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Cradle-to-Cradle in Project Management: A Case Study

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ABSTRACT

One of the most-recognized circular economy frameworks is the Cradle-to-Cradle design philosophy. However, integrating circularity in business practices impacts all organizational activities and not just the design of products and services. One of the business processes that needs to integrate sustainability is project management. The study reported in this article explores the integration of the Cradle-to-Cradle philosophy into project management practices. Based on a single in-depth case study, the integration of Cradle-to-Cradle into the knowledge areas of project management within a company that is widely recognized and praised for its commitment to sustainability and its compliance with Cradle-to-Cradle, was explored. The study revealed as most impacted knowledge areas: resource, integration, quality, communications, and stakeholder management. By identifying these areas, the study contributes to the emerging body of knowledge on sustainable project management and provides a better understanding of practical implications for companies striving to become sustainable.

KEYWORDS

Circular Economy, Cradle-to-Cradle, Project Management

INTRODUCTION

Global environmental issues such as loss of biodiversity, water and air pollution, depletion of natural resources jeopardize the Earth's life-maintaining and supporting functions (United Nations Global Issues Overview, 2019). Conventional linear economic model is argued to be the main contributor to these global problems (Andrews, 2015; Sariatli, 2017). Linear economy or so-called "*take-make-waste*" approach of consumption takes roots from First Industrial Revolution and proliferated throughout 20th century by generating unprecedented material wealth in industrial nations (Sariatli, 2017). The epitome of linear economic model is the concept of planned obsolescence which was initially introduced during Great Depression of 1930s to stimulate stagnating economy (Andrews, 2015). The aim of planned obsolescence is to produce consumer goods that are easily replaced as they rapidly become obsolete (Andrews, 2015). This, in turn, creates a vicious cycle of continuous consumption stimulating the production and generation of more waste (Andres, 2015). Some view this concept as *the systematic attempt of business to make us wasteful…permanently discontented individuals*

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(Packard, 1960, cited in Andrews, 2015: 307). In sum, linear economy benefits many industries from extractive to manufacturing to retail, while its consequences are indisputably devastating for the environment and society (Andrews, 2015; Sariatli, 2017).

Hence, as conventional linear economic approach leads to the deterioration of the Earth, there is an ever-growing pressure from global community to shift to more sustainable alternatives (Ellen MacArthur Foundation, 2019). Rising focus on sustainability in all aspects of human activities urges the academia and practitioners across all fields to continuously research and propose effective solutions to this global problem (Abidin and Pasquire, 2007). An alternative to linear industrial model is the so-called circular or closed loop economy where waste can become a new resource at the end of a product life cycle (Ellen MacArthur Foundation, 2019; Andrews, 2015). One of the ways to ensure this is to design a product that can be disassembled at the end of its life cycle and its parts can be re-used. This is the thinking behind the Cradle-to-Cradle philosophy, that views waste as *food* and suggests using it for manufacturing new products either through biological or technical cycle (Bakker, Wever, Teoh, and De Clercq 2010; Bjorn and Strandesen, 2011).

And although the implementation of Cradle-to-Cradle concept mainly focuses on the product development, shifting to sustainable product design is not possible without changes in the *…product development process from the overall business strategy, and product lines, through operations practices* (Waage, 2007:648). Therefore, companies opting for sustainable product design employ more sustainable management practices.

Labuschagne and Brent (2005) argue that within organizations three levels of sustainable transformation are recognized: strategic level, operational level and process or methodological level. Therefore, for organizations there are many alleys to incorporate sustainability into their operations such as inclusion of sustainability principles into the strategies, supporting sustainable practices, expanding the vision of sustainability beyond the company and developing sustainable projects (Labuschagne and Brent, 2005). The last option of developing sustainable projects through project management becomes widely discussed in academia (Økland, 2015). Aarseth, Ahola, Aaltonen, Økland, and Andersen (2017) have conducted the research of almost 70 articles and identified the emergence of two streams of research in the field of sustainable project management: the viewpoint of project organization and the viewpoint of host organization. According to Aarseth et al. (2017) within the first perspective of project organizations there are three distinct strategies aimed at reducing the negative footprint on environment and contributing to the benefits of wider society. These strategies are setting strategic and tactical sustainability goals, developing sustainable supplier practices, and emphasizing sustainability in project design (Aarseth et al., 2017). Within the second perspective of host organizations the authors have identified two particular strategies aiming at integration of sustainability and project management which are setting sustainability policies and influencing sustainability of project practices (Aarseth et al., 2017). Finally, the third group includes three strategies mutually adopted both by project organizations and host organizations: these strategies include the involvement of sustainability-promoting actors in project organization, developing sustainability competencies and emphasizing sustainability in project portfolio management (Aarseth et al., 2017).

However, once companies decide to integrate sustainability concepts into their strategies and operations, project management processes and practices are rarely described explicitly as company's main focus area (Brones, de Carvalho and de Senzi Zancul, 2014). In addition, sustainability factors were not systematically and explicitly integrated into project management standards such as PRINCE2 (Axelos, 2019), PMBOK (PMI, 2017), ISO 21500 or the IPMA ICB (Brones et al., 2014). And although the latest versions of these standards include references to sustainability, the integration of sustainability into project management practices is still scarce and mostly limited to realizing projects with sustainable products or services (Marcelino-Sababa et al. 2015; Schipper and Silvius, 2017). It is for this reason that the study reported in this article aims to capture the impact of Cradle-to-Cradle concept implementation on the project management practices through the case study of a selected company that successfully realized this sustainable product design. In doing so, the study

aims to answer the question *How do the organizations that adopt the cradle-to-cradle design as the foundation of their sustainability strategy integrate this concept into their project management processes and practices?*

A second question the study addresses is *What are project management knowledge areas most affected by the implementation of the cradle-to-cradle concept?*

The remainder of this article is structured as follows. The following paragraph will provide an overview of the concepts of circular economy, Cradle-to-Cradle, Project Management and the integration of sustainability into project management, based on the relevant literature on these topics.

The third paragraph describes the strategy and methodology used in this study and introduces the case company that was studied. The findings paragraph presents and discusses the findings of the study, after which the final paragraph of the article presents its conclusions and limitations.

The main contribution the study makes is in identifying new ways of integrating sustainability aspects into projects management practices. Primarily, the scope of this work is the identification of alleys to develop sustainable project management practices. Secondly, the scope includes selection and prioritization process of project management knowledge areas where the greatest possibilities for integration may happen, since there is a great development of individual cases with recognized sustainability achievements.

LITERATURE

This paragraph introduces the main two concepts addressed in the study: sustainability, Cradle-to-Cradle and project management. In order to find the relevant literature the following two groups of terms were applied in the academic search engine Google Scholar: cradle-to-cradle related terms "circular economy", "cradle-to-cradle", "eco-design", "sustainability", "sustainable design", and "sustainable development" along with the terms of "project", "project management", "project management practices" and "project knowledge areas", as well as multiple combinations from both groups. The articles were considered relevant for further detailed study if selected terms were present in the titles, abstracts or among the articles' key words line.

