their usage. This is already on par with a linear economy where resources are effectively utilized in order to reduce the production cost. Slowing the loop refers to extending the life cycle of the product by increasing the durability of the product which enables slowing down the resource flow. Closing the loop refers to the recycling process where resources are sent back to the flow with the help of end-of-life strategies such as reverse logistics and remanufacturing. These strategies are identified as an important component in the destination of PSS after use (Tokarz et al., 2021).

Furthermore, this is in line with Stahel (1994), which explains the difference between two approaches i.e., reuse and recycle. The reuse of goods is concerned with product lifecycle extension through increasing quality of raw materials used, increasing maintenance and repair, reconditioning and upgrading. Whereas recycling refers to closing the loop by bridging the resource gap between production and post use. The former makes an impact on speed of resources in the flow whereas the latter doesn't. This is in line with three strategies of circular business model as explained by (Bocken et al., 2021).

Innovation strategy can be classified based on the openness of the development in business model to be open innovation strategy and closed innovation strategy. Closed innovation strategy deals with involving circularity within the firm's boundaries and hence it can be controlled by the company easily. Some examples could be designing long lasting products, recycling and reuse of products to enhance the resource efficiency. In case of open innovation strategy, Companies collaborate with external actors i.e., actors outside the company like stakeholders, customers, retail sellers, secondhand markets etc., where the company does not have control unlike closed innovation strategy (Bocken et al., 2021).

Bocken et al. (2015) comes up with a framework to address the challenges faced by CE practitioners in the transition process from linear economy to circular economy by adding innovation to the above strategies. It is done so by making a distinction between strategies for circular product and circular business models. As circular product is more concerned with the designers and circular business models are more relevant to strategic team of organization.

Circular product design can be enabled through either designing a long-life product or designing for product life extension. The former is done by ensuring reliability, physical and emotional durability. Reliability is more like an assuring that the product will not experience failure for the specified time period if it is used as per usage manual provided by the manufacturer. Physical durability is concerned with the usage of corrosion resistant materials. Emotional durability according to Chapman (2005) is more concerned with behavioral aspects of end users towards the product. This is enabled by developing a long-lasting partnership or resilient relationship between end user and the product which consequently reduce the consumption and waste of natural resources (Bocken et al., 2015).

Circular economy can make a great impact on current business models for product-focused industries and can make them turn towards servitization like leasing, renting and subscriptions etc., (Tunn et al., 2019). Though there are some challenges associated with CE like complex trade-offs and synergies between climate change, biodiversity and resource scarcity addressed by Friant and Vermeulen (2021), they need to be researched. When it comes to circular design of the products, majority of the existing literature were written up revolving only the technical aspects without much consideration towards user's behaviors and usage patterns (Wastling et al., 2018).

Friant and Vermeulen (2021) analyzed that there are various definitions and explanations provided for circular economy by academia, practitioners and legislations and they are interpreted in different ways by different actors. But this thesis takes up the below definition of circular economy.

Bressanelli et al. (2021) defines CE as “economic system restorative and regenerative by design, implemented by one or more supply chain actors through one or more levers and enablers (circular product design, servitized business models, supply chain management and digital 4.0 technologies) to replace the end of life concept with reduce, reuse, remanufactured or recycle materials, components and products in production, distribution and consumption processes for both technical and biological cycles, with the aim to accomplish sustainable development” . This master thesis takes up the first two steps under consideration, i.e., circular product design and servitized business model.

3.METHODOLOGY

This chapter on methodology entails the “how” part of answering the research question of this thesis. The overall research process is presented first, and selected research strategy and approach is explained with supporting factors. Further, data collection and data analysis processes are explained in detail followed by highlighting the research quality of this thesis.

3.1 Research Process

This master thesis has been carried out in collaboration with a research project called CIK - The Circular Kitchen 1.0 (Chalmers) in which basic research and a first prototype for a more circular kitchen furniture has been developed and the follow up project CIK 2.0 from prototype to implementation (Chalmers). The CIK project is the collaboration between several industry partners, kitchen producers, housing developers and material producers. In this thesis, Jemmett a housing developer with a higher profile for sustainability and ASKO/ATAG are CIK partners that has been part of the study.

The goal of circular kitchen is based on creating replaceable modules and reusing them later by collecting them together. CIK takes up a more holistic approach of circular economy and thus ensures circularity in end-to-end processes which is denoted by its three key pillars namely, circular product design, a circular supply chain and circular business model. The circular kitchen is based on a plug and play model designed based on the technical and aesthetical product lifespan. Co-creation workshops were conducted to assess and obtain feedbacks on prototypes of circular kitchen and ensures the progress of creating a market ready circular kitchen within four years (TU Delft, 2022).

The research process in this thesis was initiated by a meeting with the circular kitchen team and business partners was conducted which gave potential contacts of experts for the study and a preliminary planning was made for the research. Further, an intensive literature study was carried out which gave great insights on circular economy, servitized business models, kitchen and household appliances industry. This kickstarted the work of preparing questionnaires for a qualitative interview. A semi-structured interview approach with few members from CIK team gave the background of the research question and enhanced the scope of literature study. This is followed by interviews with professionals from partner company ATAG who showed the industrial interest in developing circular business model and highlighted the potential demand of such business model in Netherlands.

Industrial visit to the focal company ASKO and interview with Innovation and Development manager from ASKO gave great insights on the background of focal company and focal product dishwasher which helped in developing a draft business model -Version 1. Further, a group discussion with key employees from product management team and project guide from focal company helped selecting the customer segments and the draft model was updated to Version 2.

Following interviews with representatives from Jemmett AB and Bostads AB Poseidon gave great insights on economic benefits of such business models in B2B customer segments. In this case, rental housing companies were identified as key customer segment. Jemmett is a recently started housing company with the ambition to build, own and manage rental apartments in Southern

Sweden. They have several on-going projects but none is yet realized. Bostads AB Poseidon (from now on called as Poseidon) is a municipally owned housing companies that owns and manages 28000 rental apartments in Gothenburg. Poseidon does not build new housing themselves but owns, maintains and rents out existing apartments. An economic analysis was further performed and updated model - Version 3 was developed. A scenario analysis was performed and a workshop with key members from CIK team was conducted to gain feedback on the developed model. Later, the final model was proposed based on the feedback obtained. Figure 4.1 illustrates a flowchart for the research process for this thesis work.

The flowchart of this research process will detail on the various phases of this thesis starting from the meeting the CIK team and developing a successful business model for two potential customers who were key partners of the CIK team.

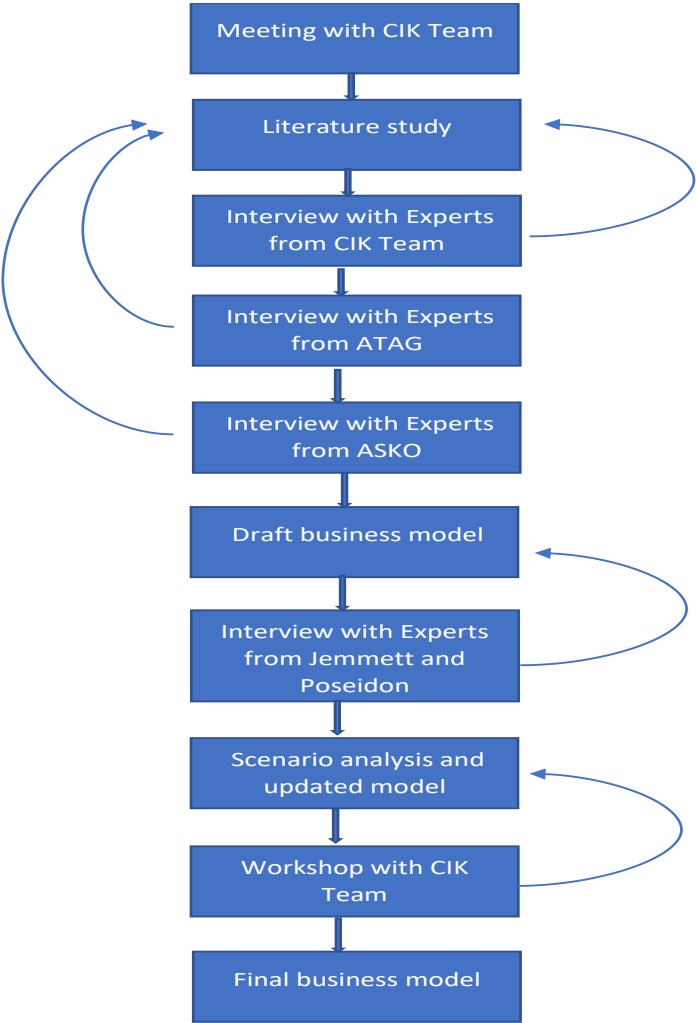


Figure 3.1 - Flowchart of research process

3.2 Research strategy

Research strategy is the overall approach taken to exhibit relation between existing theory and collected data in the research project. Research strategy is of two types, quantitative and qualitative. Generally, qualitative research strategy is chosen by researchers to gain rich and deep understanding of contexts of the research subject. Since this project deals with designing and exploring circular business models, this research demands extensive knowledge on the subject areas of circular economy and servitization under the context of household appliances industry. This is the main factor for choosing the qualitative research strategy (Bell et al., 2019).

Qualitative research is often called as “theory-emergent” research since it is used to generate new knowledge on existing research by collecting primary data, most often from the opinions of research participants. Though the process is quite unstructured, it allows the researcher to collect rich and deep data helps in contextual understanding of the selected microenvironment under natural settings (Bell et al., 2019).

According to Bryman and Bell (2007), the conceptual work may sometimes lead to tighter specification of research question and hence further data collection may be needed which makes the process to take up an iterative approach. Drawbacks of qualitative research could be that sometimes it is too subjective. Since there is variability in the data collection, it is difficult to replicate the study. Further, there is a lack of transparency and problems of generalization may occur.

3.2.1 Design research

The overall research process is based on design research method as this study is intended in the process of designing and developing circular business models by deriving information and knowledge from many domains. Further, according to Dokter (2021), design research supports the explorative nature of this qualitative research and intended to design solution focused strategies by synthesizing based on real scenarios, design research is more suitable for this thesis. Design research is intended to identify end user’s perspectives on using a specific product or service so that product or service can be designed and developed specifically to meet the customer needs and provide value. Further, this process is client or customer focused and hence it is often related with market research. Though both processes have common features, the prime difference lies in the focus of research. The market research focuses on sales perspective whereas design research focuses on user behavior and product experience.

End user perspectives on using circular business model of dishwashers and refurbished dishwashers were identified significant by researchers and hence participants are asked to answer from end user point of view since all participants are end users of dishwashers. Hence the data collection process is primarily qualitative and ethnographic approaches like workshops, interviews were conducted to design and develop a suitable circular business model for the focal company. The design research usually has the following steps. First the collected data is processed and synthesized into certain formats to get insights on existing knowledge which is later translated into actionable knowledge. Here, a conceptual business model is developed which provides the final actionable knowledge (Lee, 2012).

3.2.2 Research Approach

Abductive research approach is considered more suitable approach for this thesis as it involves selection of best explanation or interpretation from competing ones as per Mantere and Ketokivi (2013). Since this thesis is about exploring circular business models and choose the best usage focused business model among other competing alternatives, abductive approach is considered more useful in this research. Further, abductive reasoning emphasizes the search for suitable theories to an empirical observation, which Dubois and Gadde (2002) call as “theory matching”, or “systematic combining”. This is done by integrating knowledge gained from diverse research domains. In this case, researchers gained new insights from various domains like circular economy, product-service systems and business models and integrated the combined knowledge into new research. Further, every time when a new data collection process is done, the author gained more surprising insights which lead to new questions or puzzles and in order to solve that question, new data collection process was done in an iterative manner.

This is in line with Bell et al. (2019) which elucidates the favorable situation of abductive approach as follows “*When a researcher encounters a puzzle or surprise in an empirical phenomenon that cannot be accounted for by existing theory and that's when abduction starts when the researcher tries to explain that puzzle or surprise*”. Considering all the above factors, abductive research approach is used in this research.

3.2.3 Research design

A research design relates to the criteria used to evaluate the quality of business research. Further, it provides a framework for data collection and further analysis. Bell et al. (2018) explains about five different types of research designs. They are experimental, cross-sectional, longitudinal, case study design and comparative design. Case study research design is adopted in this research since it allows for deep understanding and investigation of real-life research problems as advocated by Bell et al. (2019).

Further, Case study is more commonly used in a qualitative study to answer the “how” part of the research question by assessing the “as-is” situation of the case by examining various factors in highly contextualized study. In this thesis, the “as-is” situation of the circular economy in focal company is assessed with the context to research question and explored various circular business models to define the future state of appliances industry. Finally, a new circular business model is designed considering the background of the focal company and hence case study approach was more useful in the design process. One notable disadvantage of case study design could be it does not employ any measurable data. So, the reliability of findings may depend on the researcher's observational and integrative ability (Bell et al., 2019).

3.3 Data collection

Data collection can be defined as the process of collecting relevant information from all possible sources to answer the research question in context. Data collection is divided into two types: primary and secondary. Primary data collection involves collecting unique data through performing a quantitative study or qualitative study. Here qualitative data collection is used as it is more suitable for this research in order to obtain rich and deep data on circular economy business models as there are not much sufficient secondary data available regarding the research context. This involves collecting data through interviews, focus groups, observations, workshops, case studies

etc., The data collection process used in this research primarily contains a literature study, interview study and workshop which are detailed as below (Dudovskiy, 2022).

3.3.1 Literature study

The initial information required was collected from reviewing literatures from various sources like google scholar, science direct, research gate, Chalmers library. The keywords used to shortlist the literatures includes Product-service systems, servitization, circular economy, servitized business models, dishwashers and kitchen appliances.

According to Bell et al. (2019), Literature study is considered as a useful tool to gain an in-depth theoretical understanding of the research topic by synthesizing existing theoretical findings through reviewing various published journals, articles , conference proceedings etc., Bell et al. (2019) explains that literature review is a crucial part of any research as it provides the foundation for justification of research questions and develop a suitable research design. Further, literature review lays the groundwork for upcoming data collection and helps researcher analyze the data by providing knowledge on the research domain. In a qualitative study, constructing an intertextual coherence is very crucial to organize and represent existing knowledge obtained from literature and relating it with research study. Approach of synthesized coherence is adopted in this research since it bridges the gap between two unconnected pieces of literature (Golden-Biddle and Locke, 1997).

In this case, literature review helped the researcher bridge the gap between circulareconomy and servitization and helped synthesize a business model. Further according to Bell et al. (2019), it problematizes the situation by unearthing the research problem. In this case, literature review is aimed to bridge the research gap between circular economy and servitization with context to the business model. Literature review is often conducted either as systematic or narrative review. According to Bell et al. (2019), Narrative review is “less focused and wide ranging” when compared to systematic review. According to Geertz (1973), “Narrative review is intended to gain initial understanding of the research topic” and Bell et al. (2019) ascertains that “narrative reviews are more suitable for qualitative research”. Moreover, empirical study is done through interviews and focus groups to assess the research subject in real life through practical aspects and which further triangulates the findings of literature study thereby enhancing the research quality.

3.3.2 Interview study

To assess the embryonic stage of circular economy and to know the potential future prospective it holds for the focal company, Semi-structured interview style is opted as it can provide rich, reliable, and comparable data especially in qualitative research. Denscombe (2014) affirms that semi-structured interview possesses the merits of structured and unstructured interviews by combining them together which helps interviewer in providing more space to collect related additional information through open ended questions and asking related additional questions without diverging from the research scope. This facilitates the interviewer in gaining more knowledge by understanding issues, patterns, events, and various behavioral forms through this process (Bell et al., 2019). Semi structured interviews are more suitable for this research since the researcher already had a “fairly clear focus” on the research topic by performing a literature study which facilitated to address some specific contexts. The interview process basically had two prominent stages. They are sampling and conducting interviews.

Bell et al. (2019) says that in qualitative research, selection of sampling techniques is essential and that is more concerned with the background of the research data. Purposive sampling technique is

adopted in this research since it involves selecting participants who can provide more relevant and in-depth information so that the researchers can come up with more accurate findings in qualitative research. In order to obtain knowledge on circular economy, household appliances sector and housing companies, Research experts from CIK team, industrial experts from household appliances company and professionals from housing company were selected as sample cases for the research.

