Spectrum of Circular Economy and its Prospects in Logistics

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Abstract
The paper explores and reviews the concept of Circular Economy (CE) by conducting a systematic literature review (SLR) to develop an in-depth understanding of the growing trends of CE, its framework, implementation, and barriers. The overview of published literature is pigeon-holed under 10 dimensions. Furthermore, the paper explores the attention given to the Logistics sector from the perspective of Circular Economy and highlights the need for in-depth research to develop new frameworks/models for CE’s implementation in the Logistics sector to establish Circular Logistics as an outcome.

Keywords
Circular Economy; Circular Logistics; Sustainability; Environmental.

1. Introduction
Rapid growth in technological advancement, automation, and development of cross border trade has and is changing the rules of the game for businesses. This development has raised the standards of production and living, and made life easier for consumers, but at the same time it has also raised serious concerns due to excessive resources depletion and that the current economic system is developed with no concern for the environment and clue for recycling (Su et al., 2013). Jowit (2008) clearly marks it as an ‘ecological credit crunch’ that the world is heading to, with approximately resource usage ratio being 30% higher than the earth can replenish each year.

Such concerns have not just surfaced recently but have gained the attention of scholars since the last 5 decades, in particular, when Boulding (1966) pointed out the damages caused to the environment and resource depletion. Over the last two decades, the concept of sustainability has gained momentum and as a result a newer concept, i.e. Circular Economy, has emerged. CE is believed to have its origin in Ecological and Environmental Economics (Ghisellini et al., 2016) and Eco-Industrial Development (EID), which suggest that both a healthy economy and a healthy environment can coexist (Geng & Doberstein, 2010).

In realisation of the fact that the current production and consumption pattern are not long lasting (Jowit, 2008), businesses have been forced to rethink their strategy to minimise their negative impact to the environment and resource depletion. Over the last two decades, the concept of sustainability has gained momentum and as a result a newer concept, i.e. Circular Economy, has emerged. CE is believed to have its origin in Ecological and Environmental Economics (Ghisellini et al., 2016) and Eco-Industrial Development (EID), which suggest that both a healthy economy and a healthy environment can coexist (Geng & Doberstein, 2010).

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This paper is of an exploratory nature and by no means it intends to neglect the importance of technology and its development, rather the paper focuses on the attitude towards the environment, sustainability, and future generations; under the current economic system and its implications to the field of Logistics. The emergence of this concept is indeed timely and in realisation of its necessity, therefore the contemporary nature of this paper is highly concurrent.

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The remainder of this paper addresses the following topics: Section 2 covers the research methodology followed by this research; Section 3 defines the CE concept, its framework, and an overview of published literature; Section 4 discusses the prospects of CE in Logistics, and barriers/enablers in its implementation; and finally, Section 5 provides the conclusions.

2. Research Methodology
The recent attention paid to the concept of CE has attracted authors to explore its scope and implementation in different dimensions, including the field of Logistics. This research firstly analyses the published literature utilising a systematic literature review (SLR) adapted from Garza-Reyes (2015). Figure 1 provides an overview of the SLR by describing its phases, objectives, methods adopted, tools utilised, and their location within the article. On the other hand, Figure 2 presents a glance of descriptive analyses of the published literature in terms of journal publications on the topic of CE, reports published by organisations working with CE, and books published from 1990 to December 2016.

