Circular Instrument Management as Corporate Social Responsibility Initiative for Sustainable Healthcare

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ABSTRACT
The paper analyses the relationship between Corporate Social Responsibility (CSR) and the Circular Economy (CE). This paper is based on a literature review complemented by an analysis of the outcome of a real business case of instrument repair and circular reprocessing of surgical instruments. The authors have examined the impact of extending the product life cycle of surgical instruments using certified repair and refurbishment instead of replacing it with new instruments. Surgical instruments were collected, repaired and refurbished into new manufacturing condition. More than one ton of rejected instruments were collected from four different hospitals during a period of six months. One container of 100 Kg with disposable and contaminated instruments was collected and, after disinfection in a thermal washing machine, melted and recycled to new raw material. This raw material was used on a water jet cutting machine to make new components for surgical instrument mesh baskets. The outcome indicates that circular models such as the reprocessing of medical waste are feasible, leading to the prevention of waste and reduction of costs associated with waste management.

Keywords: Corporate Social Responsibility, Circularity, Circular Economy, Circular Instrument Management, Sustainable Healthcare,

INTRODUCTION

Research questions
Socially responsible management practices and Corporate Social Responsibility (CSR) may provide sustainable benefits to society and contribute to sustainable business. Corporate Social Responsibility is also termed as CSR, sustainable business, responsible business1, 2, 3. To address the impact and effectiveness of such benefits, the following research questions are proposed:
- How can circularity and circular economy models contribute to sustainable healthcare?

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• How will circularity concerning CSR contribute to society and protection of our natural resources?

In essence, Corporate Social Responsibility is about making ethical decisions and contributing to society. These research questions are formulated from the assumption that business ethics leads to the central question of how responsible one wants to be to society. The term ethics is derived from the Greek word ethikos which itself is derived from the Greek word ethos, meaning custom or character. In philosophy, ethical behaviour is something that is ‘good’. The field of ethics or moral philosophy involves developing, defending, and recommending concepts of right and wrong behavior.

Business ethics often referred to as corporate ethics, is a form of applied ethics or professional ethics, that examines ethical principles and moral or ethical problems that can arise in a business environment. It applies to all the aspects of business conduct and is relevant to the conduct of individuals and entire organisations.

OBJECTIVE
The objective of this paper is to create an overview of the relation between Corporate Social Responsibility (CSR) and the Circular Economy (CE). Seen from the perspective of a circular business case, the paper presents conceptualisation of CSR in healthcare using ‘Circular Instrument Management’ in hospitals. Furthermore, the objective is to determine the effectiveness of Circular Instrument Management as a circular tool within Corporate Social Responsibility.

CORPORATE GOVERNANCE VERSUS CORPORATE SOCIAL RESPONSIBILITY
Literature review of Corporate Governance shows that it is a broad term defining different methods, structures and processes of an organisation. It describes the business and affairs of the organisation managed and directed towards fair play in business conduct. Corporate Governance furthermore, enhances the long term shareholder value by means of accountability of managers and augmentation of the organisation’s performance. It furthermore, eliminates the conflict of ownership and control by separately defining the interest of shareholders and management.

The development of the link between Corporate Governance and Corporate Social Responsibility at an organisational level seems to be a global phenomenon. Corporate Governance and Corporate Social Responsibility may not always be aligned, where Corporate Governance is a system of mechanisms helping to ensure that investors get a return on their investments. Corporate Social Responsibility is concerned with creating a balance between economic and social goals of business encompassing the effective use of resources, accountability in the use of its power, and the behaviour of the company in its social environment.

Such behaviour may positively influence all of its stakeholders if it results in a contribution to the society. There are many forms and CSR programs which result in increased customer loyalty. Even more, it may result in increased acceptance of the organization by the society. These days, many businesses adopt and determine sustainable strategies which are embedded in Corporate Social Responsibility programs which are used as powerful reputation management tools as well. Some examples of common Corporate Social Responsibility programs are given as under:

• Reduction of carbon footprints to mitigate climate change.
• Improving labour policies and embrace fair trade.
• Engaging in charitable giving and volunteer efforts within the local community.
• Changing corporate policies to benefit the environment.
• Making socially and environmentally conscious investments.
• Reducing carbon footprints and climate change.