Circular Economy

In the last decade, 'Circular Economy' (CE) emerged as a prominent concept in the political and corporate discourse around sustainable development (Genovese and Pansera, 2019). The concept of CE emerged in 1960s and since then has been developed in parallel with sustainability paradigm (Kalmykova, Sadagopan and Rosado, 2018; Korhonen, Honkasalo and Seppälä, 2018). CE is based on the paradigm that Earth is a closed system with a limited interaction with external environment (Boulding, 1966). Sustainability of nature and humanity can therefore only be achieved through an equilibrium between the economy and the environment (Geissdoerfer et al., 2017; Ghisellini et al., 2016). This equilibrium should leave the natural capital of Earth intact, which means *that the source and sink functions of the environment should not be degraded. Therefore, the extraction of renewable resources should not exceed the rate at which they are renewed, and the absorptive capacity of the environment to assimilate waste, should not be exceeded.* (Gilbert et al., 1996). However, as it is estimated that today humanity uses the equivalent of 1.75 Earths to provide the resources it uses and the waste it produces (Global Footprint Network, 2020), the concerns about humanity's ecological overshoot may have never been more eminent.

The root-cause of humanity's ecological overshoot lies in the 'linear' socioeconomic metabolism, in which nature's resources are transformed into products that are used for a limited amount of time, and eventually end up as waste in landfill. CE aims to replace this linear model of 'extraction-production-consumption', by a 'circular' model in which waste, by-products and end-of-life products are ideally totally reused, recycled or remanufactured (Genovese et al., 2017). CE represents an *economy that is restorative and regenerative by design* (Ellen MacArthur Foundation, 2019) and suggests a new

paradigm that will push the frontiers of environmental sustainability by transforming the relationships between ecological systems and economic activities (Ghisellini et al., 2016).

The contemporary use of the CE in the industry has seen its practical application through multiple frameworks such as looped and performance economy, industrial ecology biomimicry, and many more (Geissdoerfer et al., 2017; Ghisellini et al., 2016; Kalmykova et al., 2018). However, one of the most renowned and widely implemented strategies within circular economy is the so-called *Cradle-to-Cradle* philosophy.

Cradle-to-Cradle

The term "cradle-to-cradle" was coined by Walter R. Stahel in 1970s as a sustainable alternative to conventional "cradle-to-grave" within make-use-waste approach of linear economy (Hebel, Wisniewska, and Heisel, 2014). However, Cradle-to-Cradle as a design concept was first introduced in 2002 by Michael Braungart and William McDonough in their book Cradle-to-Cradle: Re-making the way we make things. It is an innovative design framework suggested to achieve positive ecological impacts by improving the quality of products and services (Ankrah, Manu and Booth, 2015). As discussed earlier, sustainability remains a driving force of major paradigm shift in the way organizations make business. To a large extent, these attempts to become more eco-efficient are driven by goals such as zero emissions, zero carbon, zero waste and so forth. However, Cradle-to-Cradle philosophy detaches itself from the notion of eco-efficiency, claiming that "less bad is no good" (McDonough and Braungart, 2008). Instead, the authors suggest a more ambitious approach focusing not on eco-efficiency, but eco-effectiveness which is "doing the right things" (McDonough and Braungart, 2008). The difference is that while eco-efficient sustainability approaches focus on the minimization of the negative footprints, the eco-effective solutions create positive footprints (Ankrah et al., 2015). Widely known and commonly used sustainability method in evaluating the eco-efficiency and assessing environmental impact of a product is Life Cycle Assessment or Analysis – a so-called LCA (Moreira A.C, Moreira A.C and Ferreira, 2017; Bakker et al, 2010; Bjørn and Hauschild, 2013). This method is thoroughly studied and compared with Cradle-to-Cradle concept (Bakker et al, 2010; Bjørn and Hauschild, 2013). LCA is an industry standard and is considered as a starting point in the assessment of eco-design projects (Bakker et al, 2010:3). LCA takes into account the whole life cycle of a product from extracting and obtaining raw materials, production cycle, use and final disposal: in other words, from cradle to grave (Moreira A.C, Moreira A.C and Ferreira, 2017). It consists of four steps which are definition of the scope, Life Cycle Inventory, Life Cycle Impact Assessment and Life Cycle Interpretation (Moreira A.C, Moreira A.C and Ferreira, 2017:58) aimed at quantifying the environmental impact of material flows throughout a product life cycle. Bakker et al (2010) argue that LCA differs significantly from Cradle-to-Cradle concept. They argue that LCA takes into consideration energy consumption of a product while also aiming at reducing its use during a product design stage, which is not properly addressed within Cradle-to-Cradle concept (Bakker et al, 2010). However, they agree that industrial designers working with LCA method are obliged to operate within set limits, meaning that they can improve the environmental aspects of a product only to certain pre-defined boundaries (Bakker et al, 2010). Therefore, as McDonough and Braungart, (2008) suggest Cradle-to-Cradle concept promotes the way of thinking in the design process that involves a positive synergy with the environment. This concept offers necessary innovations suggesting the transition to technologic and economic growth instead of limiting it which is caused by conventional eco-efficiency as argued by authors (McDonough and Braungart, 2008; Bakker et al, 2010). In order to achieve this synergy, the authors formulated three principles of eco-effectiveness, which are discussed below:

Waste Equals Food

*"*To eliminate the concept of waste means to design things - products, packaging, and systems – from the very beginning on the understanding that waste does not exist*" (McDonough and Braungart,*

2008:104). The waste equals food principle revolves around the need to select the materials that can serve as a technical or biological resource once the designed product's life cycle is over (McDonough and Braungart, 2008). These "nutrients" can be biological or technical that feed respectively into biological or technical metabolism. Already at the design stage the loss of material value should be prevented. Otherwise, according to the authors, this way of recycling is downcycling, as the quality of the following product degrades over time. Alternative to this is upcycling or true recycling, meaning that the materials become necessary resources that feed into the production of high-quality product (McDonough and Braungart, 2008).

Use of Renewable Energy

The second principle of Cradle-to-Cradle concerns the use of the solar energy and other sources that are primarily driven by the sun's energy – wind, hydro, geothermal and bio energy. Though industry mainly consumes conventional energy sources, according to authors solar energy is overseen despite being abundantly available without any restrictions (McDonough and Braungart, 2008). As per authors "*all of nature's industry relies on energy from the sun, which can be viewed as…renewing income*" (McDonough and Braungart, 2008:31). Cradle-to-Cradle design application requires the use of renewable energy only.

Respect Diversity

The third principle is related to the diversity. The purpose is to ensure that the design reflects the natural ecosystems where various organisms function in synergy for the collective good of the entire nature. In order to fulfil this principle, the design has to develop and incorporate bio, socio-cultural and conceptual diversity. Only by respecting diversity innovations and breakthroughs are possible (McDonough and Braungart, 2008).