According to Saunders et al. (2012), Purposive sampling is a non-probability sampling method where the representative sampling elements are selected strategically by the sound judgment of the researcher. In some cases, this is also done to ensure variety in the sample by selecting participants with different backgrounds. Purposive sampling is suitable only when there are a limited number of primary data sources available for the research. Further, this technique is proven to be very useful in exploring anthropological scenarios with intuitive approach and hence more suitable for qualitative research. Additionally, participants are considered more relevant by the researcher as per the predetermined criteria for the research participation.

However, there are pros and cons associated with this sampling technique as per Saunders et al. (2012). One significant merit could be that this sampling technique is cheaper and not so time consuming compared to other sampling techniques. Some of the demerits could be that this technique is less reliable and highly vulnerable as it is more subjected to researcher’s judgment bias. Further, generalization of findings is difficult. An interview guide was prepared where the topics are arranged in a sequence and interview questions were written and ordered in a flexible way to introduce follow-up questions whenever needed. It is also ensured that all questions would be independent so that even if a question is skipped, it doesn’t affect the whole interview structure. The questions were revised so that no topic or context to be addressed is missed out. Further, all the questions were written in a clear and comprehensible manner without unnecessary jargons (Bell et al., 2019).

Initially, a pilot study was conducted to verify the reliability of questions to the interviewees. Our supervisor directed us to the first set of interviewees who are experts on circular economy in the kitchen industry. This led to another set of interviews with partner companies who are interested in circular business models for white goods other than dishwashers. Next, the researchers proceeded with the interviewees from focal companies from departments like Research & Development, product management etc., Finally, interviews were held with rental housing companies to check the response of the designed circular business model. This is followed by a workshop with internal experts to gain feedback on the developed business model. The details of interviewees are tabulated as below.

Table 3.1 – Details of Interviewees 1

Interviewees (CODE)	Role	Organization
Interviewee 1 (IN 1)	Professor	Chalmers CIK team
Interviewee 2 (IN 2)	Researcher and product designer	Chalmers CIK team
Interviewee 3 (IN 3)	Architect and Researcher	Chalmers CIK team

Interviewee 4 (IN 4)	Innovation and sustainability manager	ATAG
Interviewee 5 (IN 5)	Global design manager	ATAG
Interviewee 6 (IN 6)	R&D expert	ASKO
Interviewee 7 (IN 7)	Business expert	ASKO
Interviewee 8 (IN 8)	Business expert	ASKO
Interviewee 9 (IN 9)	CEO	Jemmett AB
Interviewee 10 (IN 10)	Procurement Manager	Poseidon AB

Before conducting the actual interview, the interviewees are provided with a short presentation of the research background. The interviewees were also granted permission for recording their response for transcription purpose. Once the permission is granted, the interviews were recorded to avoid data loss. These recordings were helpful to researchers during the transcription phase in case of doubts and clarifications. Field notes were made during the interview process. All the interviews were conducted in a quiet place.

Recording and transcription of interviews has following advantages as per Bell et al. (2019). Since human brains has natural limitations of remembering participants response and hence recording responses and transcribing them later is found useful for the purpose of analysis. Since qualitative study could be iterative sometimes, it further helps in repeated analysis of data to gain new understandings and generate useful insights. Demerits could be it takes more time and sometimes respondents may have some discomfort, or they become more self-conscious or alarmed that their words are being preserved and hence sometimes they may refuse or might not provide honest answers (Bell et al., 2019).

3.3.3 Workshop

Workshops are nowadays used as a tool for data collection as it creates a place for collaborating participants to brainstorm on describing scenarios in a simulated environment and hence most suitable for design process. The size of group is usually kept small as it requires active participation of experts who can practice relevant scenarios and the insights are provided as feedback. This workshop was done with the below participants and intended to gain opinions on the scenario analysis done before that. (Ørngreen & Levinsen, 2017)

Table 3.2 Details of workshop participants

Participants (CODE)	Role	Organization
Workshop participant 1 (W1)	Architect and Professor	Chalmers CIK team

Workshop participant (W2)	2	Product designer and Researcher	Chalmers CIK team
Workshop participant (W3)	3	Architect and Researcher	Chalmers CIK team
Workshop participant (W4)	4	Architect and Professor	Chalmers CIK team

3.4 Data analysis

Most qualitative data obtained from interviews often contains large chunks of text which needs to be analyzed to generate knowledge in research. There are no specific guidelines for qualitative data analysis unlike quantitative research. The most commonly used qualitative data analysis approach were qualitative content analysis, narrative analysis, thematic analysis, grounded theory and ad-hoc approach (Bell et al., 2019).

Qualitative content analysis is the most used method intended to identify patterns by analyzing large chunks of qualitative data predominantly available in texts. This is done by grouping large volume of text into codes and classifying them under certain categories to arrive at the pattern of how frequently the content is discussed (Dudovskiy, 2022).

Narrative analysis is gaining understanding from people or experts conversing about their ‘tell-tale’ experience and stories and making stories from their stories which is like revising the primary data obtained from qualitative research. Discourse analysis involves analyzing the natural conversation usually available in text. Thematic analysis is quite related to an exploratory work of identifying certain themes from opinions and viewpoints of people’s experience towards a certain context. Grounded theory is a potential analytic technique to develop new theories based on the initial research question with focus to main case and investigate additional cases based on the common patterns and insights obtained from the analysis (Dudovskiy, 2022b).

All the above discussed methods were used in combination as an ad-hoc approach to analyze the collected data through interviews. First, all the interview transcripts are synthesized into one concept memo under a common umbrella term of “Stakeholders’ perspectives on circular economy” where the responses were structured in an order based on the origin of data collection i.e., academic or industrial experts and were further classified under two broader themes circular economy and product-service systems. Next, few concepts were developed based on the main themes intended to cover the product circularity and development of business model for the focal product dishwasher with special focus to appliance industry. Later, based on the feedback obtained from a workshop session, a more detailed scenario analysis was developed which finalized the conceptual model.

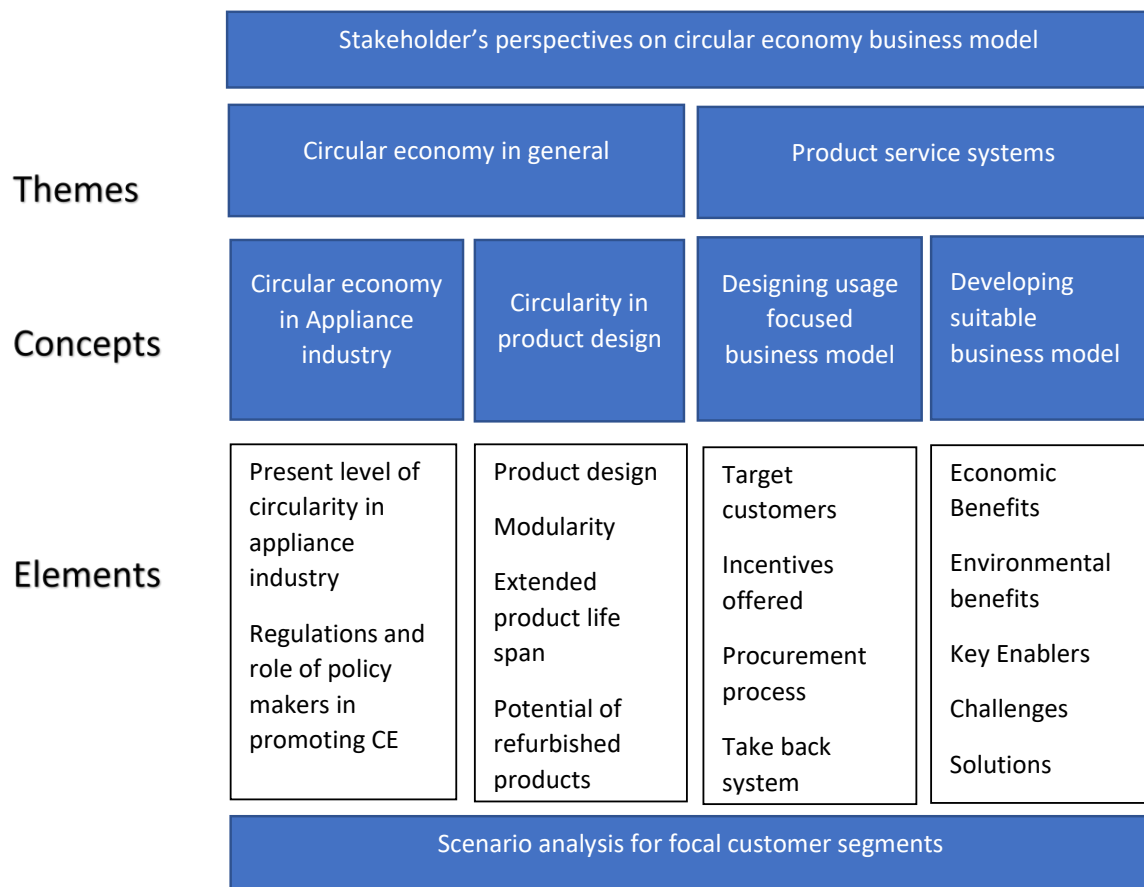


Figure 3.2 – Data analysis process

3.5 Research Quality

Forero and Nahidi (2018) explains the four prominent quality criteria used in qualitative research. They are credibility, transferability, dependability, and confirmability.

Credibility is a research quality that ensures the outcome of the research to be true, credible, and believable. It also means confidence in the truth of the findings. Whereas *Transferability* refers to the extent or degree to which outcome can be generalizable and applicable to other contexts. *Dependability* is about ensuring the consistency and repeatability of the research findings within the same cohort of participants, coders and contexts and usually done by inquiry audit. *Confirmability* refers to the degree of confidence that the outcome can be confirmed or corroborated by other researchers to make sure that the findings are from participants point of view and not affected by researcher bias, motivation, or interest (Bell et al., 2019).

Credibility of the research is ensured by pilot interviewing and collection of referential adequacy materials. *Dependability* of the research is established with the help of an audit trail where we keep a detailed track of our data collection process. Further it is also confirmed by the rich description of study methods and protocol. *Confirmability* of the research is assessed by triangulation techniques of comparing the previous literature study with an interview study,

feedback seminars with CIK team and industry stakeholders through confirmation of results throughout the progress of this thesis. Lastly, *Transferability* is assessed by a purposeful sampling technique (Forero & Nahidi, 2018).

3.6 Ethical Considerations

Diener and Crandall (1978) discuss about the common ethical principles considered in business research. First ethical principle is to ensure that this research has not created any harm to participants. In this study, the researcher ensured the protection of confidentiality and anonymity of all the participants. Further, the participants were informed that the information gathered will remain confidential meaning that it not used for other purposes. The anonymity of the participants were protected by assigning codes (Bell et al., 2019).

Second ethical principle is about informed consent. All the participants were provided with an opportunity to ask questions about the research and provided sufficient time to decide upon their participation in the research. Mainly, all interviewees were informed about recording of their responses for transcription and data analysis and obtained permission for the same (Bell et al., 2019).

The third principle is regarding invasion of privacy referring to the protection of personal information of participant. This is done by keeping the personal records of participants in a confidential manner. The fourth principle is to avoid deception by providing complete information on the purpose and background of the research to participants without concealing the truth. All the participants were provided a glimpse of the research background and its purpose in the beginning of the study (Bell et al., 2019).

4. FINDINGS FROM INTERVIEWS

This chapter covers the findings obtained from interviews and workshops conducted with key stakeholders CIK team, ASKO, ATAG, Jemmett and Poseidon. Their perspectives on present level of circularity in business and dishwashers, significance of circular design of dishwashers, incentives for entering a circular business model, challenges involved in a circular business model is discussed broadly in this chapter.

This section covers various perspectives of key stakeholders CIK, ASKO, ATAG, Jemmett and Poseidon on significant research topics like circularity in business, circularity in dishwashers, development of circular business models with usage focus.

4.1 CIK team's perspectives

The Experts from CIK team share their perspectives on developing circular business models for dishwashers by analyzing from various dimension like the design features of a circular kitchen, role of modularity in product design and challenges associated with designing and developing a circular business model for dishwashers.

The circular kitchen project focus on developing circular kitchen designs through various phases of cocreation, development and testing by installing various prototype models. The academic partner for this main CIK project is Delft University of technology, Netherlands and this research is funded by European institute of Technology (Chalmers, 2020a).

The project mission is to design more climate smart and innovative circular kitchen models in practice by reducing the wastage due to linearity that exist in the process of producing, using and discarding the kitchen. Generally, kitchen is an essential part of the house that are involved in frequent premature alterations and renovations. Added to this, non-reparability and inadaptability of products used in kitchen make them more linear with less feasibility to close the resource loop and redirect the materials back to process before sending into trash which adds more wastage and bears high negative impact on environment (Chalmers, 2022b).

Currently, the project is developing second version of circular kitchen prototype by including digital services in order to enable easy upgrade and replacements which eventually extend the lifespan of product where the notion of slowing the loop is achieved in circular economy. The current version Circular kitchen 2.0 involves collaboration with four partner organizations namely the household appliance manufacturers ASKO from Sweden and ATAG from Netherlands, International kitchen producer Nobia and sustainable housing developer Jemmett (Chalmers, 2022c).

4.1.1 CIK team's view on circularity in kitchen

This section specifically covers the CIK team's opinions on designing and developing a circular kitchen by exploring various topics like circular product design, standardization, modularity, role of redesigning a product for circularity and mode of implementation of a circularity in kitchens.

All interviewees from CIK team had quite similar opinion when it comes to promoting significance of product design with respect to circular economy especially in kitchen appliances industry. IN 1 who has demonstrated working experience in product design affirms that using products and furniture that are durable, reusable for endless cycles possess high value in enabling

circular kitchen. IN 2 adds up a point that using durable materials may extend the lifespan of product which slows down the loop. But to close the loop, one must think of solutions like modularity which supports easy disassembly and upgrading parts of the product without sending entire product to wastage. There exists one more strategy of narrowing the loop which stress upon using least possible resources and hence there is no one good strategy for enabling circular economy but it is up to the company to choose the best one considering the context.

The interviewees had diverse opinion on whether to create a completely new design or minor modifications to the existing design. As IN 1 said that she supports totally new design as IN 1 sees this as a long-term process and hence it would be appropriate to be designed from scratch. This is done by fixing the optimal state first and assess the current situation and thereby to think of bridging the gap which is the best way to enable circular economy in kitchen. IN 1 also firmly believes that design is the potential to bridge that gap and enable optimal state in future. One notable example could be prototype with innovative circular kitchen design installed in HSB living lab at Chalmers. Standardization and modularity are believed to be key enablers in creating such circular kitchen design. However, IN 2 added up the fact that it is actually very expensive to redesign completely.

When the present condition of circular economy is discussed, IN 1 also strongly poses that the circular economy that exist in present kitchens is below 1% which is hard to know but still there are some initiatives from industry like ATAG although remaining in the experimental stage. Whereas IN 3 says that it depends upon other factors like policy makers who trigger companies to be more circular with their production, distribution, usage and recycling mechanism and hence more companies will be involved in circular economy in the long run where it becomes more profitable.

Further, on discussing about circular business models in general which is quite new to the industry that are operating in traditional linear economy logic, interviewees came up with barriers and challenges that industries face while stepping into the circular economy initiative. IN 1 affirms that the real challenge for industries lies in successfully phasing out the old traditional logic and successively placing in the new circular business model. IN 3 explains that a new business model comes with lot of uncertainties. There is a risk related to losing profits, existing customer base and market which is further worsened by lack of associated technology and service systems to enable such business models. Further standardization supports modular products and indeed it supports circularity of products and hence such initiatives should be appreciated.

But to overcome the above challenges, few interviewees proposed some solutions to make the transition process from linear to circular easier. IN 1 assert that companies can take up pilot approach of running existing business on one hand and starting a new side-track with circular business model and running them parallel for few years until making the complete transition. IN 2 agrees up with the fact on step-by-step approach would mitigate the risk of changing business logic rather than a radical or break-through transition.

Regarding the role of stakeholders in initiating circularity, IN 3 explains that cocreation could be a new strategy to enable circular economy and affirms that stakeholder's collaboration is very crucial in such transition of business model. IN 1 agrees with this and adds that suppliers should be motivated to try this new business model by providing economic incentives. This can be facilitated by digital technologies and outsourcing services like reverse logistics with external expertise.

Overall, the experts from CIK team affirms that the role of circular economy is significant in a

kitchen but not widely practiced currently. Further, they explain the role of product circularity and modularity in designing and developing a circular kitchen.