![SLR Phases Diagram](image-url)

*Figure 1: SLR phases, objectives, methods, tools and location within the article (adapted from Garza-Reyes, 2015).*

Papers and articles were searched online using the keywords ‘Circular’, ‘Circular Economy’, and ‘Circular Logistics’; and were accessed using Science Direct (www.sciencedirect.com), Emerald Insight (www.emeraldinsight.com), Inderscience (www.inderscience.com), Springer (www.springer.com), Taylor & Francis (www.tandfonline.com), IEEE Xplore (ieeexplore.ieee.org/Xplore/home.jsp), Google Scholar (scholar.google.co.uk), websites of organisations working/promoting CE (e.g. www.ellenmacarthurfoundation.org; circle-economy.com; www.wrap.org.uk; www.mckinsey.com), and reports from their respective authors’ websites. These databases were considered major sources of information to establish an understanding of the CE concept and to develop arguments for further research needed within the field of Logistics. The major criteria for the selection of published work was that it had to explore the scope of CE, building on, expanding the understanding, and exploring further research possibilities by identifying any gaps in the development/implementation of CE in the field of Logistics. The research only included articles which had been published with direct focus, and within the purview of Circular Economy/System. Any paper written with
similar ideas but not directly addressing them from this perspective of CE were excluded. For instance, ‘Green Logistics’, where it did not establish any direct relation to Circular Economy.

2.1 Descriptive Analysis
Based on the SLR, the research included the review of 10 books, 13 reports published precisely to address the topic of CE, its development, strategies, implications, and evaluation, and 106 journal and conference articles published in well-known journals. Figure 2 below presents infographics of the descriptive data.

![Infographics of descriptive data](image)

**Figure 2:** Descriptive data - (a) Proportion of journal, books and reports publication, (b) Year of publication

3. Circular Economy – Development & Definition
The concept of CE has evolved over last 5 decades, but it is believed that its roots cannot be traced back to any specific point in time (Webster, 2015) and that it has existed for much longer than it is thought to be (Murray et al., 2015). The core uniqueness of the concept is its contrast to the linear approach of taking – making – disposing (Ellen MacArthur Foundation, 2015), also known as “Cradle to Grave” (Braungart, 2002), and introducing new concept of ‘roundput’ instead of ‘throughput’ where the resources are used but not used up (Webster, 2015). In published work, the concept is believed to be conceived by a pioneer environmental economist, Professor Kenneth E. Boulding (1966) under the realisation of resource scarcity, climate change, and attitude towards these problems (George et al., 2015).

3.1 Definition(s) of CE
At first glance, it might appear to be that CE is perhaps a new title, cover, and wrapping to the concept of recycling, but at a closer examination, it is evident that there is a difference between the two as CE does envelop the concept of recycling within its broader scope but recycling does not have the same privilege. Past development in the forms of Green (McKinnon et al., 2010), Ecological, Environmental Friendly, Sustainability, Lean (Thomas Goldsby, 2005), Just-in-Time - JIT (Liker, 2004), Recycling, and other similar concepts have their significance but they all seem to be more reactive. Within the realm of current challenges, new and different rules of game are needed (Webster, 2015) as scholars believe that the economic growth model over last 250 years has been living on borrowed time (Lacy & Rutqvist, 2015). CE emerges with a more proactive approach, by tackling the problem of resource depletion (Gregson et al., 2015) (Singh & Ordonez, 2015) (Li et al., 2013), resource efficiency (Hu et al., 2011) (Schulte, 2013), and environmental issues at the stage of design of products and services (Velis, 2015), instead of managing the issue at the end of life cycle (Ellen MacArthur Foundation, 2015). The following four definitions of CE lay a foundational understanding to develop further arguments on their basis.

“A circular economy is one that is waste-free and resilient by design. It is a new economic model that is ambitious as well as practical. Designing the economy in a way that is restorative of ecosystems, ambitious with its innovation, and impactful for society, is a bold challenge but one that is achievable when guided by the principles of the circular economy” (Circle Economy, 2016).

“In a circular economy profits, jobs and growth come not from extracting, moving, shaping, selling and dumping ever more resources, but from the work done and value created by handling resources with sufficient care that ecosystems and total natural resources actually expand, making it possible to meet human needs everywhere” (Greyson, 2015).

“The circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles” (Ellen MacArthur Foundation, 2015).