Cradle-to-Cradle product design recognizes two cycles or so-called metabolisms: biological and technical. *Material flows can be divided into two categories: biological mass and technical [industrial] mass* (McDonough and Braungart, 2008:92). The biological metabolism includes all the processes from the resource extraction and manufacturing to the consumption and final return of the materials to the systems in order to be reused as a resource again (Braungart McDonough and Bollinger, 2007). Within biological metabolism the materials of the products can be returned to nature as biological nutrients which the authors refer to as products of nutrition (Braungart et al., 2007:7). A biological nutrient is "a material or product…that is literally consumed by microorganisms in the soil and by other animals" (McDonough and Braungart, 2008: 105). These nutrients can be both plant-based and natural materials, as well as consisting synthetic substances (i.e. biopolymers) that do not cause harm to the natural system (Braungart et al., 2007). In the technical cycle the nutrients are identified as technical and as non-renewable (McDonough and Braungart, 2008:109-110). Therefore, they should stay in closed-loop systems to serve in the manufacturing of new products (McDonough and Braungart, 2008). The authors suggest calling technical nutrients *products of service, which are durable goods that render a service to customers* (Braungart et al., 2007:7). As per the authors this concept is mutually beneficial whereby the products containing these technical nutrients are sold to customers as services, while the full ownership of the materials remains with the manufacturers that reuse them in the following cycles at the end of this service's life span (McDonough and Braungart, 2008:111).

After the launch of the book *Cradle-to-Cradle: Remaking the way we make things* in 2002, Braungart and McDonough established a Cradle-to-Cradle certification program (Cradle-to-Cradle Products Innovation Institute, 2019). The increasing interest in this program, raised the need to establish an independent certification body that would manage the certification program (Bach, Minkov and Finkbeiner, 2018). As a result, Cradle-to-Cradle Products Innovation Institute (C2CPII) was established with a worldwide license to run the certification program (C2CPII, 2019). The Cradle-to-Cradle Certified Product Standard guides the assessment of a product across five quality categories

ensuring continuous improvement and is applied to substances, materials and finished products. These categories are material health, material reutilization, renewable energy and carbon management, water stewardship and social fairness (C2CPII, 2019). As the result of the evaluation process, the qualifying products obtain a certification mark, which expresses the compliance level with Cradle-to-Cradle Product Standard. The Institute issues five levels of achievement which are basic, bronze, silver, gold and platinum (C2CPII, 2019). As of August 2019, 258 companies with 588 products are Cradle-to-Cradle certified (C2C-Center, 2019). Out of 258 companies 91 represent construction industry leading the list with following two places taken by textiles and product development sectors represented by 31 and 30 companies respectively (C2C-Center, 2019). Geographically, a vast majority of these companies is concentrated in Europe.

Despite the popularity of Cradle-to-Cradle, some authors argue that the concept is utopian and the full shift to this philosophy is almost impossible, at least in near future (Bakker, Wever, Teoh and De Clercq, 2010; Bjørn and Hauschild, 2013; Llorach-Massana, Farreny and Oliver-Sola, 2015; Toxopeus, De Koeijer, and Meij, 2015). The practical applications of Cradle-to-Cradle design also faced major challenges. First of all, Cradle-to-Cradle implementation raises the need for reverse logistics developed particularly for this concept in order to ensure the continuous use of materials (Llorach-Massana et al., 2015; Bakker et al., 2010). Once the products are re-collected at the end of their lifecycle the disassembly of the product parts without causing a damage and further upcycling requires good knowledge of materials and substance composition as well as necessary infrastructure in place, putting yet another burden on companies (Bakker et al., 2010).

Moreover, viewing waste as food within biological nutrients metabolism can be dangerous according to some scholars, as introducing biological waste into ecosystem can cause negative consequences or even endanger the capacity of ecosystem to assimilate it (Llorach-Massana et al., 2015). Some also argue that Cradle-to-Cradle philosophy lacks the focus on the energy consumption: although in theory the concept focuses on the abundant solar energy, in practice the focus shifts to the materials and substances, while the impact of the energy use is not the priority (Llorach-Massana et al., 2015; Toxopeus et al., 2015; Bakker et al., 2010).

Another study revealed certain discrepancies between the theory of Cradle-to-Cradle concept and its practical assessment processes in the case of sustainable packaging development by a Dutch company (Toxopeus, et al., 2015). According to this study, out of five categories against which a product is evaluated the material health is the most important one, while the rest four categories are assessed much less critically with the declarations from the manufacturers being sufficient (Toxopeus et al., 2015). In addition, the material categorization based on the harmfulness level of the substances is an undisclosed procedure although based on the publicly available material databases of C2CPII, which leads to the lack of transparency in the assessment process and limits the possibility to cross-check this categorization by other independent institutes (Toxopeus et al., 2015). Moreover, these non-disclosure agreements signed between an evaluated company and C2CPII while lead to the optimization of the product, still constrain innovation, as new developments and improvements are not communicated even to company suppliers (Toxopeus et al., 2015).

PROJECT MANAGEMENT

The management of projects is of major importance for structuring work in most organizations and projects are viewed as one of the most crucial organizational developments (Svejvig and Andersen, 2015). Although some scholars suggest that projects were around since the construction of Egyptian pyramids to coordinate tasks and activities, project management as an independent discipline has evolved only since 1950s (Crawford and Pollack, 2007; Jugdev, 2004). The roots of contemporary project management are based in the planning-oriented techniques of the quantitative research with some researchers regarding the author of Gantt chart Henry Gantt as the father of modern project management (Söderlund, 2004; Kwak and Anbari, 2009). Project management initially was viewed

as the optimization technique within engineering and applied mathematics science (Söderlund, 2004). However, in 1959 Gaddis published an article in Harvard Business Review where he described projects as management art and practice rather than a traditionally viewed technical tool (Gaddis, 1959). In this article Gaddis defined a project as "an organization unit dedicated to the attainment of a goal — generally the successful completion of a developmental product on time, within budget, and in conformance with predetermined performance specifications" (Gaddis, 1959:89).

Some scholars argue that project management field is mostly practice-oriented and lacks a thoroughly developed theoretical background with the available studies focusing mostly in the technical domains such as infrastructure, business process engineering and cost engineering (Söderlund, 2004; Pollack, 2007; Jugdev, 2004; Kloppenborg, and Opfer, 2002; Kwak and Anbari, 2009). Kloppenborg, and Opfer (2002) conducted an extensive review of over 3000 academic research works and have identified over 19000 books on project management published in the timeframe of 40 years. Based on this literature analysis they have recognized major trends in the development of the project management discipline (Kloppenborg, and Opfer, 2002). Although the field started evolving in 1960s, only 1% of the studied works' citation has occurred in that decade (Kloppenborg, and Opfer, 2002). During the 1970s the field has seen major increase of attention with most research projects being financed by state governments, in particular in the US. The main focus in that period was on the Program Evaluation and Review Technique (PERT), cost and schedule control, life-cycle management, Work Breakdown Structure (WBS) and so forth (Kloppenborg, and Opfer, 2002). They have also found that research focus has slowly shifted from major government defense projects to commercial implementation of projects in construction, product and information system development (Kloppenborg, and Opfer, 2002). 1980s have seen a sharp rise in the literature citation with focus on computerized systems, use of knowledge-based and Artificial Intelligence systems (Kloppenborg, and Opfer, 2002). Finally, from 1990s onwards the interpersonal and behavioral aspects of projects started prevailing in the literature with research focusing on leadership, motivation, team building and other soft skills of a project team (Kloppenborg, and Opfer, 2002).The latest studies support these trends in the 21st century with the further shift in project management research from conventional problem-solving to problem structuring by adding agility and flexibility to projects (Pollack, 2007; Kwak and Anbari, 2009; Svejvig et al., 2015). Some scholars (Turner, Anbari and Bredillet, 2013; Silvius, 2017) suggest that in the past 50 years nine schools of project management have emerged which are optimization, modeling, governance, behavior, success, decision, process, contingency and marketing schools.