Corporate Social Responsibility programs not only bring an economic benefit; it may also lead to buying loyalty from all of the stakeholders. In fact, Corporate Social Responsibility is a fundamental choice of the organization to give back to the society in a meaningful manner.

CIRCULAR ECONOMY MODELS AS A POSSIBLE APPROACH WITHIN CORPORATE SOCIAL RESPONSIBILITY

The Circular Economy has gained significant interest around the world. Circularity means an economic system in which waste is minimised or even completely reused\(^1\). Circularity can be achieved through maintenance, repair, reuse, remanufacturing, refurbishing and recycling of materials. This is in contrast to a linear economy which is based on a ‘take, make, dispose’ model of consumption patterns\(^2\).

The challenge in the circular economy is to change the chain from ‘make-use-throw away’ to ‘make-use-reuse’. In this way, we prevent to deplete our natural resources using reusing these resources after using them. The current economic paradigm based on increasing human population, economic development, and standard of living, is no longer compatible with the biophysical limits of the finite earth. The continuing global crisis is also due to the scarcity of critical resources\(^3\). The constant need for raw materials is gradually depleting natural resources. Our mass consumption society contributes to our constant need for more products, and therefore there is a growing need for products that require natural resources at a rapidly growing rate resulting in further depletion of these resources.

The earth’s population in 1800 counted 1 billion, having taken all of human history to reach that number. Only two centuries later, the global population is 6 billion, half of which lives in cities\(^4\). The world’s population has touched a mark of 7.3 billion in 2015 and could attain growth level of 9-12 billion before the year 2050\(^5\). If the growth of the demand from the growing population continues at this rate, by 2030 with a global population of 10 billion people, two piles of the earth will be needed to satisfy all of the population’s demands. Planet Earth cannot resist such demands on natural resources. The environmental impact will be too significant. Since the 1970s, the global population has doubled, and the global Gross Domestic Product has grown fourfold\(^6\).

The earth will not be able to cope with these growth rates and demands on natural resources, which means that renewable resources such as water and forests cannot exceed the rate of regeneration. For non-renewable resources such as fuels, the rate of use cannot exceed the rate of inventing sustainable substitutes of these non-renewable resources. Metal-ore extraction and metal production increased three-fold from 1970 to 2010. The steepest increase occurred from 2000 to 2010\(^7\).

The Report of the International Resource Panel, 2017 (assessing global resource use, based on a material resources database that covers almost five decades (1970 to 2017) and 191 countries) shows that existing trends forecast global material reached 88.6 billion tonnes in 2017 –more than three times the amount used in 1970. The report further explains the demand for materials which
have shifted from renewable to non-renewable resources, reflecting the global trend away from traditional towards modern technologies, and from agriculture-based economies to urban and industrial economies. This creates new waste flows - thereby increasing emissions and pollution. Data in this report show the steep increases in demand for metal ores, like iron, have contributed to sharp rises in greenhouse gas emissions, aquatic ecotoxicity and emissions of smog-forming substances.

Materials and products have historically been sourced from low-income countries bearing the burden of local impacts of resource extraction but also resulting in long-distance transportation routes to high-income countries. On the other hand, however, waste export of high-income countries to low-income countries seems to be significant too. In 2018, the Netherlands exported 6.847 thousand tonnes of recyclable metal waste only. That is 3 per cent more than in 2010\textsuperscript{18}. The recyclable plastic waste that was exported to foreign countries in 2018 amounted to 361 thousand tons, which was 6 per cent less than in 2017. Although a large part of the waste is processed in the Netherlands, still Indonesia imported 25.000 tons of Dutch plastic in 2018, compared to 1.000 in 2017. Furthermore, the Netherlands export waste to other countries, including Germany, Vietnam and Turkey. Taking into account the CO\textsubscript{2} emission when transporting the waste by Sea Freight towards its destination, it may be considered to find alternatives such as the application of circular methods locally.