“The circular Economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimises, tracks, and hopefully eliminates the use of toxic chemicals; and eradicates waste through careful design” (Webster, 2015).
These definitions address the production (and service) process as a whole within one concept by focusing on pretty much an integrated supply chain mechanism. The concept ensures that the system must be mindful of resource depository, design/process development for the maximum utility, and output to be designed with maximum life cycle and end of life cycle management.

3.2 Architectural Framework of Circular Economy

Rapid developments over the concept of CE are emerging, and three major frameworks which are overlapping on few aspects emerge to define the spectrum of Circular Economy, see Figure 3. These frameworks and definitions of CE truly envelop the triple bottom line (Anderson, 2007) by addressing the environmental, societal, and economic growth model. One of the key developers of these frameworks, Ken Webster, emphasizes that ‘the boundaries of circular economy are not defined, nor are they ever likely to be’ (Webster, 2015).

The five core aspects outlined by Webster (2015) provide the foundational framework on which CE stands. These aspects are represented in other two frameworks and their connections are shown by lines in Figure 3. The additional aspects in other frameworks are the 'Share’ elements of the ReSOLVE framework (Ellen MacArthur Foundation, 2015) and the ‘Health’ aspect of the CE (2016) framework. Two main strategies remain at the core of all three frameworks; max-min policy of waste and max-max policy of utility – maximising the effort to minimise waste and maximising the effort to maximise utility. Webster’s (2015) framework points to design out any activity that creates waste and to build a resilient system with maximum utility of energy from renewable resources, thinking in systems looking at overall supply chains and impact of the business activity, while thinking in cascades.

The ReSolve framework by Ellen MacArthur Foundation (2015) is an internal development on the foundations laid by Webster (2015). The major focus being on moving to renewable resources and establish a good ecosystem by returning biological resources to the biosphere. An additional aspect of Sharing Economy is added, where participants within an economy share their resources for maximum utility and also promote their reusage. The framework further elaborates to optimise the utility of resources and keeping them in loop, and at the same time to virtualize by dematerialising such as moving from paper books to e-books, and replacing the old technology with new for effective and efficient usage of resources such as solar panels, 3D printing, etc.

The third framework developed by Circle Economy (Circle Economy, 2016), based in the Netherlands, further adds another features of health and society. While building on the same aspects as addressed in the earlier two frameworks, it also focuses on human health and happiness, and a healthy and cohesive society as core aspects of the CE framework; which in a way is the outcome of implementing the earlier frameworks but it is vital to nail them specifically while designing an economic system.

3.3 Overview of published literature

The analysed literature reveals the explored aspects under the purview of CE. These include academic aspects defining its conceptual framework (Murray et al., 2015), its holistic view (Webster, 2013) (Ellen MacArthur Foundation, 2015), its relationship with sustainable development (Anderson, 2007) (Sauve et al., 2016) (Yuan et al., 2006), and Risk/ Downsides of CE (Lee et al., 2014) (Bilitewski, 2012). As the concept directly deals with resource
depletion/utilisation, thus the published literature covers dimensions of resource preservation (Gabriela-Cornelia et al., 2015), energy conservation (Pin & Hutao, 2007) (Pan et al., 2015), resource efficiency (Hu et al., 2011) (Schulte, 2013), and resource recovery and reutilisation (Gregson et al., 2015) (Singh & Ordonez, 2015) (Li et al., 2013). Scholars also examine the interplay of environment and economics systems (Ghisellini et al., 2016) (Anderson, 2007) (Boulding, 1966) by looking at low carbon economy models (Duan et al., 2011), and examine the policy implications in terms of process analysis (Ghisellini et al., 2016), model of economic growth (George et al., 2015) (Bartl, 2015) and zero emission policy (Liu et al., 2012). In recent developments of the research, the focus has been on strategies utilised for the implementation of CE; such as 3R [reduce, reuse, recycle] (Xuan et al., 2011), 6R [reduce, reuse, recycle, recover, redesign, remanufacture] based closed-loop material flow (Jawahir & Bradley, 2016), business process reengineering approach (Schulte, 2013), green virtual enterprises (Romero & Noran, 2015), urban circular economic system (Tong & Tao, 2016), pricing strategy (Zhilei & Wei, 2011), landfill reduction (Scharff, 2014), leapfrog development (Geng & Doberstein, 2010), and waste to energy (Pan et al., 2015). Researchers have also explored the implementation models by exploring cultural model of Hakka Living (Liu, 2012), biogas project (Duan et al., 2011), systems dynamics and multi-objective programming model (SDMOP), and eco-industrial parks/ village (Wenbo, 2011) (Duan et al., 2011) (Wenbo, 2011). Some methods and tools to analyse (Jian & Kun, 2011) are waste input-output analysis (Li, 2012), life cycle assessment (Strazza et al., 2015), and two life cycle assessment (Scheepens et al., 2016).