When it comes to the practice, project management is a highly institutionalized domain with *de facto standards* and *best practices* being its backbone (Svejvig and Andersen, 2015). Major international organizations such as Project Management Institute (PMI), International Project Management Association (IPMA), International Organization for Standardization (ISO), UK Office of Government Commerce and others have established their certification programs for project management practitioners. These standards offer normative advice on the project planning and management by putting forward *generally accepted* practices (Jugdev, 2004; Drob and Zichil, 2013). Among them the most common and widely accepted standard with over 1.000,000 certified practitioners is PMI's Guide to Project Management Body of Knowledge (PMBOK), the 6th edition of which was published in 2017 (PMI, 2017). PMBOK Guide defines a project as *a temporary endeavor undertaken to create a unique product, service or result* (PMBOK Guide 2017: 4).

In this research PMBOK Guide is used due to its recognition and application both among practitioners and academia.

The PMBOK Guide describes, as 'body of knowledge' on project management, a number of 'project management knowledge areas'. A knowledge area is *an identified area of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques* (PMBOK Guide 2017: 18). In other words, project management knowledge areas define the structure, implementation and management of projects (Martens and

Carvalho, 2013). The 6th edition of PMBOK Guide describes the following ten knowledge areas which are *used in most project most of the time* (PMBOK Guide 2017:23):

- *Project integration management* "includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups" (PMBOK Guide 2017:23). In other words, this knowledge area describes the processes and activities required to integrate various aspects of the project with its main output being a project plan (Zwikael, 2009, Fitsilis, 2008). With the updates to the latest edition of the Guide, a new process of *Manage Project Knowledge* and the *lessons learned register* were added to the Integration area reflecting the increasing urgency to "address knowledge management in projects" (PMBOK Guide, 2017:644). The processes within this knowledge area the most frequently used by practitioners, which can be related to well-developed support tools, templates and software packages (Zwikael, 2009). However, some studies indicate high resistance of senior management to the involvement of a project manager in the practices of project strategy, project definition and project integration (Crawford, 2005);
- *Project scope management* "includes the processes required to ensure the project includes all the work required, and only the work required, to complete the project successfully" (PMBOK Guide 2017:23). It ensures that all the variables and factors to define and control the project are taken in the consideration (Kwak and Ibbs, 2002). Project scope is considered the core of the project and viewed as the "raison d'etre of project management" (Turner, 1993 cited by Zwikael, 2009);
- *Project schedule management* "includes the processes required to manage the timely completion of the project" (PMBOK Guide 2017:24). Previously project time management, it was renamed to project schedule management to emphasize that during the project the project schedule and not time is defined and managed (PMBOK Guide, 2017:643). This knowledge area has the highest impact on the project success according to some studies (Zwikael, 2009). It is not surprising considering that project management field has evolved from such scheduling techniques as project evaluation and review technique (PERT) and critical path method (CPM). Moreover, other optimization techniques such as critical chain analysis, Resource Constrained Scheduling Problem were developed in order to manage projects in a timely manner (Leach, 2005; Demeulemeester and Herroele, 2002);
- *Project cost management* "includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so the project can be completed within the approved budget" (PMBOK Guide 2017:24). Generally accepted concept of a project i*ron triangle* suggests that a successful project should be delivered "on time, in budget to scope" (Morris, 2001). Therefore, the cost management is one of the three pillars in project management (Atkinson, 1999). As a result, project managers invest most of the time in cost planning (Zwikael, 2009);
- *Project quality management* includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements, in order to meet stakeholders' requirements" (PMBOK Guide 2017:24). Some studies in the application of Enterprise Resource Planning (ERP) in the construction industry illustrated that the main success factors for a building project were quality management and progress control (Chung, Skibniewski, Lucas and Kwak, 2008). However, quality management processes are not commonly practiced by project managers which can be due to the lack of a project manager's authority (Zwikael, 2009; Zwikael, and Globerson, 2006);
- *Project resource management* "includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project" (PMBOK Guide 2017:24). Along with schedule management, project human resource management was renamed to *project resource management* in the Guide's latest edition, since within this knowledge area not only human resources, but "all resources" should be included (PMBOK Guide, 2017:647). Therefore, in order to distinguish between these resources, human resources are addressed as "team resources",

while all other resources are termed as "physical resources" (PMBOK Guide, 2017). Extensive literature on the critical role of human resource management in the project success raises the concern of it not being in the focus of "iron triangle" (Huemann, Turner, and Keegan, 2004; Belout, and Gauvreau, 2004; Crawford, 2005);

- *Project communications management* "includes the processes required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition of project information" (PMBOK Guide 2017:24). This area's processes are among the least used which can be linked to the lack of effective communication tools or templates (Kwak. et al., 2002; Zwikael, 2009). Kwak. et al. (2002) argue that open and clear communications at all levels from planners to implementers are essential for project success;
- *Project risk management* "includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project" (PMBOK Guide 2017:24). This knowledge area has been thoroughly researched as one of the most crucial influence factors of project success (Zwikael, 2009). Raz and Michael (2001) have studied the tools that influence the project risk management process by interviewing the project management practitioners and have grouped them in two categories. First of all, the organizations should adopt the most commonly used risk management tools (Raz and Michael, 2001). Secondly, for a more competitive advantage they should also apply the tools that are related to better performing project management practices or are already being used as part of successful project risk management process (Raz and Michael, 2001). Project risk management has implications on better achieving time and budget goals, while to a lesser degree influencing product specification or performance (Raz, Shenhar and Dvir, 2002). However, despite its significant role on the project's success, only a limited number of projects apply some of available risk management practices (Raz et al., 2002). Zwikael (2009) explains this phenomenon by suggesting that some informal processes are used to add safety margins to high-risk activities;
- *Project procurement management* "includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team" (PMBOK Guide 2017:24). Interestingly, procurement along with cost management are two knowledge areas that contribute least to project success during the planning phase (Zwikael, 2009). Also, procurement practices are among the least practiced by project managers, as these activities are mainly carried out by other team members during the execution of a project (Zwikael, 2009). Other studies (within construction industry) suggest that the impact of procurement management on the schedule and cost is twice higher in comparison to communication management processes (Chou and Yang, 2012). In addition, procurement management practices have almost 70 percent stronger impact on the project owner satisfaction that those of communication management (Chou and Yang, 2012);
- *Project stakeholder management* "includes the processes required to identify the people, groups, or organizations that could impact or be impacted by the project, to analyse stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution" (PMBOK Guide 2017: 24). According to Turner and Zollin (2012) a typical project includes project owners, investors, customers, suppliers, authorities, public, media as stakeholders. Eskerod, Huemann and Savage (2015) identified four reasons why stakeholders are crucial for a project success. Firstly, the project is initiated by a stakeholder contribution while they also set the project success criteria (Eskerod et al., 2015). Moreover, stakeholder resistance may jeopardize the project success, while a project in its turn may either detrimentally or positively affect stakeholders (Eskerod et al., 2015). Therefore, project stakeholder analysis is needed to anticipate potential project risks, although some project management standards argue that existing tools and forms do not support project managers in dealing with the complexity of stakeholder-related problems (Eskerod et al., 2015). Sutterfield, Friday-Stroud and Shivers-Blackwell (2006) have studied the project failure within US Department of Defense and based on the lessons learned suggested a nine-step project