FORMULATION OF THE UNITED NATIONS (UN) SUSTAINABLE DEVELOPMENT GOAL 12 (SDG 12)
Ensuring Sustainable Consumption and Production Patterns
The United Nations defines that at the current time, material consumption of natural resources is increasing, particularly within Eastern Asia. Countries are also continuing to address challenges regarding air, water and soil pollution. Since sustainable consumption and production aims at ‘doing more and better with less’, the UN further elaborates on net welfare gains from economic activities which can increase by reducing resource use, degradation and pollution along the whole life cycle, while increasing quality of life. There also needs to be a significant focus on operating on the supply chain, involving everyone from producer to the final consumer. This includes educating consumers on sustainable consumption and lifestyles, providing them with adequate information through standards and labels and engaging in sustainable public procurement, among others. The formulation of goal number 12 by the UN regards the responsible consumption and production, which aims to reshape consumption and production by transforming resource use in a way that reduces pressures on the environment and climate while at the same time promoting human and economic development.

The Circular Economy
A new economic paradigm, such as the circular economy, is needed to improve the protection of our natural resources. Responsible consumption and productivity with lower material and energy requirements, as well as reducing waste and emissions are the worthy imperatives. Circular Economy models aim at minimising waste. Minimising such waste with circularity in an economic system can be achieved through maintenance, repair, reuse, remanufacturing, refurbishing, recycling of products. This is in contrast to a linear economy which is based on a 'take, make, dispose' model of consumption patterns\textsuperscript{19}.

A closed economy system and a renewed economic model in which materials from discarded products are reprocessed and reintroduced as new products in the market. Furthermore, circular
economy products may be offered as services, paying for a product per time of use instead of purchasing the product. One method is to collect the product at the end of the product life cycle and either refurbish it to new manufacturing’s condition or reuse its materials to manufacture new products.

Recycling is, therefore, an essential aspect of the circular economy. Components and products need to be recycled at the end of the life cycle if we want to prevent it from becoming waste. This means that maximising the effort for collecting discarded products, materials and waste requires investigation and experiments to explore the possibilities as well as the limits and the dynamics of the circular system. Recovering materials such as metals and plastics in such a way that is not only efficient but also economical is a welcome initiative. Separating these collected materials is an important aspect to take into consideration, meaning the separation based on material specifications before reprocessing these materials.

The composition of products and all of the losses of materials, metals, alloys. These losses ideally should be minimised, resulting in optimal recycle potential. Unique processes need to be developed for products consisting of multiple compositions such as metal and plastics. Furthermore, the quality of recycled material needs to be secured. With metal materials, one of the possibilities is to regulate the process and supplying material certificates. A quality document often used in the metals industry, confirming the properties of the material as supplied after recycling. These properties often are referred to international standards, including ANSI and ASME.

All parties involved in the circular chain include those who initially designed and supplied the products, the users, parties involved with the collection of the waste, waste separation, waste recycling, material supply and manufacturers using the recycled material, notified bodies and authorities as well as the end-users and possibly other stakeholders. The performance of the circular economy depends on all of these stakeholders and their willingness to co-operate. Maximising circular economy efficiency means that maximising resource efficiency and processing is of crucial importance. The recyclability of materials will generate possibilities shortly helping to protect our earth’s natural resources by making it possible to use the same metals or other materials that have been used before.

All depends upon the availability of the materials to be recycled. These quantities should be equal to our annual need for consumption. The use of metals, for instance, is increasing exponentially due to needing in construction, resulting in a life cycle and long-lasting use. This limits the possibilities for recycling since the materials will be available after a long period. However, unlike other raw materials, metals have great potential for recycling. They do not lose their properties during recycling resulting in possibilities for multiple uses. They seem to have more permanent characteristics than other materials such as food, fossil fuels, etc. Especially materials such as stainless steel have great possibilities as a permanently available resource when appropriately recycled.