4.1.2 CIK team's view on circularity in dishwashers

This section covers the CIK team's perspectives of designing and developing a suitable circular business models for dishwashers. It is done by exploring various dimensions of circularity by enabling best material selection for dishwashers, spatial aspects of kitchen, customizing business models for specific customer base, incentives offered in a circular business model for dishwashers.

Regarding the best material to use in dishwashers to enable circular economy, All the interviewees had same thought on using durable materials like stainless steel instead of plastic which is in line with ASKO's motive to use stainless steel interior for durability of the products. IN 2 mentions the spatial aspects of dishwashers by highlighting that a free standing dishwasher would be more appropriate for functional business models which enable easy logistics and installation than other types of dishwashers.

IN 1 mentions that since each dishwasher manufacturer have different maturity levels in innovation, there is a need to customize such circular business model depending upon the context or environment in which the dishwasher is used. This discussion forms the basis of having separate business models for B2B and B2C customer segments which is discussed later in the findings. Further on developing a new circular business model for the focal product dishwasher, IN 1 excluded pay per use model for dishwasher as it is not suitable. But it could be more suitable for washing machines installed in the common laundry room and intended to be used by multiple users. IN 1 promotes subscription or leasing could be a better option for dishwasher, a product exclusively used by the same user in his or her own kitchen. Such subscription models should be more attractive to be assure companies with enough economic progress because ultimate motive of any business model is to make profits.

Hence, that subscription package should include free services and maintenance for certain period of usage. It is also more relevant to include instant repair services from the provider end so that the dishwasher becomes more reliable product. IN 2 accepts that subscription model is more attractive since the customer can choosethe dishwasher model for subscription and can upgrade the model easily as it comes with a take back guarantee.

Overall, the CIK team experts reveal their opinion on selecting a suitable business models for specific customer segments of dishwasher by outweighing the pros and cons associated with each usage focused business models.

4.2 ASKO/ATAG's Perspectives

This section of ASKO/ATAG's perspectives covers the unique characteristics of ASKO's products and explains the customer segments of ASKO. Further, it covers various perspectives of professionals from ASKO and ATAG on various dimensions of circular economy in dishwashers by exploring the design features, product lifespan and challenges associated with it.

ASKO is known for their elegant and user-friendly design with long lasting quality. Most of the ASKO appliances comes with sleek top user interfaces whereas the competitors models come with front user interfaces with plastic handles. ASKO's cheapest models are known to be elegantly self-designed. ASKO's models are designed for easy usage by creative thinking of innovative

designers. For example, baskets of ASKO's dishwashers have more features like foldability, possibilities for adjustments, provision of fine grids for loading smaller objects. The existing customer segment is B2C customers i.e., retail customers. Precisely, the focus is on the individuals above 35 years of age with high income who live in their own house or apartment. This project is aimed to enable a circular business model for ASKO's dishwashers which would increase the access of premium dishwashers by other customer segments.

Maintenance services of ASKO are completely outsourced. ASKO have B2B markets through big retailers in Europe. ASKO has B2C markets in Australia. ASKO have their own distribution setup under the names of "ASKO Australia" or "Hisense Australia" and they setup dishwashers for demonstration purposes and customers can book orders at the retailers' place and ASKO will deliver them to private customers.

4.2.1 Introduction of ATAG

ATAG is a reputed kitchen appliances and electronics brand famous in Benelux region who offers distribution services for the focal company ASKO. Currently, ATAG has around 450 employees based in Duiven. ATAG is also acquired by Chinese brand Hisense. Hisense has around 80,000 employees with annual revenue of sixteen billion euros and widely spread in 130 countries. ATAG's product range entails five brands ATAG, ETNA, Pelgrim, ASKO and Hisense. ATAG has been practicing circularity with context of providing products for use rather than ownership. Further, ATAG has been part of the circular kitchen project from 2018 to 2022 with the objective to design and develop circular kitchen in Sweden and Netherlands. This is done by developing energy efficient, long-lasting products by repairing, refurbishing and recycling products and thereby reusing materials (ATAG, 2022).

4.2.2 ASKO's opinion on dishwashers, production and life span

This section covers various opinions of ASKO professionals explaining the global presence and unique features of ASKO dishwashers and how it differs from their competitors by highlighting the long lifespan of ASKO dishwashers and pricing strategy.

ASKO, a company based in Sweden who makes an entire range of kitchen appliances such as coffee machines, dishwashers, drawers, fridge and freezers, induction hobs, kitchen fans, ovens, wine storage cabinets and various kitchen accessories. Further, they also manufacture washing machines and dryers for both private households and professional use. The focal entity is an established global brand covering 50+ markets known for its unique design and high quality. They have 3.1% market share in Europe. Our focal product dishwasher in general has 20 years of lifespan. (ASKO, 2022)

The focal entity offers three types of dishwashers - built-in, free standing and fully integrated. The product line can be classified as medium end and premium end models and thus, the cheapest dishwasher machine starts from 899 euros, which is generally higher than the average price range of key competitors like Bosch, Siemens and Electrolux. Notably, the price range of Miele's dishwashers is on par with ASKO's.

The pricing of ASKO's dishwashers can range from 899 to 2000 euros whereas Miele's dishwashers can range from 899 to 2300 euros. Bosch's dishwashers can range anywhere from 150 to 1200 euros. One of the strongest arguments behind ASKO's high price point would be the durability of materials used in dishwashers as most of the interior is made of high-quality

stainless steel which easily increases the average lifespan of the product to be around 15 years. Further, ASKO's dishwashers are tested under factory conditions and proved to have a lifespan of 15,600 hours which is approximately 20 years. The total number of products sold could be 80,000 to 100,000 annually. Overall, ASKO employs a premium pricing strategy due to the unique features and longer lifespan of its products compared to their competitors' products.

4.2.3 Interest for circular economy from design perspectives

This section covers the perspectives of professionals from ASKO and ATAG exclusively on significant role of circularity in product design phase by exploring various dimensions like modularity and ease of refurbishability.

Industrial experts from ASKO and ATAG believe that design of circular products is important but IN 5 stress the point that not only the design team, but other departments do play an equivalent role in enabling circularity. But sometimes, new business models may demand for new design of products. For example, a design team that focus on easy refurbishing of products may be a key strength for a circular dishwasher. Although, IN 6 mentions that ASKO does not release new generation products very often and in this case, when circularity impose such change in design, hardware design could be harder to modify whereas software upgrades are easy to pursue. IN 7 asserts that the time factor is important in enabling circularity in dishwasher especially for ASKO dishwashers which have quite long lifespan, it is easy to enable circular economy with no major changes to current design. Further it also depends on usage behavior, government regulations etc.,

IN 8 mentions that modularity could be a big enabler of circular design of dishwashers in repairing and replacing parts of the dishwasher rather than replacing the whole component or whole product. But the optimal state of modularization to enable circular design must be decided by the manufacturer. IN 7 comes up with a point that aesthetical look of old but fully functional dishwasher may sometimes hinder the maximum utilization of product lifespan. In that case, modularity plays an important role in replacing necessary subsystems like user interface. These subsystems can be standardized so that refurbishing the product can support complete functioning whereas refreshing the product can make the product look better.

IN 6 mentions that in case of ASKO, design is not so significant aspect in promoting circularity in dishwashers due to the practicality of product development lifecycle. As whenever a new product is developed, there will be major upgrades during the beginning phases but once it reaches a saturation point, it requires minor refinements and ASKO is said that it reached that saturation point so no major upgrades in design are not expected in future.

On overall, ASKO and ATAG professionals explains that circular product design is not appropriate for ASKO dishwashers in enabling circular economy as ASKO has already reached mature phase in design stage where no major improvements are done and hence the product cannot be made more circular.

4.2.4 Circularity in household appliance industry

This sections covers detailed view of ASKO and ATAG professionals on enabling circular economy in household appliances industry by drawing comparison on significance of circular economy between present and future conditions, ease of transition from linear economy to circular economy, challenges in implementing circular economy and explain reasons behind the existing barriers in enabling a circularity in household appliances industry.

The discussion on present condition and importance of circularity in appliances sector evoked participants responses. IN 4 mentions that circularity is still in beginning or testing phase in ATAG, as ATAG initiated its working from the aspects of repairability and reliability of products.

ATAG has invested a lot in circular economy for the past five years by focusing on leasing appliances and serviceability. Further ATAG is planning to expand their focus on reverse loop by initiating take back guarantees and refurbishments. – IN

4

IN4 illustrates the pilot approach of ATAG “ I would relate ATAG to be a mothership functioning on linear economy base is sending an expedition ship to explore circular economy”.According to IN 5 in current situation, companies ranging from start-ups to bigger organization like Siemens started realizing the significance of circular economy but hesitant to make their big step towards a complete circular business model mainly because of three reasons. First is how to make money with such circular models since we are so much used to one time transaction models, but companies should understand that these circular models can make revenue over the time in future. Second, it is towards the market or customer acceptance of circular models with refurbished machines which can be increased by constant awareness and promotion. Third is due to psychological behavior of user towards a product when he or she doesn't own which needs to be addressed. They might care less about the product and may not properly maintain it which sometimes affect the life of product.

IN 6 explains the ASKO perceives circular economy as a future concept although it is widely discussed among policy makers and governments, and even practiced in few sectors like textiles but when it comes to household appliances, it might increase in future depending on the government regulations. Regarding markets for circular products and business models, IN 5 asserts that European markets appreciate circularity as they are traditionally associated with sustainability concerns. As retail customers prefer more durable products with longer life span and hence, they are willing to spend more on such products which contributes to circular economy by slowing the loop.

But IN 7 mentions that the same population of retail customers are not that interested in using refurbished or recycled product instead they prefer to buy a new one so closing the loop would be difficult in such context. Hence enabling circular economy depends on selecting the successful strategy by understanding market needs and customer preferences. IN 4 mentions that in such case changing customer base would be beneficial. For example, B2B customers are closer with government and hence government regulations demanding circularity reach them first to invoke the change. In Netherlands, European Union has imposed standard guidelines for circularity and hence ATAG is practicing circularity more in Netherlands compared to other nations.

Further, IN 5 mentions strongly that the supporting factors can vary in developing countries where they contribute to circularity in different route like less energy utilization which is associated with narrowing the loop but might not consider the footprints. Conducting an advanced market research during the implementation phase will be more beneficial since markets are dynamic and uncertain.

When discussing about creation of new channels for circular business models, IN 8 suggests running both models in parallel so that ASKO can test new circular business models without jeopardizing the existing supply chains and markets. New circular business models can be done in online mode with one or two popup showrooms to exhibit products and to collect orders. IN 7 highlights that refurbished products demand separate supply chain and markets otherwise it might

be a trap for existing production.

The discussion on time taken to implement a circular business model provided some positive signs of success of business models in future. IN 5 explains that the transition could approximately take up ten years for ASKO, the duration might even reduce with a strong push from government. IN 6 mentions that it will take a lot of time to setup the needed infrastructure, but to get a holistic transition it is very uncertain since the change has to be evoked psychologically starting from society, and then should be reflected to industry and consumers. IN 7 and IN 8 mentions that it is harder to fix certain time period but made a guess of minimum 4 or 5 years for a change in business model, but it will take more time to design a circular product upstream and to connect with suitable distribution and supply network which would further extend the time.

IN 5 mentions that some techniques like design thinking, change management and market research would be highly helpful for the transition process and comments that the overall process is very challenging. IN 6 explains the significance of pricing in such business models since it has to be attractive and at the same time should be affordable for customers when compared to owning the same product. Circularity may contribute to reduced sales due to reduced production which needs to be compensated by making money through services provided along with the product.

On overall, the experts discussed about the ease of transition from a linear to circular business model and concludes that it is very challenging to make a transition to circular economy from economic perspectives and hence postpones the transition process to future.

4.2.5 Incentives for circular economy business model

In this section, ASKO and ATAG professionals discuss on incentives to be provided for specific customer segments of usage focused business models to attract new customers and to have a win-win situation for both company and customers thereby successfully enabling circular economy in dishwashers.

Regarding the most suitable functional or circular business model for the dishwasher of focal company, IN 6 asserts that pay per use could be one which is suitable because ATAG has tested such model for washing machines in Netherlands especially with rental apartments.

In the circular economy business model, both the customer and company can be profitable at the same time. For a B2B customer, which is rental company in this case, they can get incentives like discounts on next purchase, free service and maintenance contract, Instant repair services in case of breakdown, free upgrade to next models etc., For ASKO, they can save more on reverse logistics and transportation as they do it for large number of appliances at the same time. IN 7 agrees with pay per use and rental business models can be more suitable when provided with incentives like guarantees and warranties could support introducing business models.

At the same time, being first with circular solution in market can be attractive in case of B2B customers like housing companies where the subscription model can be attractive as it does not require huge upfront or investment from them which can be a huge pressure for construction companies who construct hundreds of apartments at a time. IN 4 suggests using a pay per use model as dishwashers are still a luxury product. Housing companies seems to be the most suitable customer for such models and holiday house owners are the least suitable customer for these models as they are least utilized over there. Further, subscription could be more suitable for temporary residents who would like to avail the service of clean dishes without owning it and without

paying a huge upfront amount. Providing incentives could attract customers for such models but constant motivation is needed to sustain this model.

On overall, industry professionals from ASKO and ATAG highlights the positive financial aspects of circular economy business models. For example, no requirement on huge upfront amount to avail the service of product can attract new customers who are not interested in owning a product but avail the service of product. Such business models becomes even more attractive for customers when they do not hold any responsibility for maintenance and repair services.

4.2.6 Challenges involved in circular economy

This section explains various challenges involved in enabling a circular economy for dishwashers by exploring various technical, design, logistics, behavioral and financial aspects and discuss various solutions to overcome those challenges.

IN 4 mentions that “*It’s a big change where ownership changes drastically*”. In reality, companies want to finish this as one time transaction whereas customers would like to own the product after paying the whole price of product although on a monthly basis. IN 8 mentions that the limitations of technology in manufacturing modular products could be one more challenge as affirmed by IN 7 who agrees that modular products are more expensive to buy further some products are not meant to be modular, changing production lines to produce modular products will be more expensive. IN 8 adds that more money, time and efforts have to be invested to come up with modular solution which could be a hurdle to enter circular approach.

Regarding refurbished products, IN 7 adds that producing products that are easy to refurbish require huge investments since it involves change in production line. IN 4 agrees that it is expensive as reverse logistics cost are also involved which can also impact carbon footprints. IN 6 says that no major drawbacks are associated with subscription model for refurbished products but customers need to be convinced from hygiene aspects. But all these challenges must be dealt by the motivation towards enabling circular economy to counteract less utilization of product lifespan which is the research problem in the focal company as mentioned by IN 6.

Stakeholder management is an interesting solution to overcome the above challenges where intrinsic motivation especially be a major convincing factor applied towards stakeholders. IN 5 mentions that giving the sense of security to stakeholders that business will be still running but in a new mode can help the change management process easier. Gaining stakeholders participation through providing education and creating awareness, motivating them to try new ideas and develop confidence is crucial pillar for the transition process. But IN 6 mentions that pushing or forcing stakeholders to involve in circular economy can backfire and hence creating awareness and motivation might work but the transition may take a lot of time.

Regarding end user aspects of using refurbished products on subscription, IN 4 responds as an end user, would prefer buying a firsthand product although the refurbished appliance on subscription model looks interesting.

Without any guarantee from manufacturer or refurbished products, it would be hard to try such models. – IN4

IN 6 mentions that recycling in Sweden is taken care by the government and hence there is no need

for manufacturer to recycle the product and reuse the materials involved. IN 3 mentions that choosing for the option to use refurbished appliance depends on the size of appliances. IN 6 comments that “I would prefer to buy bigger appliances from retailer and if it is small kitchen appliance, it can be bought in second hand which needs to be cost efficient without any discoloration and damage”.

IN 7 and IN 8 ascertain that they prefer buying a refurbished appliance if there is some guarantee on functionality and hygiene aspects. Regarding end user aspects of availing services without owning a product, IN 6 says that it might not work in Sweden since all houses either own or rental comes with all the white goods installed. This may differ in countries like Germany where the tenant or owner need to purchase the white good for an apartment. So in that case, usage focused models could be attractive.