stakeholder management strategy framework to aid project managers manage the interests of various project stakeholders.

As these ten knowledge areas enable to have a holistic view on a company's project management activities (Zwikael, 2009), this structure will be employed in the empirical part of this research in order to investigate the practical implication of Cradle-to-Cradle certification on company's project management practices.

CRADLE-TO-CRADLE IN PROJECT MANAGEMENT

Our literature search did not identify a single study focusing on the impact of Cradle-to-Cradle design on project management processes and practices. However, the developing literature on sustainability in project management did provide certain useful insights.

The relationship between project management and sustainability is regarded as one of the key developments in the project management field (Silvius, 2017). Labuschagne and Brent (2005), in one of the first publications on sustainability and project management, point out that 'sustainable project management' requires the consideration of the project beyond the project's life-cycle. Based on their concept of 'interacting life-cycles', they argue that when considering sustainability in project management, not just the total life cycle of the project (for example, initiation–development–execution–testing–launch) should be taken into account, but also of the 'result' the project produces, being a change in products, assets, systems, processes or behavior. This result, in their words: the 'asset', should also be considered over its full life cycle, being something like design–develop–manufacture–operate–decommission–disposal. In its life cycle, the asset has a productive phase ('operate'), in which it generates value by producing products or services. Elaborating on the life cycle view even further, Labuschagne and Brent claim that the life cycles of the products or services that the asset produces should also be considered. Figure 1 visualizes how these three life cycles, 'project life cycle', 'asset life cycle' and 'product life cycle', interact and relate to each other. Including sustainability considerations in projects therefore suggests that all three life cycles should be considered (Silvius et al., 2010).

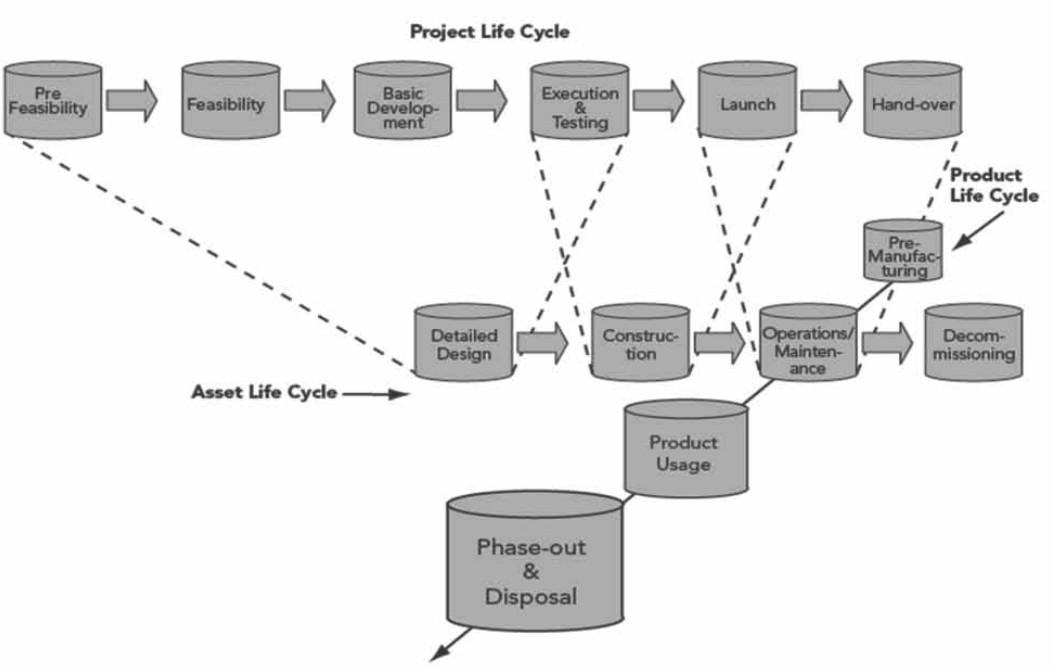
And although Labuschagne and Brent do not explicitly refer to CU, the life-cycle orientation on different levels, project-asset-product, links to CE in the sense that the principles that are given by the CE concept, end-of-life and by-products are completely reused, recycled or remanufactured (Genovese et al., 2017), form criteria for the design of the products, manufacturing assets and enabling projects.

As projects are temporary organizations, the impression may arise that the principles of sustainability or CE do not apply. However, several authors (For example Kivilä et al., 2017 and Silvius, 2017) point out that project deliverables cannot be considered sustainable if the processes employed throughout the project's lifecycle were not sustainable. The relationship between project management and sustainability is two-dimensional (Silvius and Schipper, 2015; Sabini et al., 2019):

- "Sustainability by the project" (Huemann and Silvius, 2017, p. 1066): the sustainability of the deliverable or result that the project realizes;
- "Sustainability of the project" (Huemann and Silvius, 2017, p. 1066): the sustainability of the delivery and management processes of the project.

Sustainable Project Management is therefore defined as *the planning, monitoring and controlling of project delivery and support processes, with consideration of the environmental, economical and social aspects of the life-cycle of the project's resources, processes, deliverables and effects, aimed at realizing benefits for stakeholders, and performed in a transparent, fair and ethical way that includes proactive stakeholder participation* (Silvius and Schipper (2014a:79).

Figure 1. The interacting life-cycles of project, asset and product (Silvius et al., 2012)



Based on this definition, Silvius and Schipper (2014a) identified 14 'impact areas' in which considering sustainability impacts project management processes and practices. Marcelino-Sababa et al. (2015) also suggest that a commitment to sustainability impacts not only project products, but also project processes and organizations. According to Brones, de Carvalho, and de Senzi Zancul (2014) the most critical areas of project management where the integration of environmental aspects is possible are quality, deadlines, risks and supply chain.