China has widely adopted the concept of CE and many publications are focused on the driving forces for CE in China (Park et al., 2010) (Xinan & Yanfu, 2011), the implementation process and results at regional level (Lihong & Hui, 2011) (Junjie et al., 2011) (Guo-gang, 2011) (Geng et al., 2009) (Qing et al., 2011) (Xue et al., 2010) (Guohui & Yunfeng, 2012), methods to critically evaluate and analyse (Su et al., 2013) (Lee et al., 2014) (Wenbo, 2011) (Liu et al., 2012) (Wu et al., 2014) (Guo-gang, 2011) (Chun-rong & Jun, 2011) (Li & Su, 2012) (Xu et al., 2009) (Jiao & Boons, 2015) (Pin & Hutao, 2007) (Qing et al., 2011) (Xiong et al., 2011) (Li, 2012) (Geng et al., 2012), implementation challenges, constraints, and barriers (Naustdalslid, 2014) (Zhu et al., 2010) (Geng & Doberstein, 2010) (Li et al., 2010), action programs and counter measures (Qiping, 2011) (Shen & Qi, 2012) (Zhijun & Nailing, 2011) (Guo-gang, 2011) (Geng et al., 2009) (Qing et al., 2011) (Xue et al., 2010) (Guohui & Yunfeng, 2012), consumer acceptance of CE (Weelden et al., 2016), and how to optimise industrial structure (Lihong & Hui, 2011). The above mentioned research avenues covers the broad spectrum of product/service and related business aspects. They have received considerable attention by scholars and it would be correct to say that more research would come to surface soon to develop further understandings.

At Industrial level, researchers have explored CE’s implementation in the paper making industry (Li & Ma, 2015), electric power industry (Zeng & Zhang, 2011), mining (Zhao et al., 2012) (Ru-yin & Xiao-ting, 2009), agriculture (Zabaniotou et al., 2015) (Jun & Xiang, 2011) (Junjie et al., 2011) (Xi, 2011) (Xuan et al., 2011), oil & gas (Kun & Jian, 2011) (Jian & Kun, 2011), RO desalination (Landaburu-Aguirre et al., 2016), construction industry (Smol et al., 2015), iron and steel industry (Ma et al., 2014), chemical industry (Liguori & Faraco, 2016) (Li & Su, 2012), leather industry (Hu et al., 2011), animal husbandry industry (Li & Su, 2006), tourism (Ping, 2011), two life cycle assessment – water tourism (Scheepens et al., 2016), and automotive industry (Despesse et al., 2015). Researchers have further explored the concept of manufacturing and re-manufacturing (Li et al., 2013) (Lieder & Rashid, 2016) (Kurilova-Palisaitiene et al., 2015), product service systems (Tukker, 2015), process engineering (Reh, 2013), consumer acceptance of CE (Weelden et al., 2016), and how to optimise industrial structure (Lihong & Hui, 2011). Few articles also explore the important role of CE towards sustainable supply chain management (Pan et al., 2015) (Genovesa et al., 2017) and the necessity to develop circular models of supply chain (Velis, 2015).