To sum up all the findings obtained from various interviewees, A SWOT analysis is done to assess the feasibility and profitability of usage focused business models for ASKO’s dishwashers. SWOT analysis is a simple tool to lay the groundwork of developing a business model by assessing strength and weakness internally within the organization and later assess the environmental by analyzing external factors through opportunities and threats. This SWOT analysis explains the current strengths, and weakness, future opportunities and threats of enabling a circular business model for ASKO.

SWOT analysis for ASKO is shown in the figure as below.

<p>Strengths</p> <p>Economic Benefits</p> <p>No big upfront amount needed for customers to avail service of product</p> <p>Environmental benefits</p> <p>Resolves resource scarcity</p> <p>Increased energy efficiency</p>	<p>Weakness</p> <p>Demands circularity and modularity in product design</p> <p>Lack of infrastructure for reverse logistics</p> <p>Might be expensive initially</p>
<p>Opportunity</p> <p>Gaining new customers</p> <p>Market expansion</p> <p>Increase in market share</p>	<p>Threats</p> <p>Risk of losing existing customers</p> <p>Risk of losing reputation in producing refurbished products</p> <p>Risk of noncooperation of key Stakeholders</p>

Figure 4.1- SWOT Analysis for ASKO

4.3 Jemmett's perspective

Jemmett AB, a new housing development company based in Gothenburg started providing smart and sustainable houses at various parts of the country. Their mission is to “*create modern, life-affirming and sustainable homes that make life more safe, easier, comfortable*”. Currently, they possess three ongoing projects with 200 apartments with 100 people on waiting list and yet to be finalized. Further, there are two upcoming projects. The variety of housing solutions range from town houses, semi-detached houses, villas, apartments, condominiums and multi residential buildings (Jemmett , 2022).

Some of the key features of smart sustainable homes are that they are certified for passive house technology and Nordic Ecolabel. Further, the utilization and storage of solar energy through solar cells with provision of green houses, cultivation plots, electric carpool and community space with shared resources under subscription basis are some of the sustainable approaches from Jemmett. These certifications assure that chemicals were excluded in building materials, enhanced energy efficiency with tight specifications on design quality and materials used in construction. These solutions are aimed to provide “*sustainable and healthy world class living*” as per Jemmett. This research study focuses on their ongoing construction of rental apartments at Tjörn, targeting customer base of age above 65years (Jemmett , 2022).

4.3.1 Significance of circularity in general and business

IN 9 prefers to call circular economy as functional economy in which a product should be energy efficient and long lasting enabling maximum utilization of the product providing better value to both customers and organization. IN 9 considers that a major transformation is needed for a company to change their business models into function oriented from a product oriented one because it creates a demand for long lasting machines which should last for more than 15 years. This could be a great start for ASKO to collaborate with Jemmett to start their circular business models since their products are already designed for life span of 15-20 years. Regarding the circular design of products, IN 9 prefers to carry out some fine tunings to make the machine more energy efficient and believes that it won't take major transformation in design part as in the case of business model.

While discussing about the challenges involved in enabling a functional economy, convincing the top management from ASKO to engage in sustainability practices. But since ASKO is a brand owned by Hisense, a Chinese company it could be challenging to change the business model of a huge company. Further, they are already a pioneer in eco-cycle design, convinced with this sustainability route and might not be interested to change their business models. Hence IN 9 makes a comment that “*there is a hurdle with the business structure itself*” and compares the company's transition from linear to circular economy could be like “*turning an elephant upside down*”. Regarding drawbacks involved in this business model, IN9 has similar opinion like other interviewees that it has no major drawbacks.

But if ASKO be the only company in future to enter new markets with new business model, benefits outweigh the pitfalls of being the only company in functional economy - IN9

4.3.2 Procurement of dishwashers

For Jemmett, Procurement of dishwashers happens by collaborating project managers with purchasing department for all household appliances. The selection of household appliances brand is based on the various aspects like pricing, life cycle assessment, energy efficiency and has ongoing plan to short list two or three brands which will finalized in next few months. Within four or five years, circular kitchen models can be expected in Jemmett. Currently, they are procuring household appliances for common room and yet to progress with kitchen appliances.

But Jemmett is interested in procuring long lasting appliances for 50 years and reality as per them is no white goods last that long. Hence taking up this subscription model and setting up contract for 50 or 100 years would be desirable. During that contract period, all maintenance and repair services are covered in the subscription rate. In case of breakdown, focal company will take care of replenishing the old dishwasher with new one. To cover the service costs, the total subscription rate could be 20% more than the actual purchase of product, this model will not be attractive to customers. Hence the pricing strategy has to be designed by ASKO by considering many other factors.

4.3.3 Interest in circular solution for dishwashers

As per IN 9, *“Its more common in United states for an household appliance industry especially the laundry machines to enable functional economy by developing partnerships and make the business profitable.”* But major companies take up the common sustainability routes and show results on green washing and reduced CO2 emissions. But awareness should be created on shortage of natural resources and raw materials and motivate them to reduce linear model of production and engage them in usage focused business models with existing products.

To engage in circular economy, IN 9 suggests that focal company must possess cradle to cradle certification to sort out the initial design phase and focus on business model by getting top management on board. This change can take up at least five years to design a new circular product and develop a new circular business model. The time taken can be reduced to three or four years to develop a new circular business model with the existing product design.

Regarding suitable business model, IN 9 agrees with using subscription initially and later change it to pay per use which makes the business model more profitable in future. Leasing could be expensive for buyer and hence it might not be a suitable one. But he also adds that business models should be decided by the top management of focal company along with the partner companies involved. IN 9 further comments *“Subscription model is good but it’s not good enough since it doesn’t contribute to reduce CO2 emissions”*.

Regarding incentives for business models, IN9 confirms that government regulations on demanding cradle to cradle certification can trigger companies to initiate circular approach. When it comes to specific B2B customers like municipal housing companies who take up public construction work, governments demand them certain certifications like ISO 14,001. Similarly, regulations on circular economy can be imposed on industries.

Regarding the end user aspect of using refurbished appliances, IN 9 says in future, people will gain more understanding on refurbished and recycled products as equivalent to new products. He also agrees that there will be no hesitation in using such products on subscription basis since people

started gaining awareness on shortage of natural resources by highlighting “*finite planets have finite resources.*”

4.4 Poseidon’s perspectives

Bostads AB Poseidon commonly referred to as Poseidon, is a municipal commercial housing company with nearly 300 employees based in the city of Gothenburg, Sweden. With 28,000 rental apartments covering around 1.8 million square meter, they are the largest housing owner in Gothenburg and one of the largest in Sweden. Their mission is to “*create vibrant and safe districts by building sustainable society for the future*”. The targeted customer segment is youth based in western Sweden.

The sustainability contributions of Poseidon are developed around the triple bottom line covering economic, ecological and social perspectives with focus on long term business. Most of the generated profits are reinvested again in business which adds economic value. To address the environmental progress, the concepts of recycling rooms, energy efficient houses and beehives are installed. Poseidon owns and manages a large stock of residential buildings but do not build new as it is already built by another municipal company (Poseidon, 2022).

4.4.1 Significance of circularity in business

Currently, government bodies are interested in circular economy and hence imposed certain regulations regarding that. To note, Poseidon has signed an agreement with the city of Gothenburg that it will maximize reuse and recycling of materials in building construction. There are many start-ups with interesting ideas to initiate a circular economy but very little has started working in practice.

4.4.2 Significance of circularity in dishwashers

Regarding design perspectives of circular product, IN 10 prefers no major design change is needed since the present dishwashers cannot be more circular. But there is a demand for a system or right infrastructure with required knowledge and skills to disassemble parts or components at the end of lifecycle of product rather than throwing it as waste. When it comes to suitable materials used in dishwashers for circularity, electronic parts could be the weakest link rather than the mechanical parts which usually has longer life. Over the years, even the quality of plastic has changed to provide a better aesthetics. There is no concern about reverse logistics cost since cost would come done in the context of B2B customer as a greater number of appliances are handled simultaneously. Recycling and refurbishing process seems to be economically beneficial since extracting raw materials and using them in production seems more costly and impacts environment adversely.

4.4.3 Procurement of dishwashers

Regarding procurement of dishwashers for apartments in Poseidon, IN 10 explains that there are around 28,000 apartments where 2 to 3 dishwashers are replaced every week. Husbyggnadsvarde commonly called as HBV, Sweden’s largest procurement firm is responsible for procurement of all Swedish public housing organization.

Generally, in case of breakdown, Poseidon try to fix the appliances using third party service

providers certified by appliance manufacturer under the context of guarantees and warranties issued and if it doesn't work, it is discarded, and a new appliance is purchased. Electrolux and Cylinda are two brands commonly purchased in Poseidon as they are best in relation to price.

4.4.4 Interest in circular solution of dishwashers

Currently, there is not much circularity in existing business, but it would be appreciated if it could bring some economic benefits. IN 10 further comments that “ *it would be interesting if you can save the planet with an economically functioning system*” which asserts the significance of economic incentives to make the model more attractive to customers.

Currently Poseidon doesn't have any specific demands for kitchen as they focus on cheaper options and longer life span of dishwashers which is satisfied by subscription models. Since there is a government regulation to involve Poseidon in recycling and reuse, Poseidon might be interested in using refurbished appliances under subscription basis which closes the loop and accomplish circular economy.

5. DESIGNING CIRCULAR BUSINESS MODELS

This chapter of result focus on designing a circular business model for dishwashers of the focal company highlighting usage focused business models. A basic subscription model was classified into three models for three different customer segments initially. Later after gaining feedback from workshops, two potential customer segments were identified and a scenario analysis is done to find the feasibility and profitability of developed business models. The scenarios were further classified into cases to assess the distinct features of the model based on different scenarios.

5.1 Designing a business model

A business model is generally defined as the method or logic of how an organization propose, create, deliver and capture value. To put simply, business model defines the macro level organizational logic of making profits. This is a crucial part of business and hence business strategy and business development process. Organizations usually craft a business model when none is in place or reconfigure existing business model as a part of business strategy.

Basically, a business model should be able to explain the product or service that a company offers, the target markets, expenditure incurred, and financial profit expected. Further it should also address the value proposition on how it provides value to the customers and how customers perceive the provided value, competitive advantage through unique selling points, cost structure, resources required, pricing and revenue models, distribution methods etc.,

Further, a business model is developed based on three criteria desirability, feasibility and profitability. Desirability indicates the need of a new business model and should be validated to proceed to assess the possibilities of developing a new business model. Later an economic analysis is done to assess the financial viability and later tested and launched in market (Pahwa, 2022).

5.1.1 Classification of model

Three basic subscription models were proposed considering requirements and preferences of three different customer segments. First model follows the current linear economy or one-time purchase, and this model is compared with model 2 entailing subscription models of new machines and model 3 covering subscriptionmodel of refurbished machines.

Table 5.1 Classification of models

Attributes / Business Model	Model 1	Model 2	Model 3
Type	Sale	Subscription	Subscription
Ownership/Usage focused	Product ownership	Usage focused model	Usage focused model
New/refurbished	New appliances	New appliances	Refurbished appliances

appliances			
Pricing	Original selling price of dishwasher (one time purchase)	Monthly or annual subscription rate	Monthly or annual subscription rate
Customer segment	Existing customers – Retail customers B2C	New customers - Housing company B2B	New customers - Housing company B2B
Take back Guarantee	No	Yes	Yes
Special discount	No	10% discount on next purchase	10% discount on next purchase
Approach of circular economy	Slowing the loop	Slowing the loop	Closing the loop

5.1.2 Findings from workshop

This section highlights the comments and feedback obtained from the CIK team on the preliminary models developed in the above table for further improvement so as to develop and propose a final business model.

First feedback is related to excluding the model 1 as this is the existing linear business model and the customer base from model 1 are the existing customers of ASKO. There is very little probability of existing customer base of ASKO namely the retail customers to enter a usage focused business models as shown in model 2 and model 3. Since the homeowners from Scandinavia prefer to own their dishwasher most likely as this will be cheaper for them in the long run which is very clear from the interview findings as well. Hence, slowing the loop through providing functional business models is not suitable for the existing customer base and hence they are not considered further for this research.

In addition, Femenias and Geromel (2020) highlights that an average time of a private household retaining the same dishwasher can be as low as 7 years since kitchens have been found to be renovated every seven years and dishwashers are said to be replaced as a part of kitchen makeovers. So, the old dishwashers are sold in second hand markets if they are fully functional for aesthetical reasons. Further one more finding which is in line with the previous interview findings are people usually move to a new home every six or seven years and since there is a 5 year guarantee on all ASKO dishwashers and all the repair work would be taken care by ASKO during that guarantee period. People are not so interested in free maintenance service for the remaining two or three years

provided by ASKO in the subscription model (Femenias & Geromel, 2020). Hence, based on the above findings existing customer base is said to be excluded for further analysis and new potential customer segments were chosen as detailed below.

5.1.3 Existing Customer segments

The first model has customer segment who are retail customers, forming the major part of ASKO's existing customer base. Based on the findings obtained from the interview and workshop, the existing customer base prefer to own a new dishwasher through a one-time purchase and they are least expected to opt for functional business models where owning the appliance is not possible. Further, as per the empirical findings, the existing customer base is least interested in using refurbished machines. Hence there is a lower probability for this customer segment to either own a refurbished machine or use the refurbished machine under functional business models. Therefore, as per the findings obtained from the interview and workshop study, the existing customer base of ASKO consider owning a dishwasher as it is said to be economical for them and hence this customer segment is not considered for further analysis on refurbishment and usage focused business models.

Though existing one-time purchase business model is said to follow a linear economy, it is quite different in Sweden. As and when products are thrown into waste, they are sorted and recycled and thus showing the greater possibility of those recycled materials entering back into the production lines. This denotes closing the loop of circular economy and hence this model is not considered for further analysis.

5.1.4 Shortlisting focal customer segments

Upon excluding model 1 for further analysis, basic difference between model 2 and model 3 is highlighted for the ease of analysis. Basically model 2 uses new appliances and model 3 uses refurbished appliances and both are designed for usage focused business models. Further, based on the findings obtained from interviews and workshop, the housing companies are interested in using new appliances under subscription basis as they find it economical when compared to owning a new appliance. Hence the chance of them entering model 2 is quite high.

Further, as a part of their circular economy strategy, both companies are interested in using refurbished appliances as an initiative to close the loop and hence the probability of both companies entering model 3 is also quite high. Hence, in this research, both business models model 2 and model 3 are considered for further analysis as they are intended to housing companies Jemmett and Poseidon who primarily forms the B2B customer segments for ASKO in future.

5.2 Scenario analysis

“Scenario analysis is a method for predicting the possible occurrence of an object or the consequences of a situation, assuming that a phenomenon or a trend will be continued in the future” (Kishita et al., 2016).

Kosow et. al, (2008) explains that scenarios are “hypothetical constructs” and can be used as a communication tool to identify current state and predict the future state by generating knowledge on certain context through brainstorming. Further, it is used as a decision-making tool by identifying the key parameters and can be broadly classified into two types. First, the normative

scenarios are intended to design the goals for the desired future state and the thought process starts from the future and connect it with present whereas exploratory scenarios are used to identify feasible developments in the conceptual future state with the thought process beginning from the present state and explore how to reach the future state. Selection of suitable scenario techniques depends upon the research question.

In this case, exploratory scenario technique is used since it is the initial stage for ASKO to enter circular economy and hence we are not sure of the future desired state. So exploratory technique is used to identify the potential developments that can be done in present state of linear economy. This scenario analysis can be done by studying the potential key parameters and test the possible circumstances and enable decision making. This scenario analysis is based on the previous interview study and literature state to done to identify and highlight the central elements of the proposed circular business models for Jemmett and Poseidon. This approach will be more of a qualitative since it doesn't require any formalization and quantitative knowledge with long term chronological projection space (Kosow et. al, 2008).

The scenario analysis follows an exploratory approach to determine the feasibility and probability of previously developed models under various scenarios built to generate new insights on how one could efficiently design a circular economy business model under given circumstances. To initiate this scenario analysis, pricing of subscription models has to be done based on various parameters to effectively compare two models under different scenarios and decide the best model.

5.2.1 Pricing

The pricing strategy has been formulated to compare one time purchase of dishwashers with subscription models to assess the benefits and drawbacks involved in both the models. ASKO dishwasher's actual price ranges from 9000 SEK to 20000 SEK. Though there are numerous variants available with different prices, only 3 variants are chosen for this study for simple understanding. A low-end variant , mid-end variant and high-end variant are chosen for this study. The three variants are priced as follows.