From the studies discussed above, we conclude that integrating the concepts of sustainability and CE impacts the way projects are defined, organized, managed and governed. This impact should also apply to projects that develop or innovate products according to the Cradle-to-Cradle principles, however, empirical studies on the integration of Cradle-to-Cradle into project management have not been published yet. The study reported in this paper aims to provide insights into this knowledge gap, by analyze the impact of the Cradle-to-Cradle concept on project management.

METHODOLOGY

As the relation between the Cradle-to-Cradle concept and project management is under-researched and not much is known about the impact of this sustainable design concept on project management activities, the study took an explorative approach.

Research Design

The study deployed a single case study design, as case study is a suitable strategy to study the explorative 'how' type of question (Yin, 2018). The rationale for choosing a single case design is its critical character. In the case of a critical case the aim is to capture the conditions and circumstances of a certain situation and the findings from these cases can serve as explanation to the studied phenomenon (Yin, 2018).

The unit of analysis of the study is an organization. The authors therefore selected a company for the study that fulfilled the following criteria:

- Have at least one Cradle-to-Cradle certified product;
- Certification should be valid for the time of this research (June-December 2019);
- Use the Cradle-to-Cradle philosophy as a basis of company's sustainability strategy.

From the official website of the C2CPII companies that have successfully passed the Cradle-to-Cradle certification process, a list of potential suitable case companies could be identified. Once identified, the companies and their certified products were cross-checked on their official websites to ensure the consistency of information with C2CPII. Potential companies meeting the selection criteria were studied further in terms of their sustainability strategy and role of Cradle-to-Cradle in it, and a total 17 companies were approached by e-mail and through LinkedIn professional social platform. As hands-on experience in managing projects was critical in order to provide extensive and rich answers to questions, a company's sustainability and/or project management expert was approached rather than executive management.

After evaluating the responses from the approached companies, a Dutch tile manufacturer with nearly its entire tile collection being Cradle-to-Cradle certified was selected. In this article, the company will be addressed as "Tiles".

The Case

The selected case company is tiles manufacturer operating in international professional construction market and according to its official website is present in over 50 countries with annual turnover of 101 million euros (2016) and over 600 employees from 15 countries. The company is Cradle-to-Cradle certified since 2009 and a chartered member of C2CPII since 2012. The Cradle-to-Cradle certification process by the sustainability manager who works with other departments across the organization. This process is supervised by a sustainability steering committee that meets every two months to discuss sustainability in a broad perspective. According to company's sustainability manager, Tiles follows the Cradle-to-Cradle philosophy in its design and production processes and uses it as a platform for process improvement and product innovation.

Adoption of Cradle-to-Cradle philosophy in the past years impacted many operating procedures of the company, such as purchasing guidelines, while serving as the guideline for the company's sustainability program. In addition, according to company's sustainability report, environmental goals like reducing CO2 emissions by 48%, efficient water management in a closed loop striving to fully eliminate the discharge of water to municipal sewage system by 2020, waste management and recycling were achieved while the whole production factory was modernized to improve the efficiency of production processes.

Data Collection

Data collection for the case study was based on a questionnaire with open questions, complimented by analysis of the case company's documents and website.These data collection methods were combined for the triangulation that helps to mitigate a single method's weaknesses (Baskarada, 2014; Sanders et al., 2016).

The questionnaire was structured in three parts as demonstrated in Table 1 and addressed various aspects of Cradle-to-Cradle and project management via a set of 52 open-ended questions. The first part focused on the company information and its Cradle-to-Cradle strategy, followed by section about the respondent's role in the organization and projects. Finally, the questions in third part were developed and structured based on the literature review while guiding the respondent into more in-depth

Table 1. Overview of the questionnaire

Part A: Company Information
1. Company name:
2. When did the company receive C2C certification? For which product(s)?
3. What was the driver to apply for C2C?
4. How is the responsibility for certification within the company organized?
5. What are the effects from the certification on the organization?
6. In what areas policy/procedure changes have occurred in your organization since C2C certification?
7. Future plans of the organization regarding C2C (e.g. strive to maintain the certification, apply for new product(s) certification, terminate once the certification period expires etc.)?
8. How is the project management (PM) organized in your organization? (e.g. is it part of the organizational structure as a separate office/department/function?)
9. Is there a single PM standard or handbook used across organization? Is there any methodology that PM is based on?
Part B: Respondent Information
1. Name/Surname:
2. Position:
3. Experience in the company:
4. Role in projects:
Part C: Integration of C2C in project management knowledge areas
1. How did the adoption of C2C design impact the project integration management?
2. How did the adoption of C2C design impact the project scope management?
3. How did the adoption of C2C design impact the project schedule management?
4. How did the adoption of C2C design impact the project cost management?
5. How did the adoption of C2C design impact the project quality management?
6. How did the adoption of C2C design impact the project risk management?
7. How did the adoption of C2C design impact the project resource management?
8. How did the adoption of C2C design impact the project procurement management?
9. How did the adoption of C2C design impact the project communications management?
10. How did the adoption of C2C design impact the project stakeholder management?

discussion practices with regard to sustainability aspects in the organizations' project management practices and were based on PMBoK's ten knowledge areas aimed at investigating the level of impact Cradle-to-Cradle design had on company projects. A brief description of each knowledge area was added in each section in case if respondent was not familiar with PMBoK standard.

Respondents were selected from the case company's staff, with as requirement that the respondent should have an good understanding of both the Cradle-to-Cradle concept and how this is implemented in the organization, and the project management processes and practices within the organization. These criteria were met by a company representative whose experience in the organization expanded over nine years and was currently holding the position of sustainability manager. From this position, the respondent had extensive knowledge of the integration of the Cradle-to-Cradle concept into the company's sustainability strategy. Based on her prior positions in the organization, the respondent also possessed competency and experience in project management in the studied company. The respondent's current role in projects varied from leading projects to being part of the project team and participating in an advisory role.

Document-based data were collected primarily and mainly from the company's official website which include documents such as annual corporate social responsibility reports, official press releases and news on the release of new products and innovations in product design or achievements in sustainability activities. As these documents were processed and reviewed, they were categorized as highly important and relevant to the impact of Cradle-to-Cradle on the organization's operations and processes. In total, in order to ensure a structural approach in the analysis of the data, 27 files were grouped in two categories of company documents such as reports, whitepapers and standards, and news and press releases on company activities in sustainability. However, it should be mentioned that studied documents did not provide sufficient insights into the specifics of company's project management activities. Therefore, document data were used mainly as supportive material to data collected via the questionnaire.

Data Analysis

The data were analyzed using a computer-based qualitative data analysis software (CAQDAS) MAXQDA Analytics. Data analysis occurred in two cycles. First, the raw data were read and reread and coded based on the key discussions in the literature review on sustainability, Cradle-to-Cradle and project management. At this stage company's project management activities were identified in accordance with ten project management knowledge areas and sub-codes were employed where relevant. Once the initial coding was finalized, they were categorized based on their relevance to one or more project knowledge areas and the frequency of their use was calculated to facilitate the reporting part of the research, while the illustrative quotes were selected. The findings from the analysis are reported in the following chapter following the structured approach according to PMBoK's knowledge areas.