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4. Circular Economy and its implementation in the Logistics Sector

While conducting the search using the string words “Circular Logistics” to search for journal articles/conference papers and the word “Logistics” within the journal articles on the topic of CE, only 21 article were found, discussing the implications of CE in the Logistics sector. These 21 articles (summarized in Table 1) are part of the total 107 selected articles for this paper and are discussed below.

If we look at the historical perspective, scholars have focused their attention towards Logistics and Supply Chain Management at the same time as the world’s attention has focused on environmental aspects. The important role of supply chain, which includes Logistics, is an inevitable choice while attempting to make a business sustainable (Park et al., 2010). Recent trigger of attention being focused on the correlation between CE and Logistics (Guihua, 2013) highlight the importance and urgency to develop new models of logistics in alignment to CE (Kai et al., 2010). The concept of Circular Logistics is also linked with Green system (Guo-shen et al., 2010) (Gui-hua, 2010) and is believed
to be at the core of CE (Rong, 2014), as well as with 3PL (Yuan & Xi-long, 2009) and is considered as value increment multiplier being the core value in a recycling economy (Zhongzhi & Haochen, 2011).

Table 1: Literature published on the topic of Circular Logistics

<table>
<thead>
<tr>
<th>No</th>
<th>Author</th>
<th>Title</th>
<th>Paper Type</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Rao Zhao; Da-wei Hu; Lan Zhu; (2015)</td>
<td>Design of Supply Chains with Integration of Reverse Logistics of Automobile Parts</td>
<td>Conference</td>
</tr>
<tr>
<td>2</td>
<td>Zhao Rong (2014)</td>
<td>Study on the Sustainable Development of Logistics for Circulation Economy</td>
<td>Conference</td>
</tr>
<tr>
<td>5</td>
<td>Xin Zou, Menggein Zhang, Huaitao Chen (2015)</td>
<td>Analysis on the Connotation of Green Logistics</td>
<td>Conference</td>
</tr>
<tr>
<td>6</td>
<td>Kai Zheng; Yihong Ru; Ruijing Wang; Yu Zhu (2012)</td>
<td>Research on Model of Circular Construction Products Logistics System</td>
<td>Conference</td>
</tr>
<tr>
<td>7</td>
<td>Tuanying He (2012)</td>
<td>Tripartite strategy selection based on non-cooperative game theory for circular logistics system of automotive industry</td>
<td>Conference</td>
</tr>
<tr>
<td>10</td>
<td>YUAN, YANG Xi-long, (2009)</td>
<td>Logistics Operation Based on Circulation Economy</td>
<td>Journal</td>
</tr>
<tr>
<td>12</td>
<td>Kee-hung Lai; Sarah J. Wu; Christina W. Y. Wong, (2013)</td>
<td>Did reverse logistics practices hit the triple bottom line of Chinese manufacturers?</td>
<td>Journal</td>
</tr>
<tr>
<td>15</td>
<td>LIU Zhao-jun; WANG Xiu-rong, (2013)</td>
<td>Research Automotive Loop Logistics System Based on Circular Economy</td>
<td>Journal</td>
</tr>
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Two major highlights with regards to logistics in the purview of CE are Reverse Logistics (Lai et al., 2013) and short supply chain (Gallaud & Laperche, 2016). While short supply chain implementation has so far been successful in the agricultural sector, its effective utilisation may not always be practically feasible for other industrial sectors, therefore businesses must focus their efforts to design effective reverse logistic system to collect any defected, used, and end of life products, to reverse them in circular system to be reutilised as raw material (Lai et al., 2013) or if not then to be disposed in a careful manner. Reverse Logistics not only plays a strategic role in implementation of CE, but it also is considered as strategic weapon and competitive advantage of good corporate citizenship (Chan & Chan, 2008).