- Low end variant costs 9000 SEK
- Mid-end variant costs 15000 SEK
- High-end variant costs 20000 SEK

The actual selling price would be considered for one time purchase where the breakdown or maintenance cost if any incurred has to be paid by the customer after 5 years of guarantee of ASKO machines. This cost varies with each machine depending on the customer usage and hence not considered for this research.

5.2.2 Subscription rate for new appliances

In practice, the subscription rate should be fixed by ASKO depending on various key factors. The subscription rate may also vary for different customers as per the contract fixed with their clients like the length of the contract, public or private customer, relationship between the customer, customer requirements and negotiations involved in a business scenario. But this preliminary analysis is done to ensure economic feasibility for both the actors involved i.e., the focal company and customers.

The subscription rate contains fixed and variable components. The annual usage cost of machine come under fixed component since it is based upon the selling price of machine. The fixed component is translated as base price and it doesn't change unless the selling price of the machine changes. But variable price can change as it covers maintenance charge, breakdown, and repair costs etc.,

Subscription rate = Base price + Variable price

5.2.2.1 Calculation of base price

The lifespan of any ASKO product is said to be a minimum of fifteen years but it is tested for full functionality until twenty years. So, in this context, lifespan of any ASKO machine is assumed to be 15 years. It might be replaced earlier or later than 15 years if the repair could not be fixed. But in this scenario analysis, for easy formulation, a proposition is made that any ASKO machine installed at customer's place under subscription basis would be replaced at the end of every fifteen years. And hence the subscription rate is calculated by dividing the entire selling price of ASKO machine by its lifespan. For example, low-end variant costs 9000 SEK whose lifespan is around 15 years and hence

$9000/15 = 600$ SEK.

600 SEK is the annual subscription rate for low-end variant.

So based on the above formulation, base price of three ASKO variants are calculated as below.

For low-end variant, $9000/15 = 600$ SEK

For mid-end variant, $15000/15 = 1000$ SEK

For high-end variant, $20000/15 = 1333 \approx 1330$ SEK

Further, B2B customer should take care of all expenses occurring due to maintenance, replacements, repairs since the customer retains the product ownership as common in any one time purchase. Since this varies depending on many factors like usage and utilization, that variable cost is not considered for this study.

For high-end variant, the subscription rate is rounded off from 1333 to 1330 SEK. Though it could impact the contract for 100 years financially, this small incentive is done to promote the high-end variant in subscription model because price could be an important factor in any B2B purchasing and hence there is lower probability of B2B customers choosing high-end variants as they are more expensive with no special reasons. So, this incentive can motivate any B2B customer to purchase high-end variants atleast in minimum quantities in cases like exclusively for luxurious apartments.

5.2.2.2 Calculation of variable price

In order to formulate variable price, the cost for maintenance, breakdown and replacement is fixed to be 5% of the annual subscription rate. But for promoting this model to reach more customers, the variable price is reduced from 5% to 2%. Hence for first 15 years, the variable price is charged as 2%. So for low-end variant, an annual maintenance cost of 12 SEK is added and for 15 years it is 180 SEK. For simple calculations, maintenance costs are fixed for the whole lifespan of the product.

Maintenance costs for low-end variant – (9000 *2)/100	=	180 SEK	(12 SEK per year)
Maintenance costs for mid-end variant – (15000 *2)/100	=	300 SEK	(20 SEK per year)
Maintenance costs for high-end variant– (20000 *2)/100	=	400 SEK	(27 SEK per year)

Hence for fifteen years, the variable price for low-end, mid-end and high-end variants are 180 SEK, 300 SEK and 400 SEK respectively. Therefore, the annual variable price of low-end, mid-end and high-end variant would be 12 SEK, 20 SEK and 27 SEK respectively.

5.2.2.3 Calculation of subscription price

Subscription price is sum of base price and variable price and hence annual subscription price would be as follows.

Annual Subscription price = Annual base price + Annual variable price.

Hence,

Annual subscription price for low-end variant, $600+12 = 612$ SEK

Annual subscription price for mid-end variant, $1000+20 = 1020$ SEK

Annual subscription price for high-end variant, $1330+27 = 1357$ SEK

Therefore, the annual subscription price for low-end, mid-end and high-end variant would be 612 SEK, 1020 SEK and 1357 SEK respectively.

Further, an incentive of 15% deduction in the base subscription rate is proposed for all repurchases from ASKO. To note, the variable pay will be changed from 2% to 5% for all repurchases. For calculation purposes, we can consolidate that there will be 10% deduction on the base subscription price and variable price will be excluded from repurchase. So, the subscription rate will change as follows for all repurchases i.e., at the end of 15 years.

Hence, annual subscription price in repurchase would be difference between the annual base price and deducted annual base price. Deducted annual base price is 10% of annual base subscription rate.

Annual subscription price for low-end variant in repurchase,
 $600 - 10\% \text{ of } 600 = 600 - 60 = 540$ SEK

Annual subscription price for mid-end variant in repurchase,
 $1000 - 10\% \text{ of } 1000 = 1000 - 100 = 900$ SEK

Annual subscription price for high-end variant in repurchase,
 $1330 - 10\% \text{ of } 1330 = 1330 - 133 = 1197$ SEK

5.2.3 Customer segments considered for the scenario analysis

The two potential customers identified for the scenario analysis are Jemmett and Poseidon. The reasons for them entering model 2 and model 3 were detailed as below.

As obtained from the previous findings, Jemmett is a housing developer who builds and owns the apartments. This scenario analysis is based on Jemmett's procurement demand of 100 dishwashers. Though they will keep constructing new apartments, this scenario is limited to their existing 100

apartments. For 100 new apartments, 100 dishwashers need to be procured. Their sustainability initiative enables them to join this initiative towards circular economy and hence they are interested in this circular business model.

Similarly, Poseidon is a municipal housing company who maintains their existing apartments. Currently, they are replacing 2 to 3 dishwashers every week for their 28000 apartments. So, this would come around to Poseidon purchasing 104 –156 dishwashers annually for their existing 28000 apartment. Since Poseidon is a municipal organization, their procurement partner HBV will have to pay for any new purchase or replacement since they are responsible for procurement of all appliances in housing. Poseidon will be responsible for any repair or minor fixing work. However, the clients here are public companies. Recently, Poseidon signed a voluntary agreement with the City of Gothenburg and also many other municipally managed companies to utilize recycled and refurbished products and this shows their interest towards having a circular business model.

In reality, one time replacing of all 28000 dishwashers with ASKO in one shot may result in wastage of existing fully functioning dishwashers which adversely impact the environment. While, Periodic replacing specifically annual replacing with current replacement rate of 104 to 156 dishwashers with ASKO machines would approximately take 180 to 270 years respectively to complete the process of fitting ASKO dishwashers in all 28000 apartments. Hence, this study is limited to purchase of 100 dishwashers by Poseidon as an initial testing of circular business models.

On overall, it is evident that there is a probability of both Jemmett and Poseidon availing the service of any of 3 variants or all three variants and hence this analysis is done for all three variants. This scenario analysis is done for the duration of 100 years assuming that the contract will be fixed for 100 years from subscribing to this business model to witness the benefits and challenges involved in such model for long term.

In this scenario analysis, we are comparing Jemmett or Poseidon under four following scenarios.

The four scenarios are as below.

Scenario 1 – Jemmett or Poseidon owning 100 new ASKO dishwashers

Scenario 2 – Jemmett or Poseidon subscribing 100 new ASKO dishwashers

Scenario 3 – Jemmett or Poseidon owning 100 refurbished ASKO dishwashers

Scenario 4 – Jemmett or Poseidon subscribing 100 refurbished ASKO dishwashers

5.2.3.1 Scenario 1 – Jemmett or Poseidon owning 100 new ASKO dishwashers

If Jemmett or Poseidon would buy 100 new dishwashers on all three variants, the total purchase cost would be 100 times the original price.

For low-end variant,

$$9,000*100 = 900,000 \text{ SEK} = 0.9 \text{ million SEK}$$

For mid-end variant,

$$15,000*100 = 1,500,000 \text{ SEK} = 1.5 \text{ million SEK}$$

For high-end variant,

$$20,000*100 = 2,000,000 \text{ SEK} = 2 \text{ million SEK}$$

Since Jemmett or Poseidon owns the dishwasher in this scenario, Jemmett or Poseidon would take care of all maintenance, breakdowns, and repairs on behalf of end user i.e., tenants here. Jemmett or Poseidon must pay for any repair, replacement which incurs in future. This cost highly varies from machine to machine depending upon the usage, utilization etc., and hence not considered for this study. Further B2B customers can avail some discounts on bulk purchase and repurchase of machines based on their contract with ASKO. Currently, ASKO doesn't have any contract with housing companies and hence there is no primary data available and hence the above mentioned parameters of maintenance charge and bulk discounts are not considered for this study.

Hence, the base price is considered as the least final price in this case. The purchase cost is calculated for the following time periods. At the end of 15 years, all 100 dishwashers has to be replaced so Jemmett or Poseidon should purchase a new one at the end of every 15 years. Let's say there is a contract between Jemmett or Poseidon and ASKO for 100 years, the cumulative purchase amount including the repurchase cost that Jemmett would pay towards ASKO is

Table 5.2 – Expenses for owning 100 new ASKO dishwashers under scenario 1

Years	Low-end variant	Mid-end variant	High-end variant
15 years	0.9 million	1.5 million	2 million
30 years	1.8 million	3 million	4 million
45 years	2.7 million	4.5 million	6 million
60 years	3.6 million	6 million	8 million
75 years	4.5 million	7.5 million	10 million
90 years	5.4 million	9 million	12 million
100 years	6.3 million	10.5 million	14 million

All the values listed above are in SEK.

So, at the end of 100 years, the total purchase cost of ASKO for all 3 variants after 1 initial purchase and 6 successful repurchases or replacements is as follows

For low-end variant, the one-time purchase price of 100 machines for 100 years is 6,300,000 SEK i.e., 6.3 million SEK

For mid-end variant, the one-time purchase price 100 machines for 100 years is 10,500,000 SEK i.e., 10.5 million SEK

For high-end variant, the one-time purchase price 100 machines for 100 years is 14,000,000 SEK i.e., 14 million SEK

5.2.3.2 Scenario 2 – Jemmett or Poseidon subscribing 100 new ASKO dishwashers

This scenario is based on Jemmett or Poseidon availing the service of 100 new dishwashers without retaining the ownership. ASKO will retain the ownership of dishwashers taking care of all maintenance, repairs, breakdowns, replacements etc., The financial incentives for Jemmett or Poseidon to enter this circular business model discussed under this scenario is as follows.

- The tenants residing at Jemmett or Poseidon will be end users of dishwashers where

Jemmett or Poseidon pays the subscription rate as fixed by the contract with ASKO and charges end user along with the rent. But Jemmett or Poseidon can charge higher subscription rate with the tenant depending on many other factors since both housing companies requires some profits as resulting from any business models

- In this case, Jemmett or Poseidon is not required to invest any upfront amount instead they pay small subscription fee on annual basis. Also, one time purchase of 100 dishwashers could be very expensive and could build high financial pressure on Jemmett or Poseidon.
- Jemmett or Poseidon does not require to pay for any skilled human resources for monitoring, maintaining, replacing, installing and repairing dishwashers since this will be done by ASKO or the third-party vendor certified by ASKO at the expense of ASKO.

The subscription rate for one machine for all three variants is obtained from previous formulations as

612 SEK for low-end variant,
1020 SEK for mid-end variant,
1357 SEK for high-end variant.

The subscription rate of 100 machines in initial purchase for all three variants is as follows

100 machines from low-end variant – $(612*100)$ = 61,200 SEK
 100 machines from mid-end variant – $(1020*100)$ = 102,000 SEK
 100 machines from high-end variant – $(1357*100)$ = 135,700 SEK

Similarly, the subscription rate for repurchase after every 15 years is as follows. (repurchase calculations are used from page 41)

100 machines from low-end variant – $(540*100)$ = 54,000 SEK
 100 machines from mid-end variant – $(900*100)$ = 90,000 SEK
 100 machines from high-end variant – $(1197*100)$ = 119,700 SEK

Based upon the above formulations, the cumulative subscription cost incurred for Jemmett or Poseidon for 100 years is as follows.

Table 5.3 Cumulative subscription rate for 100 new dishwashers under scenario 2

Years	Low-end variant	Mid-end variant	High-end variant
15 years	0.918 million	1.53 million	2.035 million
30 years	1.728 million	2.88 million	3.831 million
45 years	2.538 million	4.23 million	5.6265 million
60 years	3.348 million	5.58 million	7.422 million
75 years	4.158 million	6.93 million	9.2175 million
90 years	4.968 million	8.28 million	11.013 million
100 years	5.508 million	7.83 million	14.0145 million

For low-end variant, the subscription price of 100 machines for 100 years is 5.5 million SEK
 For mid-end variant, the subscription price 100 machines for 100 years is 7.83 million SEK
 For high-end variant, the subscription price 100 machines for 100 years is 14 million SEK

5.2.3.3 Scenario 3 – Jemmett or Poseidon owning 100 refurbished ASKO dishwashers

In this scenario one time purchase of refurbished appliances are considered. The cost of refurbished appliances is assumed to be half of the price of new dishwashers and this applies to all three variants of ASKO dishwashers. The lifespan of refurbished appliance is assumed to be ten years which is half of the ideal lifespan of any new dishwasher. If Jemmett or Poseidon would buy 100 refurbished dishwashers on all three variants, the total purchase cost would be

For low-end variant , $4500 \times 100 = 450,000$ SEK = 0.45 million SEK
 For mid-end variant , $7500 \times 100 = 750,000$ SEK =0.75 million SEK
 For high-end variant, $10000 \times 100 = 1,000,000$ SEK =1 million SEK

As discussed in Scenario 1 for one time purchase of any dishwasher be it new or refurbished appliance, Jemmett or Poseidon is responsible for all maintenance, breakdowns and repairs on behalf of end user i.e., tenants here. At the end of 10 years, all 100 dishwashers has to be replaced and this scenario considers the above factors for a period of 100 years. The cumulative purchase amount including the repurchase cost that Jemmett or Poseidon would pay towards ASKO is

Table 5.4 Expenses for owning 100 refurbished ASKO dishwashers under scenario 3

Years	Low-end variant	Mid-end variant	High-end variant
10 years	0.45 million	0.75 million	1 million
15 years	0.9 million	1.5 million	2 million
30 years	1.35 million	2.25 million	3 million
45 years	2.25 million	3.75 million	5 million
60 years	2.7 million	4.5 million	6 million
75 years	3.6 million	6 million	8 million
90 years	4.05 million	6.75 million	9 million
100 years	4.5 million	7.5 million	10 million

So, at the end of 100 years, the total purchase cost of ASKO for all 3 variants after 9 successful repurchase or replacement is as follows.

For low-end variant, the subscription price of 100 machines for 100 years is 4.5 million SEK.
 For mid-end variant, the subscription price 100 machines for 100 years is 7.5 million SEK.
 For high-end variant, the subscription price 100 machines for 100 years is 10 million SEK.

5.2.3.4 Scenario 4 – Jemmett or Poseidon subscribing 100 refurbished ASKO dishwashers

In this scenario, Jemmett or Poseidon would avail the service of 100 refurbished ASKO dishwashers without retaining the ownership. This model is estimated to possess immense economic and environmental benefits since refurbished appliances helps in closing the resource loop and cheaper compared to the previous three options. As discussed in scenario 2 as for any subscription models, ASKO will retain the ownership of dishwashers taking care of all maintenance, repairs, breakdowns, replacements etc., But the difference with the before case is these machines are refurbished by ASKO. Sometimes, the machines used by existing customer base are not fully utilized just because of the desire to fix new dishwasher in renovated kitchens from aesthetical point of view. In such case, if there is a supporting infrastructure to get those machines back, refurbish it and use them in case 3. The lifespan may drastically reduce from 15 years to 10 years. (ten years is just an assumption made. In reality, lifespan of any refurbished appliance depends upon present condition of refurbished appliance) Hence, the refurbished product price can be reduced to half of the original price.

The financial incentives for Jemmett or Poseidon to use refurbished machines is discussed as follows.