In order to ensure the quality of the research, it should meet two crucial criteria: reliability and validity (Gibbs, 2018). For this research the reliability was ensured by rigorous documentation, archiving and storage of all collected primary data while constantly sharing the findings with academic supervisor throughout the research process. Validity was ensured by triangulation of the different data sources.

FINDINGS

This paragraph presents the findings from the open-ended questionnaire as well as the from document analysis. The findings are reported based on the structure employed for the literature review as well as the questionnaire, both of which are aligned with PMBoK's knowledge areas. First part of this paragraph demonstrates to what degree Cradle-to-Cradle certification enhanced the integration of sustainability aspects in overall company activities followed by identifying the impact of this certification on specific project management knowledge areas.

Impact of Cradle-to-Cradle Certification on PM Knowledge Areas

When it comes to company's project management activities, there is not a separate project management unit within the organization, neither it employs any internationally recognized standard to guide the

management of projects. As was stated by the respondent *project management is integrated in various functions and departments. It is not a separate organization within the company*. However, as the company is considered innovative and advances its endeavors to incorporate sustainability matters in product design and production in accordance with Cradle-to-Cradle, this results in continuous research and development with focus on innovation projects. The impact of the certification on company's project management activities are discussed below, while Table 2 resulting both from document analysis and questionnaire illustrates the distribution of key codes across ten knowledge areas:

Table 2. Code distribution

Knowledge Area Coded Categories	Frequency	Percentage
Project Resource	46	23,35
Project Integration	36	18,27
Project Quality	29	14,72
Project Communications	29	14,72
Project Stakeholders	25	12,69
Project Procurement	13	6,60
Project Risk	8	4,06
Project Scope	4	2,03
Project Schedule	4	2,03
Project Cost	3	1,52
TOTAL	197	100,00

- **Project Integration Management:** As can be seen from the table integration is the second most affected knowledge area after project resource management. As company representative states "for each Development/Innovation project, C2C is considered beforehand: how relevant it is and what the expected impact in terms of costs, time and resources is". She further elaborates that "when developing a new tile collection, the C2C criteria are taken into account in the IP (Innovation Process), the PCP (Product Creation Process) and the MIP (Market Introduction Process)". Same message is communicated on company's official website: "sustainability is an important criterion for every building project. This means that all partners should make informed decisions based on independently verified facts and figures". However, integration of sustainability in this knowledge area is the necessity resulting not only from Cradle-to-Cradle but other certifications as well. As the company operates in international construction market which is highly stringent, it complies with national and international regulations such as Dutch Building Decree, LEED, BREEAM, HQE, DGNB and others. As company's CEO puts it "the share of renewable buildings in the total building sector doubles every three years", so being sustainable is viewed by the company as a competitive advantage in the long term;
- **Project Scope Management:** Although project scope is not explicitly mentioned in studied documents, company claims in its annual report that "sustainability is always a key aspect in the development of new product". This statement is backed by company representative who confirms that "Cradle-to-Cradle criteria are taken into account in company's Product Creation Process" and "especially material health and material reutilization are always important for a product development/innovation project because this influences the selection of (new) materials/ ingredients." Hence, as product quality criterion plays a major role when developing a project

scope (for product development/innovation projects), Cradle-to-Cradle therefore impacts this knowledge area. Thus, it can be concluded that integration of sustainability in scope is considered relevant for the company when the project deliverables need to meet sustainability criteria;

- **Project Schedule Management:** For the company the time aspect within the scope of a project goes beyond the scheduling and sequencing in accordance with PMBoK standard and is related more to a product's life cycle with regard to sustainability or as it is put in company's sustainability report "the time factor has a major impact on the sustainability performance, because the environmental impact is spread over the total useful life of the product." Unfortunately, throughout the document analysis, as well as the questionnaire no light was shed into the scheduling aspects of projects. This can be related to lack of understanding and challenges on the potential ways of aligning these two variables of project schedule and sustainability (Hwang and Ng, 2013);
- **Project Cost Management:** When it comes to cost management, becoming sustainable can be costly in the short-term but organizations can yield financial benefits in the long term, which the company has formulated in its annual sustainability report as "sustainability is not costly, it stimulates growth and creativity". As stated by company respondent, when viewed from sustainability point of view "costs for laboratory tests of materials are relevant per project". Thus, in the case of Cradle-to-Cradle certification, this product design can add extra costs in terms of laboratory tests, innovation in product characteristics, use of healthy raw materials and so forth;
- **Project Quality Management:** With increasing pressure on construction sector to become more sustainable, building regulations and quality requirements force companies to innovate their products and improve operational processes (Fernández-Sánchez and Rodríguez-López, 2010). In this highly competitive business environment product quality is the competitive advantage for the studied company, which according to the respondent enables it to be successfully present in excessively regulated and rigorous construction market while being able to be the frontrunner when it comes to sustainability. Therefore, integration of sustainability requirements and criteria in a project quality for the company is of no surprise. As per its representative "fulfilling the C2C criteria is an integral part of a product quality". She continues: "C2C Silver certification is one of the quality criteria for [our] branded products. So, if a product does not meet the requirements, this is considered a quality risk". However, it is worth mentioning that Cradle-to-Cradle is only one of many certifications employed by company along with many other laws and legislations governing international construction industry;
- **Project Risk Management:** The document analysis revealed that company's risks are mostly related to the product quality and operational safety during the production processes. As the latter is not related to the projects unless projects are delivered to change or improve these operational processes, risks related to product quality are more relevant when studied from sustainability perspective. In this regard, sustainability matters can be considered as a risk if Cradle-to-Cradle criteria were part of the project scope during the project initiation phase. As respondent states "not fulfilling the C2C criteria is a risk for product development and innovation projects". Therefore, company integrates sustainability related risks into projects only where Cradle-to-Cradle certification is relevant rather than in overall project risk management practices;
- **Project Resource Management:** This knowledge area is the most impacted in the management of sustainable projects for a Cradle-to-Cradle certified company as this unique case illustrates. This can be explained by two factors. Firstly, as was discussed in the literature review, the latest edition of PMBoK standard recognizes not only human resource, but also all other resources used in the project. On the other hand, Cradle-to-Cradle is focused on a product design and, the material health aspect is one of the fundamentals in becoming certified. Therefore, as in the case of studied company vast majority of projects are related to product innovation and

development, the use of "healthy" and sustainable raw materials and ingredients is essential in order to obtain and maintain this sustainability certification. Thus, company endeavors in being sustainable are directly related to the use of environmentally acceptable resources which is explicitly communicated in all company documentations.