4.1 Implementation strategies and sectors

Tuanying He (2012) discusses the circular logistics model for the automotive industry and suggests to develop a game theory model to monitor the establishment of circular logistics. Rao Zhao (Zhao et al., 2015) utilises reverse logistics and proposes a multi-period, multicmodity and closed loop supply network for the automotive industry. Other researchers suggest the model of customer focused supply chain with end to end focus (Kuhn, 2015) and highlight the need for further research to develop frameworks for circular logistics in the automotive industry (Zhao-jun & Xiurong, 2013).
Another major focus of CE based on logistics systems is in the construction industry to make it resource saving and environment friendly by integrating the logistics of construction material and solid waste created (Zheng et al., 2012). A new model of CPCLS (Construction Product Circular Logistics System) was developed by mingling CE concept with Project Management to optimize resource utilisation and efficiency (Yu et al., 2010).

The current published literature listed in Table 1 is categorized and illustrated in Figure 4 with reference to articles discussing CE within the context of Logistics. Indeed it is a ground breaking effort to highlight the need and possibilities of further research for Circular Logistics, and it would not be correct to criticise the shallowness of the current published literature, except to the extent that further research is needed to explore its depth and to develop the roots of Circular Logistics in the current context.

4.2 Barriers and Enablers of CE

While many organisations like Ellen McArthur Foundation (Ellen MacArthur Foundation, 2015), WRAP (WRAP, 2016), Circle Economy (Circle Economy, 2016), McKinsey and Company (McKinsey & Company, 2016), Capital Institute (Capital Institute, 2016), Zero Waste Scotland (Zero Waste Scotland, 2016), ARC21 (ARC21, 2016) are attempting to promote the implementation of CE, there are some barriers/challenges to such implementation. In the context of China, Geng & Doberstein, (2010) describes three barriers/challenges as: Policy, Technology, and Public Participation. Dutch researchers further add more aspects which can be considered as sub-aspects of the earlier mentioned barriers: Institutional Barriers, Economic Barriers, Social and People-related barriers, and professional barriers (Buren et al., 2016).

In one form or another, these weaknesses/barriers in the implementation of CE are in fact drivers, so once strengthened the implementation of CE would be enhanced. The three barrier mentioned above – Policy, Technology, and Public participation; are key aspects for the successful implementation of CE (Buren et al., 2016). Within the context of China, scholars analyse the Logistics sector in the light of CE and highlight the need for policy development as a key to implement CE in the Logistics sector (Gui-hua, 2010) (Wen-wu, 2012), and information system and technology to enable the realistic development of Circular Logistics (Gui-hua, 2010) (Zhongqiang, 2012).

As Webster (2013) defines it in the words of Buckminster Fuller, that “You never change things by fighting against the existing reality. To change something, build a new model that makes the old model obsolete”. A complete redesign of logistics system is necessary for its alignment with CE. By redesign the authors do not intend to point at resdesigning the structural framework – although that too is coming with the development of technology (e.g self-driven and energy efficient vehicles); but the necessity of thought pattern, policy development and integrated approach while planning and designing the CE implementation.
5. Conclusions
Circular Economy has massive potential and is a budding solution to the present day challenges of fast resource depletion, effective and efficient utilisation of resources, and waste management. In its broad spectrum, every dimension of business needs careful analysis for effective implementation of CE. One of the major dimensions of business is ‘Logistics’. At present, the amount and depth of research for CE’s implementation in Logistics sector is minimal and shallow, but is a good ground breaking effort to further instigate research and exploration of possible developments. This paper has presented the knowledge about Circular Economy in broader spectrum, based on up-to-date published literature and has further explored the published literature with CE’s implementation in Logistics sector. The scholarly contribution is acknowledged without any criticism as these papers are the first ones to explore the dimension of logistics from this prospective. Authors strongly believe that more research is needed to gird the logistics sector as one of the main contributor in establishing Circular Economy, globally.

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The Danish Government, 2013. Denmark without waste; Denmark: The Danish Government.


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