- The tenants residing at Jemmett or Poseidon will be end users of dishwashers where Poseidon or Jemmett pays the subscription rate as fixed by the contract with ASKO. But Poseidon or Jemmett can charge higher subscription rate with the tenant. The nominal profit rate is said to be around 6%.
- In this case, Jemmett or Poseidon is not required to invest any upfront amount instead they pay small subscription fee on annual basis, there will be no financial pressure regarding dishwashers.
- Jemmett or Poseidon does not require any collaboration and need not pay for any skilled human resources for monitoring, maintaining, replacing, installing and repairing dishwashers since this will be done by ASKO or the third-party vendor certified by ASKO at the expense of ASKO. No maintenance costs is added to the base subscription rate since it could be an incentive for customer to use refurbished machines.
- Since there is a government recommendation for Poseidon to use refurbished appliances, this model could be a big enabler for Poseidon to use refurbished dishwashers in the apartments. Similarly, Jemmett is a housing company pursuing sustainability and hence they would be interested in purchasing refurbished appliances which poses immense environmental benefits by closing the resource loop.

The subscription rate for one machine for all three variants is obtained from previous formulations as

300 SEK for low-end variant,
500 SEK for mid-end variant,
665 SEK for high-end variant.

For first year, the subscription rate for 100 machines is as follows

- 100 machines from low-end variant – 30,000SEK
- 100 machines from mid-end variant – 50,000 SEK
- 100 machines from high-end variant – 66,500 SEK

Similarly, the subscription rate for repurchase after every 15 years with 20% incentive is as follows

- 100 machines from low-end variant – 24,000 SEK
- 100 machines from mid-end variant– 40,000 SEK
- 100 machines from high-end variant – 53,200 SEK

Based upon the above formulation, the subscription rate is calculated for the span of 100 years is as follow. Cumulative subscription cost incurred for Jemmett or Poseidon for 100 years is as follows.

Table 5.5 Cumulative subscription rate for 100 refurbished dishwashers under scenario 4

Years	Low-end variant	Mid-end variant	High-end variant
10 years	0.3 million	0.5 million	0.665 million
15 years	0.42 million	0.7 million	0.931 million
30 years	0.78 million	1.3 million	1.729 million
45 years	1.14 million	1.9 million	2.527 million
60 years	1.5 million	2.5 million	3.325 million
75 years	1.86 million	3.1 million	4.123 million
90 years	2.22 million	3.7 million	4.921 millio
100 years	2.46 million	4.1 million	5.453 million

So, at the end of 100 years, the total purchase cost of ASKO for all 3 variants after 9 successful repurchase or replacement is as follows.

- For low-end variant, the subscription price of 100 machines for 100 years is 2.46 million SEK.
- For mid-end variant, the subscription price 100 machines for 100 years is 4.1 million SEK.
- For high-end variant, the subscription price 100 machines for 100 years is 5.453 million SE.K

Scenario analysis

Four different scenarios are defined as follows.

First scenario involves owning 100 new ASKO dishwashers whereas second scenario involves subscribing 100 new ASKO dishwashers. While, the third scenario deals with owning 100 refurbished ASKO dishwashers whereas fourth scenario deals with subscribing 100 refurbished ASKO dishwashers.

Since both scenario 1 and 2 involves new appliances whereas scenario 3 and 4 involves refurbished appliances, two separate comparisons are made for new and refurbished appliances to find whether owning or subscribing is cheaper over the span of 100 years.

From the above calculations, we find that over the span of 100 years, subscribing 100 dishwashers is found out to be cheaper than owning 100 dishwashers irrespective of new or refurbished appliances. Hence its noteworthy to identify the money that can be saved by choosing subscribing dishwashers than owning them.

This Savings are calculated based on the difference obtained between the expense incurred over owning and subscribing 100 dishwashers over the span of 100 years and tabulated as below.

Table 5.6 Savings obtained in all scenarios for 100 years

Years	New appliance			Refurbished appliance		
	Savings obtained in subscribing than owning a new appliance			Savings obtained in subscribing than owning a refurbished appliance		
	Low-end variant	Mid-end variant	High-end variant	Low-end variant	Mid-end variant	High-end variant
15 years	- 0.018 million	-0.03 million	-0.035 million	0.48 million	0.8 million	1.069 million
30 years	0.072 million	0.12 million	0.169 million	0.57 million	0.95 million	1.271 million
45 years	0.162 million	0.27 million	0.373 million	1.11 million	1.85 million	2.473 million
60 years	0.252 million	0.42 million	0.578 million	1.2 million	2 million	2.675 million
75 years	0.342 million	0.57 million	0.782 million	1.74 million	2.9 million	3.877 million
90 years	0.432 million	0.72 million	0.987 million	1.83 million	3.05 million	4.079 million
100 years	0.792 million	2.67 million	3.585 million	2.04 million	3.4 million	4.547 million

From the above table, the savings or profit is said to be generated at the end of 15years for jemmett or Poseidon. Until 15 years, owning a new appliance is seemed to be profitable than subscribing th new appliance. This is denoted by the negative values in the first row. This shows the maintenance cost in subscribing dishwasher which is paid by Jemmett or Poseidon towards ASKO but since the maintenance cost for one time purchase is not included, this negative value can be neglected and can be fixed to zero since the subscription cost for 15 years covers the selling price of product. So, the savings or profits generated at the end of 100 years through subscribing than owning 100 ASKO dishwashers is done as follows.

Table 5.7 Expenses incurred in all scenarios for 100 years

Variants	New appliance		Refurbished appliance	
	Owning	Subscribing	Owning	Subscribing
	Expense of scenario 1	Expense of scenario 2	Expense of scenario 3	Expense of scenario 4
Low-end variant	6.3 million SEK	5.5 million SEK	4.5 million SEK	2.46 million SEK
Mid-end variant	10.5 million SEK	7.8 million SEK	7.5 million SEK	4.1 million SEK
High-end variant	14 million SEK	10.4 million SEK	10 million SEK	5.4 million SEK

On comparing four different scenarios of owning and subscribing 100 new and refurbished ASKO dishwashers, We identify that the last column indicates reduced expenses of all other options which denotes scenario 4. Scenario 4 deals with subscribing to refurbished dishwashers over the span of 100 years and this is identified to be cheaper through the performed economic analysis. The detailed analysis is done in appendix 2.

A follow-up economic analysis is done to choose the least expensive and most profitable variant in subscribing a refurbished appliance to identify the expenses made and savings generated by each variant under different scenarios.

5.3 Economic analysis based on scenarios

Two-dimensional economic analysis is done to assess the following

- Least expensive variant
- Most profitable variant

A least expensive variant can be an affordable option especially for a startup companies. In this case, Jemmett can choose the least expensive variant.

Whereas, the most profitable variant need not necessarily be the least expensive one i.e., it is not the most affordable option but it has the ability to generate more profits over the long term than any other alternatives.

Least expensive variant and business model

The expenses incurred for each variant under four scenarios are tabulated as below. The first two scenarios deal with new appliance whereas the last two scenarios deal with refurbished appliances. The first and third scenario delas with owning an appliance whereas second and fourth scenario deals with subscribing an appliance.

Table 5.8 Least expensive variant and business model

Variants	Low-end variant				Mid-end variant				High-end variant			
	New appliance		Refurbished appliance		New appliance		Refurbished appliance		New appliance		Refurbished appliance	
	Owning	Subscribing	Owning	Subscribing	Owning	Subscribing	Owning	Subscribing	Owning	Subscribing	Owning	Subscribing
Years	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 1	Scenario 2	Scenario 3	Scenario 4
10 year	0.9 million	0.612 million	0.45 million	0.3 million	1.5 million	1.02 million	0.75 million	0.5 million	2 million	0.1357 million	1 million	0.665 million
15 year	0.9 million	0.918 million	0.9 million	0.42 million	1.5 million	1.53 million	1.5 million	0.7 million	2 million	2.0355 million	2 million	0.931 million
30 year	1.8 million	1.728 million	1.35 million	0.78 million	3 million	2.88 million	2.25 million	1.3 million	4 million	3.831 million	3 million	1.729 million
45 year	2.7 million	2.538 million	2.25 million	1.14 million	4.5 million	4.23 million	3.75 million	1.9 million	6 million	5.6265 million	5 million	2.527 million
60 year	3.6 million	3.348 million	2.7 million	1.5 million	6 million	5.58 million	4.5 million	2.5 million	8 million	7.422 million	6 million	3.325 million
75 year	4.5 million	4.158 million	3.6 million	1.86 million	7.5 million	6.93 million	6 million	3.1 million	10 million	9.2175 million	8 million	4.123 million
90 year	5.4 million	4.968 million	4.05 million	2.22 million	9 million	8.28 million	6.75 million	3.7 million	12 million	11.013 million	9 million	4.921 million
100 year	6.3 million	5.508 million	4.5 million	2.46 million	10.5 million	7.83 million	7.5 million	4.1 million	14 million	10.4145 million	10 million	5.453 million

From the above table, it is evident that low end variant is the most affordable or the least expensive option as it reduces the money spent towards an appliance. We focus on reducing expenses at this stage and hence it is appropriate to choose the least figures and hence subscribing low end variant is suggested to be the most affordable option as it cut down expenses.

Most profitable variant and business model

As already mentioned, the most profitable variant denotes the variant that generates more profit over the long run. In this case, we compare the profits for 100 years. Here, the profit denotes the savings obtained in subscribing an appliance compared to owning an appliance. The appliance can be new or refurbished.

From the previously conducted analysis, we are aware that subscribing an appliance is least expensive compared to owning and hence it would be appropriate to know how much money we can save while subscribing to a dishwasher than owning and hence separate analysis is conducted for new and refurbished appliance to find out the most profitable variant as follows.

Table 5.9 Most profitable variant and business model

Variants	Profits obtained					
	Low-end variant		Mid-end variant		High-end variant	
	Subscribing new appliance Vs owning new appliance	Subscribing refurbished appliance vs owning refurbished appliance	Subscribing new appliance Vs owning new appliance	Subscribing refurbished appliance vs owning refurbished appliance	Subscribing new appliance Vs owning new appliance	Subscribing refurbished appliance vs owning refurbished appliance
10 year	0.288 million	0.15 million	0.48 million	0.25 million	0.643 million	0.335 million

15 year	0.018 million	0.48 million	0.03 million	0.8 million	0.0355 million	1.069 million
30 year	0.072 million	0.057 million	0.12 million	0.95 million	0.169 million	1.271 million
45 year	0.162 million	1.11 million	0.27 million	1.85 million	0.3735 million	2.473 million
60 year	0.252 million	1.2 million	0.42 million	2 million	0.578 million	2.675 million
75 year	0.342 million	1.74 million	0.57 million	2.9 million	0.782 million	3.877 million
90 year	0.432 million	1.83 million	0.72 million	3.05 million	0.987 million	4.079 million
100 year	0.792 million	2.04 million	2.67 million	3.4 million	3.585 million	4.547 million

From the above table, it is evident that subscribing a refurbished top-end variant generates more profit or savings in the long run compared to the other alternatives. It is also noteworthy to mention that at the end of fifteen years, the top end variant didn't generate much profits but over the span of 100 years, we see that profits keep increasing than any other alternatives and hence it is advisable for any company to choose this option to generate more profits. In this case, it would be appropriate for Poseidon to choose subscribing a refurbished top end variant as they can afford this option and seeks to attain the benefits of having more profits. This option may not be appropriate for Jemmett since they are a beginner in construction business and hence at this point it would be better for them to choose the least expensive one to cut down costs incurred at the initial stages and once they reach the growth phase, they can switch gradually to the this most profitable option to generate more profits.

However, there are many other factors that can affect a company's decisions to choose the best option depending on their mission, customer's preference, project requirements etc.,

Limitations of Pricing

- Although it is widely said that the circular business models can be profitable in the long run, practical economic aspects are not researched. For example, impact of inflation on prices is not accounted in this proposed business model.
- In addition to this, the base subscription price is reduced over the years in the long run in accordance with the depreciation of the appliance. The data on depreciation amount is not available and hence it is not included in this research.
- Further, the overall pricing of refurbished appliances under subscription model can depend the current condition of the appliance. Although the appliance is refurbished, it is not a new appliance and hence the price can be reduced to 30% or 40% of the price of new appliance but consequently the lifespan of the appliance also varies.

Hence, this model should be validated in real time accommodating all the above data if made available in real time and consequently feasibility and profitability should be reassessed.

6. DISCUSSION

This chapter presents the interesting insights obtained from primary data collection in the previous results and triangulate those findings with those obtained from the literature study. Later, a discussion is developed with relation to the research question.

6.1 Circular design of dishwashers

This section covers the circular design aspects of dishwashers to find the significance of modularity, standardization, product circularity and best material selection to enable circular economy in ASKO's dishwashers.

Circular design of dishwashers is promoted as a significant part initially in promoting circularity for the household appliance industry by both academic and industrial experts. Though the focal company had no major change in product design for the last few years, it is said to have reached the saturation point in design aspects. All interviewees accept that modularity allows easy recycling and refurbishing in this case, the focal product is understood as not being able to be made more modular. The focal product is already more energy efficient and hence, most of the interviewees agree with the fact that no major design change is needed for ASKO's dishwasher in terms of circularity.

Regarding the materials used, all interviewees had similar opinion on usage of more long lasting and high-quality materials in production which can extend the lifespan of the product. ASKO already uses the durable and long-lasting stainless- steel interior for most of their appliances where most of the competitor products provide plastic interiors which is said to be major factor behind the long life of ASKO dishwashers.

Since all the materials used in ASKO dishwashers are of high quality, the price of ASKO dishwashers is generally expensive but it is justified by the product lifespan of 15 to 20 years. From a circularity perspective, slowing the loop can be achieved by multiple reuses of product which enables maximum utilization of the product. This further allows refurbishing products to extend their lifetime and recycle them to extract materials and use it back in the production line to enable further reconditioning and remanufacturing. Hence all interviewees agree upon that a circular business model can be developed with the existing product design. Even if a major design change is needed, the focal company should deeply consider it based on investments, time and efforts required to pursue that.

Apart from the design perspectives, Interviewees discussed some basic considerations required to make circular products with regards to closing the loop. Standardization of dishwashers and components can promote circularity since it allows high availability of spares for repairing dishwashers which extend the product lifespan. Further, freestanding dishwashers are mostly preferred for a circular kitchen which is easy to transport, install and repair and enables sharing by multiple users especially when they are offered in usage services like subscription models. The basic infrastructure required by the focal company for reverse logistics, refurbishment, recycling should be arranged by collaborating with key stakeholders is the key consideration addressed by most of the interviewees. Further, few interviewees recommend outsourcing the reverse logistics part if the focal company is not prepared to invest in such huge infrastructure.

On overall, the role of standardization, modularity, circular product design is not so significant in ASKO's case as ASKO has reached its mature phase in product design lifecycle and hence no redesigning the product is required. This reroute the strategy denoting that efforts should be made to focus on effective utilization of existing product lifespan in order to achieve slowing the resource loop.

6.2 Development of business models

This section focus on development of circular business models to achieve the benefits of circular economy by successfully enabling them in ASKO's dishwashers. This is done by exploring the present conditions of circular economy in kitchen appliance sector and promising future of usage focused business models in enabling circular economy.

The current level of circularity in appliance sector is below 1% as commented by IN 1 from CIK team and from the interview responses, it is evident that not so many companies have started practicing circularity in the appliance industry in Scandinavia, instead they choose sustainability route to reduce carbon footprints and acclaim their environmental contributions. But circular economy is broader than energy efficiency concept and hence expected to have a promising future. Further, there is an expectation that more companies will take this circular approach in future.

Though there are few companies practicing circularity on recommendations from national government, they are still in testing phase. As all organizations are not aware of the financial benefits of circular economy in long run, a strong demand is created for developing a circular business model to prove the financial viability with the help of usage focused business models. Usage focused business models could be a great enabler of circular economy since a product can be used by multiple users extending the product lifespan and slowing down the material flow in production helps reduce the production and thereby the material consumption which benefits the environment by preserving scanty natural resources.

As obtained from the interview and workshop findings, existing customers of ASKO i.e., the retail customers prefers ownership of products as it is considered to be cheaper in long run rather than sharing or using secondhand products as emphasized by usage focused business models. Also, different scenario exists in developing countries where they use least possible energy to produce products and devise cost effective strategy but might not contribute much in reducing carbon footprints. Hence there is a need for customizing business models depending on the context as one business model might not suit all contexts.

Almost all interviewees had opinion on the time taken to implement a circular business model. Some ascertain that it depends on many factors like market acceptance, incentives offered to promote the model, availability of suitable distribution channels etc., But all interviewees agreed that it can take from a minimum for 5 to 10 years depending on the business context.