However, the complete circular chain needs to have specific attention when optimising circular models. Circular product designs, low-carbon transport, limiting transport and freight distance and using renewable energies. Keeping track of and continuous analyses of the impact on the environment of all the process steps in this chain are essential in order to determine the impact on society. The demand for materials keeps on increasing as the world population remains to grow. As
the costs for conventional sourcing of raw materials increases, the opportunity for recycling and reusing materials efficiently and the reintroduction of valuable materials results in significant benefits.

A CIRCULAR BUSINESS CASE

A circular model was introduced by Van Straten Medical, a developer, manufacturer and global supplier of surgical instruments, with facilities in Europe in The Netherlands as well as in Germany. The circular approach was introduced using reusing hospital instrument waste, in particular discarded and rejected surgical instruments and other stainless steel waste – using it as a material for reuse in manufacturing of new medical products such as surgical instrument mesh baskets and components for mesh baskets. The objective was to demonstrate that cost savings could be realised for hospitals using instrument repair and refurbishment on the one hand and recycling of instruments if they could not be repaired in order to be reused on the other hand.

A program was implemented named ‘Circular Instrument Management’ (CIM) and divided into two categories:

- Focus on instrument repair instead of instrument replacement in order to extend the life cycle of medical instruments.
- Recycling of rejected medical instruments when they could not be repaired using melting it into new raw material. Also, single-use instruments were included.

The services and experiments were setups having diverse machinery through which instrument repair and refurbishment is carried out for hospitals. The process of instrument repair and refurbishment, including instrument maintenance activities, was validated on forehand. The measurement of quality and consistency of the quality was seen as of great importance about the high standard of instrument repair services. The quality of a refurbished instrument should meet the standard of new manufacturing’s condition. A quality assurance program was implemented according to ISO 13485:2016 in order to validate the refurbishment process. ISO 13485 is a tool which reassures that the medical devices are being manufactured through a systematic approach to make them safer for use. Device manufacturers need to follow ISO 13485 for marketing their device globally. If a manufacturer meets the requirements of ISO 13485, the device can quickly meet the quality requirements in many regulated countries including the US. Repair and refurbishment were regarded as having a nexus with manufacturing processes resulting in the application of ISO 13485:2016. The ISO 9001 in the case of instrument repair and refurbishment was not regarded as sufficient since ISO 13485 is a Quality Management Standard, specifically targeted for the manufacturing of medical devices. These quality standards refer to continued improvements in products or manufacturing processes as instrument repair and refurbishment may be regarded as such.

The new revision of the ISO 13485 (Medical devices – Quality management systems – Requirements for regulatory purposes) underlines both risk management and usability engineering. For this reason, a Risk Assessment, according to ISO 14971 was conducted on the process of instrument repair, refurbishment and instrument maintenance. ISO 13485 and ISO 14971 standards were applied in the repair and maintenance of surgical instruments in order to maintain regulatory compliance accurately. It furthermore, combines the GMP and ISO requirements (ISO 13485 and ISO 14971).
Next to instrument repair, experiments were conducted with rejected instruments made from stainless steel as well as with single-use instruments. The objective was to determine whether the instruments could be recycled using melting and reuse as new raw material. Surgical instruments are generally made from stainless steel, in particular stainless steel type 316SS. Stainless steel is an alloy of mainly iron, chromium, nickel and carbon. Stainless steel should have a minimum of chromium, usually 11 to 12% and a maximum of carbon, usually 1.2%. Molybdenum, titanium, manganese, nitrogen and silicon are also present in many types of stainless steel. The stainless steel type 316L – where L stands for low carbon- has less carbon in order to limit corrosion sensitivity after welding.

The objective of this type of material is that corrosion is prevented as is needed with surgical instruments. These instruments are washed intensively in hospitals in thermo disinfectors using chemicals to disinfect. After disinfection, the instruments are sterilised in most European countries in autoclaves reaching temperatures of 134 degrees Celsius. The characteristics of stainless steel are very suitable under these conditions but also to have it used as raw material for making surgical instruments. The material is furthermore, suitable for recycling and reuse.

The combination of repair and refurbishment with the recycling of medical instruments when they could not be repaired anymore resulted in the program ‘Circular Instrument Management’ (CIM). Prominent within this CIM program was to create effective outcomes. The circular approach is intended to save not only locally but should have positive effects globally. Waste management, primarily when exported to other countries, leads to global effects with footprints.