Subscription model is considered more suitable for the focal company by most of the interviewees by excluding non-suitable models. Pay per use is more suitable for laundry machines since it is installed in a common place and multiple users can access from there. But it cannot be suitable for a dishwasher which has to be installed in user's private space called kitchen inside their homes. Despite all the challenges in transitioning to a circular model from linear model, almost all interviewees agreed that this subscription model can pose immense benefits for both customer and service in long run from various perspectives.

Challenges involved in developing a business model is discussed to find interesting insights. Setting price could be hard as IN 1 from CIK team affirms that we don't calculate the cost to the environment as we focus only on the economic aspects. IN 6 from ASKO confirms that there could be difficulties in tracking down the profits due to the monthly installments. Providing attractive incentives like free maintenance and breakdown services can promote this business model and attract customers. New business models usually make less sales in the beginning and hence promotions and incentives are considered an integral part.

On overall, suitable usage focused business models are identified for specific customer segments and some implementation concepts regarding enablers like incentives and challenges faced are studied.

6.3 Scope of refurbished appliances

This section covers the potential of refurbished appliances usage in closing the resource loop is studied to enable circular economy and practical aspects of using refurbished appliances are understood from enduser's perspectives

Appliances manufactured with circular intentions might have less appealing design and more expensive and people are not ready to pay. But in the case of refurbished appliances, though it is a reused product it is made to look like a new product both functionally and aesthetically. They are usually returned by customers to the manufacturer for small faults or damage in packaging.

But these refurbished appliances possess the potential scope of closing the resource loop which is the ultimate motive of circular economy. But end-user's acceptance and thoughts on using a refurbished product is considered significant for this research and hence all the interviewees provided their end-user aspect towards it.

Regarding the hygiene aspects, most of the interviewees expect the refurbished appliance to be sold directly from the manufacturer through other distribution channels with some sort of guarantees. The smell and odor in reused cooking appliances could be major complaint with secondhand users and hence that should be taken care by utilizing professional cleaning services. Since existing retail customers of ASKO have a low preference to use refurbished products or products as a service due to the economic reasons, this model is focused on B2B customers where in this case, the owners and developers of rental housing can see the economic benefits from cheaper options without the demand of paying high upfront amount and look for availing maintenance and breakdown services from the partner company.

To sum up, these business models built upon refurbished appliances require cooperation and collaboration from key stakeholders and actors on certain key aspects like refurbishing and logistics process and hence creating awareness of circular economy among them and motivating them internally and by providing incentives is considered important as agreed by most of the interviewees. Further appropriate customer segments has to be identified to develop a successful business model built upon refurbished appliances.

6.4 Economic analysis of business models under different scenarios

This section covers upon the findings obtained from economic analysis and scenario analysis built upon four combinations employing one time purchase and subscription model of new and

refurbished appliances . An economic analysis is followed to assess the profitability of proposed business models.

A scenario analysis is done to assess the feasibility and profitability of developed business models under four different scenarios. They are 1. Owning a new dishwasher through one time purchase 2. Availing the service of a new dishwasher without retaining the ownership 3. Owning a refurbished dishwasher through one time purchase 4. Availing the service of a refurbished dishwasher without retaining the ownership. A two-dimensional economic analysis is done over the period of 100 years to assess the least expensive variant and business model and the most profitable variant and business model. Scenario 4 is found to be both least expensive and most profitable among other three business models among other three scenarios.

This denotes availing the service of a refurbished dishwasher is least expensive and the most profitable option for both Jemmett and Poseidon over the period of 100 years as it generates the profit of 4.5 million SEK. Although this business model provides common results for both of them, the housing company should make perfect choice of variants under the same scenario 4 based on their economic conditions as explained below.

Poseidon is a well-established municipal housing corporation who owns and maintains the apartments and other white goods installed in the apartments. So, Poseidon has a stable economic structure and hence they might prefer a profitable scenario over reducing expenses. Further they have around 28000 apartments and hence if they choose more profitable model, they can generate more profits. Hence it would be appropriate for Poseidon to choose variant 3 under scenario 4 to generate more profits over the long run.

Whereas, Jemmett is a new housing developer in the market who owns, builds and maintains the apartments and the white goods installed in the apartment. Further, they have their new 100 apartments ready to occupy and other projects are in progress. So, it would be appropriate for them to choose the least expensive business model i.e., variant 1 and scenario 4 at present so that they can save more money by reducing the expenses and can use their capital for upcoming projects.

On overall, refurbished appliances under subscription business model may be profitable over the long run as shown in the proposed model but some real time conditions like accounting prices for inflation, depreciation of appliances, current condition after refurbishment, average life span of refurbished appliances must be included in pricing strategy so that the overall subscription rate will come down over the years in long run and hence it is not constant on every repurchase as shown in the proposed model.

7. CONCLUSION

The main aim of the thesis work was to close the resource loop by exploring various circular business models and design suitable one for the focal company which was accomplished. Although the literature study denotes that circular economy can unfold triple bottom line benefits by providing environmental, economic and social benefits most of the research on circular economy focus on the environmental aspects of circular economy. In order to bridge the research gap, this study focus upon proving the economic viability of a circular economy business models.

In order to develop such a profitable business model, qualitative data was collected through semi-structured interviews, workshops and preliminary literature review. As a result of data collection process, few insights are obtained which redirects the researcher to the basic three strategies of circular economy. All the three strategies are studied in this thesis to assess the suitability scenario for enabling circular economy in ASKO's dishwashers.

Regarding the first strategy of narrowing resource loop, ASKO's dishwashers already reached its mature product design phase and hence maximum circular product design is achieved already. Thus narrowing the resource loop is not appropriate for this context. Moving over to the second strategy of narrowing a resource loop, ASKO's dishwashers already have a long product lifespan but the real problem is the products are not effectively used until the end of life and hence to encourage slowing the resource loop, usage focused business model was brought up to discourage the product ownership by end users so that the service or functionality of the product is effectively used by multiple users until the end of product's life without retaining its ownership.

Surprisingly, retail customers who are the existing customers of ASKO are not interested in such usage focused business models due to their economic preferences and hence a new B2B customer segment like housing company is identified to be appropriate customer for such business models since they find this model more attractive due to the following reasons. First they are not interested in ownership of products and hence are not interested in one time purchase of products which actually requires huge investment from housing companies for hundreds of appliance. But if they choose the option of availing service of dishwashers, they are not required to pay huge upfront amount, instead they are required to pay an monthly or annual which can be covered from the housing rent paid by tenants.

Further, all maintenance services are handled by vendors of ASKO and hence its hassle free for an housing company to control those expenses related to maintenance and repair services. Incentives provided for repurchase of appliances from ASKO makes this model more attractive for B2B customers which appreciates them to set up a contract for 50 or 100 years which not only enables a win-win situation for both ASKO and housing companies but also successfully enable slowing the resource loop.

Further refurbished appliance are also introduced in these models in an attempt to close the resource loop which proves to be more economic for B2B customers over the long run. Further, with the usage of refurbished appliances they also accomplish regulations posed by policy makers like National Governments and European union in order to trigger initiatives for circular economy.

As a result, a subscription model was developed, and the findings are proposed based on a scenario analysis. The conducted two dimensional economic analysis clearly shows that the refurbished appliances under usage focused business models yield more profits and cut down the expenditure made by the B2B customer Jemmett and Poseidon when compared to linear traditional business models.

Further, Jemmett being a startup in housing industry can choose the least expensive business model which is availing a low end refurbished appliance on subscription which enables them to cut down expenses and save the capital for their upcoming projects. Meanwhile, Poseidon , a well-established housing company with over 28000 apartments can choose the most profitable business model which is availing a high end refurbished appliance on subscription which enables them to generate more profits as profits relatively increase with the number of apartments.

On overall, this study highlights that circular economy business models with usage focused approach can not only deliver immense environmental benefits but can be more profitable than linear traditional business models. The proposed model overcame the drawbacks associated with existing linear model and provides benefits associated with triple bottom line and contribute to a sustainable and functional way of doing business.

Although it is concluded that circular business models can be profitable in the long run, practical economic aspects are not researched in this thesis due to some limitations on availability of real time data . For example, impact of inflation on prices is not accounted in this proposed business model. In addition to this, the base subscription price is reduced over the years in the long run in accordance with the depreciation of the appliance. Further, the overall pricing of refurbished appliances under subscription model can depend the current condition of the appliance. Although the appliance is refurbished, it is not a new appliance and hence the price can be reduced to 30% or 40% of the price of new appliance but consequently the lifespan of the appliance also varies.

7.1 Managerial Recommendations

Based on the research findings, Some recommendations were developed for ASKO for both short term and long term and are listed below.

7.1.1 Short term recommendations

- Life cycle assessment of products under this subscription model is suggested to be made over the years in order to come up with the average lifespan of products and further identify the depreciation pattern of appliances and fix the replacement period of dishwashers accordingly.
- Post implementation of the subscription model, the focal company can do market research and analyze the profitability of the subscription model between different variants of dishwashers and can start focusing on the most profitable variants over the long term.
- Modularity in circular product design can reduce the material loss and wastage in refurbishment and remanufacturing and hence modularity in product design and development stage is suggested.
- Since the focal company also manufactures many other kitchen and household appliances

other than dishwashers, a suitable circular business model can be enabled for other products as well. For example, pay per use is suggested as more suitable model for washing machines in the common laundry room which encourages effective utilization of product by multiple users.

- More B2B business customer segments can be focused and targeted like student housing companies for the existing business model which can multiply the benefits obtained through this model.
- Further, several economic aspects like inflation has to be studied to come up with more appropriate pricing strategy for subscription models.

7.1.2 Long term recommendations

- Supplier management and stakeholder involvement is said to be more crucial for the overall success of the developed circular economy business model. Hence the focal company can collaborate with their material suppliers in the long term to create a reverse supply chain to enable a closed loop supply chain.
- Separate retail markets and distribution channels must be created for refurbished products and hence collaboration with third party vendors is said to make the process more feasible and profitable. Outsourcing the maintenance and breakdown services and reverse logistics related to refurbished products is suggested.
- Reverse logistics cost is more expensive in these types of circular business models and hence global pickup points are suggested over the long term.

7.2 Future Research

Since existing literature paid less attention towards implementation of circular economy business models especially in the kitchen appliances industry, this study aimed to bridge that research gap. However, this thesis is developed based on the results and findings obtained from a single company and hence it opens multiple arenas for future research. First, customers' perception of such business models can be studied in depth. Similarly other key actors involved in this supply chain network can be studied.

Further research can delve deeper on the aspects of involving key actors like suppliers, distributors, retailers in circular economy to close the resource loop and thereby add more value can be studied. Similar research on other white goods can be made to investigate suitable changes in business models that could provide interesting findings in future. Other usage focused business models like leasing, renting and sharing can be researched to effectively implement circular economy. In addition, there is no clear interpretation of circular economy implementation in existing research and to bridge the gap, research can be made on existing policies, rules, and regulations of circular economy.

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Appendices

Appendix 1

Interview guide

Product specific questions

Design

1. How efficiently could the circular economy be enabled from the design perspective?
2. When talking about circularity, will you suggest a complete new design for a product from scratch? Or will you prefer redesigning?(modularity)
3. What will be the impact in the economical aspects (sales, profit, position in the market etc.,) if a completely new design is developed?
4. What are the basic considerations needed for installing a dishwasher?
5. How does the built material of a product affect its circularity? What could be the materials suitable for a dishwasher in your perspective?

Development

6. What could be the drawbacks and limitations that could be expected when implementing circularity in household appliances (especially a dishwasher)?
7. What in your perspective are the potential barriers (technical) that are preventing a product from going circular?

Business model (project specific)

8. How in your opinion is circularity seen in the appliances sector, what is the level of importance given to circularity?
9. Do the existing markets seem supportive to circular business models? What is your view on it?
10. When converting from a linear business model to a circular business model, what are the basic factors that need to be considered?
11. What could be the average time needed to implement a circular business model for an existing product? (is less for new product or existing product)
12. What are the suitable business models that you would suggest for implementing circular economy in dishwashers?
13. What could be the possible challenges that are encountered while choosing a circular business

model?

14. Can you think of any trade offs that have to be made when implementing a circular business model for a dishwasher?
15. How could the involvement of the key stakeholders and suppliers be increased in promoting the circular economy in your opinion?
16. Is ATAG/ASKO practicing any implications of circularity into any of its products? If yes, what are the benefits and challenges that you are facing or faced?
17. People say “ sustainability in a linear economy focuses more on the same optimal point whereas a circular economy demands complete change of system”. What is your view on that

End User specific

18. How in your point of view, the quality and safety aspects are seen when going for a used or refurbished product (Preferably kitchen related products)?
19. What do you think about using a dishwasher without owning it? What are the factors to choose that?
20. If a high end, expensive dishwasher is expected to be offered as a subscription based product, what would be your thought, would you prefer to take its subscription ?

Appendix 2

Table 5.3 Subscription rate for 100 new ASKO dishwashers under scenario 2

Years	Variant 1	Variant 2	Variant 3
15 years	918000	1530000	2035500
30 years	810000	1350000	1795500
45 years	810000	1350000	1795500
60 years	810000	1350000	1795500
75 years	810000	1350000	1795500
90 years	810000	1350000	1795500
100 years	810000	1350000	1795500

Table 5.8 Subscription rate for 100 new dishwashers under scenario 4

Years	Variant 1	Variant 2	Variant 3
10 years	30000	50000	66500
15 years	24000	40000	53200
30 years	24000	40000	53200
45 years	24000	40000	53200
60 years	24000	40000	53200
75 years	24000	40000	53200
90 years	24000	40000	53200
100 years	24000	40000	53200

Economic analysis for Jemmett/Poseidon by comparing when owning a new appliance and using the new appliance under service basis without ownership.

Years	owning			subscription			Cheaper option			Cumulative subscription			savings for Jemmett/Poseidon in subscription		
	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3
	9000	15000	20000	612	1020	1357	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper						
	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper				838800	1398000	1864300
1 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	61200	102000	135700	838800	1398000	1864300
2 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	122400	204000	271400	777600	1296000	1728600
3 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	183600	306000	407100	716400	1194000	1592900
4 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	244800	408000	542800	1035600	1692000	2245200
5 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	306000	510000	678500	1326000	2091000	2872500
6 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	367200	612000	814200	1581600	2484000	3366800
7 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	428400	714000	949900	1771200	2772000	3761100
8 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	489600	816000	1085600	1960800	2961600	4055400
9 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	550800	918000	1221300	2150400	3151200	4349700
10 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	612000	1020000	1357000	2339200	3340800	4544000
11 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	673200	1122000	1492700	2528000	3530400	4738300
12 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	734400	1224000	1628400	2716800	3720000	4932600
13 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	795600	1326000	1764100	2905200	3901600	5126900
14 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	856800	1428000	1899800	3090000	4082400	5321200
15 year	900000	1500000	2000000	61200	102000	135700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	918000	1530000	2035500	3274800	4263200	5515500
1st replacement															
				540	900	1197									
16 years	1800000	3000000	4000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	972000	1620000	2155200	3460800	5652000	7500000
17 years	1800000	3000000	4000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1026000	1710000	2274900	3648000	5840000	7890000
18 years	1800000	3000000	4000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1080000	1800000	2394600	3836000	6028000	8080000
19 years	1800000	3000000	4000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1134000	1890000	2514300	4024000	6216000	8270000
20 years	1800000	3000000	4000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1188000	1980000	2634000	4212000	6404000	8460000
21 years	1800000	3000000	4000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1242000	2070000	2753700	4400000	6592000	8650000
22 years	1800000	3000000	4000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1296000	2160000	2873400	4588000	6780000	8840000
23 years	1800000	3000000	4000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1350000	2250000	2993100	4776000	6968000	9030000
24 years	1800000	3000000	4000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1404000	2340000	3112800	4964000	7156000	9220000
25 years	1800000	3000000	4000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1458000	2430000	3232500	5152000	7344000	9410000
26 years	1800000	3000000	4000000	594000	990000	1316700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1512000	2520000	3352200	5340000	7532000	9600000
27 years	1800000	3000000	4000000	648000	1080000	1436400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1566000	2610000	3471900	5528000	7720000	9790000
28 years	1800000	3000000	4000000	702000	1170000	1556100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1620000	2700000	3591600	5716000	7908000	9980000
29 years	1800000	3000000	4000000	756000	1260000	1675800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1674000	2790000	3711300	5904000	8096000	10170000
30 years	1800000	3000000	4000000	810000	1350000	1795500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1728000	2880000	3831000	6092000	8284000	10360000
31 years	2700000	4500000	6000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1782000	2970000	3950700	6280000	9500000	12540000
32 years	2700000	4500000	6000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1836000	3060000	4070400	6468000	9690000	12730000
33 years	2700000	4500000	6000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1890000	3150000	4190100	6656000	9880000	12920000
34 years	2700000	4500000	6000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1944000	3240000	4309800	6844000	10070000	13110000
35 years	2700000	4500000	6000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	1998000	3330000	4429500	7032000	10260000	13300000
36 years	2700000	4500000	6000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2052000	3420000	4549200	7220000	10450000	13490000
37 years	2700000	4500000	6000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2106000	3510000	4668900	7408000	10640000	13680000
38 years	2700000	4500000	6000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2160000	3600000	4788600	7596000	10830000	13870000
39 years	2700000	4500000	6000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2214000	3690000	4908300	7784000	11020000	14060000
40 years	2700000	4500000	6000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2268000	3780000	5028000	7972000	11210000	14250000
41 years	2700000	4500000	6000000	594000	990000	1316700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2322000	3870000	5147700	8160000	11400000	14440000
42 years	2700000	4500000	6000000	648000	1080000	1436400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2376000	3960000	5267400	8348000	11590000	14630000
43 years	2700000	4500000	6000000	702000	1170000	1556100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2430000	4050000	5387100	8536000	11780000	14820000
44 years	2700000	4500000	6000000	756000	1260000	1675800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2484000	4140000	5506800	8724000	11970000	15010000
45 years	2700000	4500000	6000000	810000	1350000	1795500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2538000	4230000	5626500	8912000	12160000	15200000
46 years	3600000	6000000	8000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2592000	4320000	5746200	9100000	12350000	15390000
47 years	3600000	6000000	8000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2646000	4410000	5865900	9288000	12540000	15580000
48 years	3600000	6000000	8000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2700000	4500000	5985600	9476000	12730000	15770000
49 years	3600000	6000000	8000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2754000	4590000	6105300	9664000	12920000	15960000
50 years	3600000	6000000	8000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2808000	4680000	6225000	9852000	13110000	16150000