Globalisation, therefore, has its effects on Corporate Social Responsibility. Increased awareness of what happens next door, environmental changes, and other influences may lead to a drive for a sustainable global economy. International guidelines such as the UN, millennium goals and Organization for Economic Co-operation and Development (OECD) set the tone for international social norms. Reducing carbon footprints on the one hand and protecting our scarce natural resources, on the other hand. When using a circular approach by refurbishing surgical instruments and recycling to new materials when they cannot be refurbished lead to less replacement with new instruments.

Generally, medical instruments are imported from other countries and therefore, shipped across the globe. The shipment and movement of these products can be measured in terms of carbon footprint using various methods for carbon footprint calculations. The carbon footprint can be defined as a measurement of the total Greenhouse Gas (GHG) emissions caused directly and indirectly by an individual, an organisation, event or product and is expressed as a carbon dioxide equivalent (CO$_2$). The CO$_2$ of a new medical or surgical instrument supplied in order to replace a discarded instrument can be calculated taking into consideration the carbon footprint of the manufacturing of the instrument, generating the packaging which is often made out of plastic as well as the calculation of CO$_2$ emissions along freight transport chains.

Furthermore, some surgical instruments are partly manufactured in Asia, then shipped to Germany to be further processed and packed before being exported to various other countries. A great deal of the surgical instrument manufacturers are concentrated in Tüttlingen, Germany, which is located in the south of the country near the border of Switzerland. These German-based companies manufacture a large part of the world’s surgical instrument supply. Tüttlingen’s instrument manufacturers are closely linked with medical manufacturing’s concentrations in Pakistan.
The surgical instruments sector exemplifies how globalisation promotes the emergence of commodity chains and in turn, how commodity chains foster globalisation. Dominated by two clusters of small scale producers in Sialkot (Pakistan), Tüttlingen (Germany) and a few large subsidiaries like in Penang (Malaysia), the industry’s dynamic depends on global buyers and their shifting ties to end-customers, hospitals and surgeons.23

Semi-finished instruments are, therefore, frequently imported from countries such as Malaysia and Pakistan. These semi-finished products are generally finished in Tüttlingen, laser marked, branded and packed. The carbon footprint of these instruments when part-manufactured in Asia or Pakistan, freighted to Tüttlingen and exported to any country in the world, contributes to higher CO2 emissions than when it would be manufactured at one destination or when locally circularly refurbished and recycled. Local circular instrument programs could, therefore, contribute to lower CO2 emissions when compared to the conventional approach.

Comparing local circular programs with conventional ‘replace-with-new-products’ would be beneficial for determining the impact of the different approaches. A wide range of methodologies and tools are available for the calculation of carbon footprints of freight transport, based on varying emissions data, routing and allocation assumptions and conflicts between actual and assumed vehicle loading performance. The European EN 16258 standard provides the most comprehensive framework to date about global emission calculation standard applicable to the carbon footprinting of freight transport. Stakeholders have quickly become aware of EN 16258 and are keen to understand its requirements and the implications for the way that they currently approach their carbon footprint calculations.24

Understanding the effects on aspects such as carbon footprint, waste reduction and contribution to society is of great importance within Corporate Social Responsibility. Corporate Social Responsibility programs need to prove their effectiveness and not used in terms of greenwashing. The term greenwashing is typically used as a pejorative, referring to the practice of construing an activity as more environmentally friendly than it really is.25

Social auditing could be of benefit in proving the effectiveness of Corporate Social Responsibility programs. A social audit is a process in which details of the resources, both financial and non-financial, used by public agencies for development initiatives are shared with the people, often through a public platform. Social audits allow people to enforce accountability and transparency, providing the ultimate users of services and projects with an opportunity to scrutinise development initiatives. It is a form of citizen advocacy based on the power of knowledge and is grounded in the right to information.26 A social audit is a formal review or examination of a company’s responsibility and impact on society, regarded as an assessment of how effective the company’s goals and strategy are in terms of social responsibility. These audits may help any type of organisation to determine if their objectives are reasonable and practical. A social audit is a method to determine if the actions taken are being received and relates that information to the organisation’s public image meeting environmental and social standards. Social audits can help companies create, improve, and maintain a positive public image.

The circular business case, as described in this article, leads to effective reuse of waste and even further prevents waste. In terms of effectiveness, it seems that what is claimed is effectively there, namely new products manufactured out of collected waste. The complete circular chain within this
business case was given special attention and could even be possibly further optimised. Collection of the waste in the four hospitals was done by road; however, combined with other collections in order to limit the logistical movements. In order to have the melting process as efficient as possible, the stainless steel waste collected was separated by Van Straten Medical based on material specification. After reprocessing, the metal sheets were stored in a central warehouse 6.4 km from the location of Van Straten Medical. The metal sheets were cut into smaller plates and transported 6.4 km to Van Straten Medical when used for further manufacturing of medical components. Effects of the carbon footprint of the supply of these components depend on the location of the end-user.

METHODOLOGY
This paper consists of a literature review in combination with the analysis of the outcome of an existing business case of instrument repair and circular reprocessing of old instruments. The combination of the outcome was reflected in the definition of corporate social responsibility. First, papers and abstracts were screened using researchgate.net and Google Scholar using search terms ‘Corporate Social Responsibility (CSR)’, ‘Responsible Corporate Management (CRM)’ and ‘Corporate Governance’.

A review was conducted of the papers selected. The selection process has been expanded to search for the CG-CSR nexus. Afterwards, a nexus was made to a real business case and practical experiments with circular reprocessing of hospital waste in The Netherlands. These experiences were included in this paper. A Dutch company implemented corporate Social Responsibility within a real-life context - Van Straten Medical-, a manufacturer and supplier of surgical instruments who investigated and implemented a program to collect hospital waste, in particular stainless steel waste consisting of rejected stainless steel surgical instruments, rejected stainless steel mesh baskets as well as used stainless steel disposable instruments. This waste was collected at different hospitals during a period of six months.

The company has been active since 1975 on the healthcare market, introducing instrument repair services actively since 2008. These activities were started-up as a commercial service upon the hospital’s request. In 2018 these services were expanded to collect instruments which were discarded as well as stainless waste such as obsolete instruments and instrument mesh baskets from different hospitals. The material was deposited since September 2018 in dedicated containers. These containers, when full, were collected by a metal reprocessing and recycling company. This company reprocessed the stainless steel waste and had it melted in melting furnaces, after which it was processed into metal sheet of 1 – 1.5 mm thickness. These metal sheet plates were cut into smaller plates. The metal sheet in turn was acquired from the same metal reprocessing company and used to manufacture new medical products and parts such as components used for instrument fixation where surgical instruments are fixated into stainless steel mesh baskets. Furthermore, complete mesh baskets were made from recycled stainless steel.

Van Straten Medical aimed to close the circular loop by:

- Extending the product life cycle of surgical instruments using certified repair and refurbishment instead of replacing it with new instruments.
- Preventing waste by collecting used disposable instruments, rejected/scrapped instruments and other waste, and had it melted and reprocessed into sheet metal for reuse in the manufacturing new medical components and products.
Experiments were conducted with rejected and disposable instruments and waste made from stainless steel, grades 304SS and 316SS. It was determined whether it could be recycled using melting and reprocessing to the sheet metal of plates of 1 – 1.5 mm thickness. The plates were cut in smaller pieces and supplied to Van Straten Medical who used it as new raw material for the manufacturing of components used in instrument and mesh basket fixation.

RESULTS
Surgical instruments were collected, repaired and refurbished into new manufacturing’s condition. These instruments -if not repaired- would have been discarded otherwise and processed through the conventional waste procedure. A total of 1.380 Kg of rejected and disposable instruments and stainless steel waste was collected from four different hospitals during the same period between 25 September–30 March 2019. One container of 100 Kg with disposable used and contaminated instruments was collected by Van Straten Medical and, after disinfection in a thermal washing machine, melted through a reprocessing company.