Years	owning			subscription			Cheaper option			Cumulative subscription			savings for Jemmett/Poseidon in subs		
	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3
51 years	3600000	6000000	8000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2862000	4770000	6344700	738000	1230000	1655300
52 years	3600000	6000000	8000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2916000	4860000	6464400	684000	1140000	1535600
53 years	3600000	6000000	8000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	2970000	4950000	6584100	630000	1050000	1415900
54 years	3600000	6000000	8000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3024000	5040000	6703800	576000	960000	1296200
55 years	3600000	6000000	8000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3078000	5130000	6823500	522000	870000	1176500
56 years	3600000	6000000	8000000	594000	990000	1316700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3132000	5220000	6943200	468000	780000	1056800
57 years	3600000	6000000	8000000	648000	1080000	1436400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3186000	5310000	7062900	414000	690000	937100
58 years	3600000	6000000	8000000	702000	1170000	1556100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3240000	5400000	7182600	360000	600000	817400
59 years	3600000	6000000	8000000	756000	1260000	1675800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3294000	5490000	7302300	306000	510000	697700
60 years	3600000	6000000	8000000	810000	1350000	1795500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3348000	5580000	7422000	252000	420000	578000
													0	0	0
61 years	4500000	7500000	10000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3402000	5670000	7541700	1098000	1830000	2458300
62 years	4500000	7500000	10000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3456000	5760000	7661400	1044000	1740000	2338600
63 years	4500000	7500000	10000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3510000	5850000	7781100	990000	1650000	2218900
64 years	4500000	7500000	10000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3564000	5940000	7900800	936000	1560000	2099200
65 years	4500000	7500000	10000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3618000	6030000	8020500	882000	1470000	1979500
66 years	4500000	7500000	10000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3672000	6120000	8140200	828000	1380000	1859800
67 years	4500000	7500000	10000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3726000	6210000	8259900	774000	1290000	1740100
68 years	4500000	7500000	10000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3780000	6300000	8379600	720000	1200000	1620400
69 years	4500000	7500000	10000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3834000	6390000	8499300	666000	1110000	1500700
70 years	4500000	7500000	10000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3888000	6480000	8619000	612000	1020000	1381000
71 years	4500000	7500000	10000000	594000	990000	1316700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3942000	6570000	8738700	558000	930000	1261300
72 years	4500000	7500000	10000000	648000	1080000	1436400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	3996000	6660000	8858400	504000	840000	1141600
73 years	4500000	7500000	10000000	702000	1170000	1556100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4050000	6750000	8978100	450000	750000	1021900
74 years	4500000	7500000	10000000	756000	1260000	1675800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4104000	6840000	9097800	396000	660000	902200
75 years	4500000	7500000	10000000	810000	1350000	1795500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4158000	6930000	9217500	342000	570000	782500
76 years	5400000	9000000	12000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4212000	7020000	9337200	1188000	1980000	2662800
77 years	5400000	9000000	12000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4266000	7110000	9456900	1134000	1890000	2543100
78 years	5400000	9000000	12000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4320000	7200000	9576600	1080000	1800000	2423400
79 years	5400000	9000000	12000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4374000	7290000	9696300	1026000	1710000	2303700
80 years	5400000	9000000	12000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4428000	7380000	9816000	972000	1620000	2184000
81 years	5400000	9000000	12000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4482000	7470000	9935700	918000	1530000	2064300
82 years	5400000	9000000	12000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4536000	7560000	10055400	864000	1440000	1944600
83 years	5400000	9000000	12000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4590000	7650000	10175100	810000	1350000	1824900
84 years	5400000	9000000	12000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4644000	7740000	10294800	756000	1260000	1705200
85 years	5400000	9000000	12000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4698000	7830000	10414500	702000	1170000	1585500
86 years	5400000	9000000	12000000	594000	990000	1316700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4752000	7920000	10534200	648000	1080000	1465800
87 years	5400000	9000000	12000000	648000	1080000	1436400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4806000	8010000	10653900	594000	990000	1346100
88 years	5400000	9000000	12000000	702000	1170000	1556100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4860000	8100000	10773600	540000	900000	1226400
89 years	5400000	9000000	12000000	756000	1260000	1675800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4914000	8190000	10893300	486000	810000	1106700
90 years	5400000	9000000	12000000	810000	1350000	1795500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4968000	8280000	11013000	432000	720000	987000
91 years	6300000	10500000	14000000	54000	90000	119700	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	5022000	8370000	11132700	1278000	2130000	2867300
92 years	6300000	10500000	14000000	108000	180000	239400	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4266000	7110000	9456900	2034000	3390000	4543100
93 years	6300000	10500000	14000000	162000	270000	359100	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4320000	7200000	9576600	1980000	3300000	4423400
94 years	6300000	10500000	14000000	216000	360000	478800	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4374000	7290000	9696300	1926000	3210000	4303700
95 years	6300000	10500000	14000000	270000	450000	598500	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4428000	7380000	9816000	1872000	3120000	4184000
96 years	6300000	10500000	14000000	324000	540000	718200	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4482000	7470000	9935700	1818000	3030000	4064300
97 years	6300000	10500000	14000000	378000	630000	837900	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4536000	7560000	10055400	1764000	2940000	3944600
98 years	6300000	10500000	14000000	432000	720000	957600	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4590000	7650000	10175100	1710000	2850000	3824900
99 years	6300000	10500000	14000000	486000	810000	1077300	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4644000	7740000	10294800	1656000	2760000	3705200
100 years	6300000	10500000	14000000	540000	900000	1197000	Subscription is cheaper	Subscription is cheaper	Subscription is cheaper	4698000	7830000	10414500	1602000	2670000	3585500

Appendix 2 is based on the economic analysis which is basically a comparison of expenditure for owning a new dishwasher and availing the service of new dishwasher without owning it. So basically, it is an economic analysis done between a linear business model and circular business model.

Explanation for economic analysis :

The first column denotes the number of years the machine is availed for subscription. The next three columns named “owning” denotes the amount spent by the customer towards owning the machine for three different variants with three different prices. The following three columns named “subscription” denotes the amount spent by the customer towards availing the service of dishwashers under subscription basis without owning. The following three columns named “cheaper option” denotes the cheapest option among owning and subscribing three variants by calculating the difference between the expenditure on both models. “Cumulative subscription” denotes the total expenditure spent under subscription package for all three variants from year 1 until the current year. The last column “savings for customer” denote the savings generated by selecting the cheapest option i.e., the subscription model by comparing it against owning the dishwasher.

Similarly appendix 3 illustrates the economic analysis for comparing the purchase of refurbished appliances vs subscribing the refurbished appliances for 100 machines.

Appendix 3 is as follows:

Appendix 3

Economic analysis for Jemmett/Poseidon by comparing when owning a new appliance and using the new appliance under service basis without ownership.

years	owning			subscription			Cheaper option			Cumulative subscription			savings for jemmett from subscrip		
	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3
1 machine	4500	7500	10000	300	500	665	subscription is cheaper	subscription is cheaper	subscription is cheaper						
100	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper						
1 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	30000	50000	66500	420000	700000	933500
2 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	60000	100000	133000	390000	650000	867000
3 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	90000	150000	199500	360000	600000	800500
4 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	120000	200000	266000	330000	550000	734000
5 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	150000	250000	332500	300000	500000	667500
6 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	180000	300000	399000	270000	450000	601000
7 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	210000	350000	465500	240000	400000	534500
8 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	240000	400000	532000	210000	350000	468000
9 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	270000	450000	598500	180000	300000	401500
10 year	450000	750000	1000000	30000	50000	66500	subscription is cheaper	subscription is cheaper	subscription is cheaper	300000	500000	665000	150000	250000	335000
													0	0	0
11 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	324000	540000	718200	576000	960000	1281800
12 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	348000	580000	771400	552000	920000	1228600
13 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	372000	620000	824600	528000	880000	1175400
14 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	396000	660000	877800	504000	840000	1122200
15 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	420000	700000	931000	480000	800000	1069000
16 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	444000	740000	984200	456000	760000	1015800
17 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	468000	780000	1037400	432000	720000	962600
18 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	492000	820000	1090600	408000	680000	909400
19 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	516000	860000	1143800	384000	640000	856200
20 year	900000	1500000	2000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	540000	900000	1197000	360000	600000	803000
													0	0	0
21 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	564000	940000	1250200	786000	1310000	1749800
22 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	588000	980000	1303400	762000	1270000	1696600
23 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	612000	1020000	1356600	738000	1230000	1643400
24 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	636000	1060000	1409800	714000	1190000	1590200
25 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	660000	1100000	1463000	690000	1150000	1537000
26 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	684000	1140000	1516200	666000	1110000	1483800
27 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	708000	1180000	1569400	642000	1070000	1430600
28 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	732000	1220000	1622600	618000	1030000	1377400
29 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	756000	1260000	1675800	594000	990000	1324200
30 year	1350000	2250000	3000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	780000	1300000	1729000	570000	950000	1271000
													0	0	0
31 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	804000	1340000	1782200	996000	1660000	2217800
32 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	828000	1380000	1835400	972000	1620000	2164600
33 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	852000	1420000	1888600	948000	1580000	2111400
34 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	876000	1460000	1941800	924000	1540000	2058200
35 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	900000	1500000	1995000	900000	1500000	2005000
36 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	924000	1540000	2048200	876000	1460000	1951800
37 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	948000	1580000	2101400	852000	1420000	1898600
38 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	972000	1620000	2154600	828000	1380000	1845400
39 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	996000	1660000	2207800	804000	1340000	1792200
40 year	1800000	3000000	4000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1020000	1700000	2261000	780000	1300000	1739000
													0	0	0
41 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1044000	1740000	2314200	1206000	2010000	2685800
42 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1068000	1780000	2367400	1182000	1970000	2632600
43 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1092000	1820000	2420600	1158000	1930000	2579400
44 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1116000	1860000	2473800	1134000	1890000	2526200
45 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1140000	1900000	2527000	1110000	1850000	2473000
46 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1164000	1940000	2580200	1086000	1810000	2419800
47 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1188000	1980000	2633400	1062000	1770000	2366600
48 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1212000	2020000	2686600	1038000	1730000	2313400
49 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1236000	2060000	2739800	1014000	1690000	2260200
50 year	2250000	3750000	5000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1260000	2100000	2793000	990000	1650000	2207000

Years	owning			subscription			Cheaper option			Cumulative subscription			savings for customer		
	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3	variant 1	variant 2	variant 3
51	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1284000	2140000	2846200	1416000	2360000	3153800
52	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1308000	2180000	2899400	1392000	2320000	3100600
53	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1332000	2220000	2952600	1368000	2280000	3047400
54	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1356000	2260000	3005800	1344000	2240000	2994200
55	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1380000	2300000	3059000	1320000	2200000	2941000
56	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1404000	2340000	3112200	1296000	2160000	2887800
57	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1428000	2380000	3165400	1272000	2120000	2834600
58	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1452000	2420000	3218600	1248000	2080000	2781400
59	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1476000	2460000	3271800	1224000	2040000	2728200
60	2700000	4500000	6000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1500000	2500000	3325000	1200000	2000000	2675000
													0	0	0
61	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1524000	2540000	3378200	1626000	2710000	3621800
62	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1548000	2580000	3431400	1602000	2670000	3568600
63	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1572000	2620000	3484600	1578000	2630000	3515400
64	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1596000	2660000	3537800	1554000	2590000	3462200
65	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1620000	2700000	3591000	1530000	2550000	3409000
66	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1644000	2740000	3644200	1506000	2510000	3355800
67	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1668000	2780000	3697400	1482000	2470000	3302600
68	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1692000	2820000	3750600	1458000	2430000	3249400
69	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1716000	2860000	3803800	1434000	2390000	3196200
70	3150000	5250000	7000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1740000	2900000	3857000	1410000	2350000	3143000
													0	0	0
71	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1764000	2940000	3910200	1836000	3060000	4089800
72	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1788000	2980000	3963400	1812000	3020000	4036600
73	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1812000	3020000	4016600	1788000	2980000	3983400
74	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1836000	3060000	4069800	1764000	2940000	3930200
75	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1860000	3100000	4123000	1740000	2900000	3877000
76	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1884000	3140000	4176200	1716000	2860000	3823800
77	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1908000	3180000	4229400	1692000	2820000	3770600
78	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1932000	3220000	4282600	1668000	2780000	3717400
79	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1956000	3260000	4335800	1644000	2740000	3664200
80	3600000	6000000	8000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	1980000	3300000	4389000	1620000	2700000	3611000
													0	0	0
81	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2004000	3340000	4442200	2046000	3410000	4557800
82	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2028000	3380000	4495400	2022000	3370000	4504600
83	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2052000	3420000	4548600	1998000	3330000	4451400
84	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2076000	3460000	4601800	1974000	3290000	4398200
85	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2100000	3500000	4655000	1950000	3250000	4345000
86	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2124000	3540000	4708200	1926000	3210000	4291800
87	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2148000	3580000	4761400	1902000	3170000	4238600
88	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2172000	3620000	4814600	1878000	3130000	4185400
89	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2196000	3660000	4867800	1854000	3090000	4132200
90	4050000	6750000	9000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2220000	3700000	4921000	1830000	3050000	4079000
													0	0	0
91	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2244000	3740000	4974200	2256000	3760000	5025800
92	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2268000	3780000	5027400	2232000	3720000	4972600
93	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2292000	3820000	5080600	2208000	3680000	4919400
94	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2316000	3860000	5133800	2184000	3640000	4866200
95	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2340000	3900000	5187000	2160000	3600000	4813000
96	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2364000	3940000	5240200	2136000	3560000	4759800
97	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2388000	3980000	5293400	2112000	3520000	4706600
98	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2412000	4020000	5346600	2088000	3480000	4653400
99	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2436000	4060000	5399800	2064000	3440000	4600200
100	4500000	7500000	10000000	24000	40000	53200	subscription is cheaper	subscription is cheaper	subscription is cheaper	2460000	4100000	5453000	2040000	3400000	4547000

DEPARTMENT OF ARCHITECTURE AND
CIVIL ENGINEERING
CHALMERS UNIVERSITY OF TECHNOLOGY

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