All of the collected materials were melted and recycled to the sheet material. The sheet material was cut into smaller pieces and used to manufacture components for instrument mesh baskets and stainless steel components used in instrument fixation. The sheet metal cut plates were used in a Water Jet Cutting Machine at Van Straten Medical to cut components for surgical instrument mesh baskets and mesh basket instrument fixation. The leftover machining material was then returned to the circular container to be picked up for circular melting. In this way, no waste would be generated during the process.

This paper reviewed the outcome of the circular approach of reprocessing stainless steel waste into new raw material and reflected this approach with a literature review on Corporate Social Responsibility. One of the outcomes of this research is that circular models such as the processing of medical waste is feasible, leading to the prevention of waste and reduction of costs associated with waste management? The environmental impact, although needed to be researched further, is positively influenced by the reuse of waste and therefore has a nexus with Corporate Social Responsibility and may, therefore, be seen as a possible method of Corporate Social Responsibility.

CONCLUSION
Reflecting on Corporate Governance about Corporate Social Responsibility comes down to comparing the separation of ownership from control and effective management to the impact on the social environment. Corporate governance is a broad term defining different methods, structures, whereas Corporate Social Responsibility is concerned with creating a balance between economic and social goals; however, they may contribute to one another. Such programs may have a positive influence on all of its stakeholders if it results in a positive contribution to society. It may even contribute to buying loyalty from its stakeholders.

Focussing on Corporate Social Responsibility is a fundamental choice and may be carried through a variety of programs. The circular program -named circular instrument management- was regarded as a Corporate Social Responsibility program. The results of this circular program demonstrate that circular reprocessing of surgical instruments and stainless steel waste into new raw material can be used for the manufacturing of new medical products. Furthermore, it may not only contribute to waste prevention but also to save costs, as is the case with contaminated and non-contaminated hospital waste management.
Further research in recycling, refurbishment, remanufacturing, and reuse of medical products is needed primarily due to its impact on society and CO₂ emissions. Future research could further identify which alternatives could reduce the CO₂ footprint associated with hospital waste. Waste is not only processed locally but also exported overseas over long distances to other countries resulting in CO₂ emissions which could be reduced using local circular reprocessing. A comparison in terms of CO₂ footprint of refurbished surgical instruments as opposed to replacement with new instruments is necessary, taking into account not only the manufacturing of new instruments but also the shipment of these instruments as well as the impact of creating waste when throwing away these instruments.

The various methodologies could be further examined such as the different circularity approaches, possible surgical designs of medical products, facilitating easier circular reprocessing after use of the products as well as circular reprocessing of other materials then stainless steel. It may be concluded that circularity and circular economy models contribute to Corporate Social Responsibility—a contribution to the entire society, involving multiple countries. The final conclusion is one of optimism. Metals are excellent materials for a circular economy and Circular Instrument Management. The instruments can be recycled again and again without losing their properties. There is an alternative to the use of natural resources. Circular methods such as refurbishment and reprocessing of waste seem to be valid with surgical products made from stainless steel grades 304SS and 316SS. These sustainability programs contribute to international ambitions, preserving our planetary natural resources. The scarcity of our natural resources, leading to price increases and longer lead times of products, maybe resolved by innovative and circular solutions being part of Corporate Social Responsibility programs.

**AUTHOR CONTRIBUTIONS AND DISCLOSURE**
This paper formed part of a Ph. D. research. Dr. Nupur Tiwari supervised the research, advised and proofread the paper. Dr. Nupur Tiwari was lecturing professor on a Ph. D. seminar ‘Corporate Social Responsibility’ at the International Business School, The Hague, The Netherlands. B. J. van Straten is General Manager at Van Straten Medical and is specialising on Circular Economy models as alternatives for sustainable healthcare and has joined the research line of Dr. Ir. Ing. T. Horeman Delft University of Technology – Circularity for Sustainable Surgery.

**ENDNOTES**
2. Mackey, John and Sisodia, Rajendra, Conscious Capitalism (2013)
4. A B C Internet Encyclopaedia of Philosophy "Ethics"