At the same time employees are in the center of the company when it comes to the social aspect of Cradle-to-Cradle certification. According to company representative "staff is becoming more engaged with the [Cradle-to-Cradle] concept over time, especially with the recently increased focus on sustainability, circularity, healthy materials and climate change in our key markets." Although key sustainability-related decisions are made by sustainability steering committee, so-called "virtual teams" from various departments are involved in the projects and can contribute to more sustainable and informed decisions supported by company's flat organizational structure.

- **Project Procurement Management:** Procurement is one of the areas statistically not significantly impacted by Cradle-to-Cradle certification, as contractor management partially fell under wider stakeholder management. However, as per company respondent "purchasing criteria were adopted/extended [based on Cradle-to-Cradle requirements]". Plus, new suppliers are required to fill out survey with sustainability related criteria, provide documentation while chemical analyses are conducted in company laboratories and externally. Company has strict selection of suppliers: 80% of raw materials suppliers are complaint with ISO 9001 and 35% meet also ISO 14001 requirements. For packaging providers these numbers are 64% and 36%, and for moulds suppliers 50% and 25% respectively. This illustrates that sustainability is a selection criterion when it comes to procurement practices which is related to meeting Cradle-to-Cradle certification standards in the use of raw materials;
- **Project Communications Management:** From sustainability perspective, project communications have two distinctive characteristics: transparency and accountability. According to the company respondent "C2C acts as a door opener and its one of the arguments for customers to choose [our] products". Therefore, its communications activities can be observed extensively via various means from more traditional media to social media and official website. Customer feedback "over the years…also…became more intense". The company conducts a life cycle analysis (LCA) on the environmental impact of its products which further communicates to customers to help make more informed decisions. As stated in company's sustainability report "we…uncover information on how we can improve our products and working methods to meet [stakeholder] expectations". In parallel, the company ensures internal communications on sustainability matters "through the quarterly staff magazine". Plus, the company runs Cradle-to-Cradle Café with other partners where seminars and lectures on Cradle-to-Cradle are delivered. As one of the company partners stated in a media interview "[In our view], sustainability comes down to communication and raising awareness";
- **Project Stakeholder Management:** This is yet another knowledge area where sustainability-related matters are properly described in the unique case of this study. As per company's sustainability manager "…sustainability lies not only in materials, but also in behavior. In people. In your personnel, suppliers and customers alike". When managing projects "stakeholders (clients) are interviewed during the course of a project. Internal stakeholders are kept informed through formal and informal project meetings and through the sustainability steerco meeting". However, to what extend stakeholders and in particular the external ones have influence on a project remains unclear due to limited access to more insightful data.

Discussion

Based on the findings from data analysis, the sub-question of this research can be answered: *What are project management knowledge areas most affected by the implementation of the cradle-to-cradle concept?*

As Table 2 illustrates the knowledge areas most affected by the implementation of Cradle-to-Cradle concept are project resource management, project integration management, project quality management, project communications management and project stakeholder management. These findings are consistent with previous research conducted in the field of sustainable project management.

- **Project Resources:** Tagaza and Wilson (2004) have identified that enthusiasm in sustainability among the team members is important for a project. This finding is supported by another study suggesting that meetings with specialists in green construction to fine-tune project-related issues can affect the project team (Hwang and Ng, 2013). Silvius and Schipper (2014b) also linked further development of project management domain with increasing role of project teams and especially project managers who should take responsibility for project sustainability. This, according to authors, requires certain competencies and skillset, which they identified as systems thinking competences, strategic competences, normative competences, anticipatory competences, and interpersonal competences (Silvius and Schipper, 2014b). The study of project management practices in oil and gas industry revealed similar findings, concluding that project manager's roles has expanded beyond their standard duties to include the responsibilities to consider more sustainable practices (Michaelides, Bryde and Ohaeri, 2014). The same study also identified that integrating sustainability aspects in projects has positive results in retention of knowledge workers as well as improving employee morale (Michaelides, Bryde and Ohaeri, 2014). When it comes to natural or technical resources as identified by PMBoK, this topic has received significant attention in the field of sustainable project management as environmental sustainability is measurable when addressing consumption of hazardous materials, water/energy consumption and reduction, waste management, reduction of pollution and emissions (Armenia, Dangelico, Nonino, and Pompei, 2019; Kleindorfer, Singhal, Van Wassenhove, 2005; Marcelino-Sádaba, González-Jaen, Pérez-Ezcurdia, 2015; Silvius, Kampinga, Paniagua, Mooi, 2017; Martens, Carvalho, 2017);
- **Project Integration:** According to the study conducted by Martens and Carvalho (2016), Environmental Policies and Resources Saving factor which consists of nine variables such as use of natural resources, management of environmental policies, energy and water consumption and many more is the key factor of sustainability in project management. Their findings demonstrate that project managers focus on the environmental impact of projects and consider environmental standards and policies, particularly in the project initiation phase (Martens and Carvalho, 2016). Another study by (Liu, Kasturiratne and Moizer, 2012) investigated why companies integrate sustainability aspects in their supply chain management and identified the drivers and obstacles on their way. According to their findings, top external drivers for companies to integrate sustainability matters in their supply chain projects were government regulations, as well as to meet the expectations of communities and demands from green customers, while internally striving to demonstrate best business performance (Liu, Kasturiratne and Moizer, 2012). The authors concluded that companies opting for strategies based on planned integration, consider setting clear environmental goals and KPIs, as well as changing their practices to more ethical and environmentally friendly ones (Liu, Kasturiratne and Moizer, 2012). This reflects the findings of current research which illustrates that compliance with environmental policies, laws and regulations impacts significantly project integration management knowledge area;
- **Project Quality:** Not surprising is the impact of Cradle-to-Cradle certification on quality management. Although previous studies have demonstrated that quality is one of the areas within

project management that can incorporate sustainability aspects (Kuei and Lu, 2013; Marcelino-Sádaba et al., 2015, Martens and Carvalho, 2016), in reality quality throughout the project is one of the aspects having "the largest gap" in this integration (Brones et al., 2014:115). However, having such an impact on this knowledge area can be explained with the fact that for the studied company project management is equivalent to product development and quality is the dimension of the final product rather than the project;

- **Project Communications:** Communications throughout planning and delivery of projects is the area with major obstacles when it comes to environmental management and integration of sustainability in projects (Tam, Shen, Yau and Tam, 2007). According to a study in the field of green construction, when it comes to dissemination of correct and timely information as well as conveying more sustainable practices, communication management is vital for the success of a project (Hwang and Ng, 2013). According to some scholars, transparency in communication leads to constructive feedback which is positively related to the motivation of teams and overall success of a project (Heising, 2012). A study by Liu, Kasturiratne and Moizer (2012) illustrates the significance of sustainability strategies communication in the advertisement and promotion of products. Strategies such as clear and self-explanatory labeling on a product's environment-related statistics and disposal instructions, promoting products' sustainability characteristics in a justifiable way and communicating company credentials on sustainability achievements with understandable expressions are among most used by companies (Liu, Kasturiratne and Moizer, 2012). This echoes with the findings from current case study. As was stated by the company representative in the questionnaire, communication is essential for their business performance as their sustainability strategy and Cradle-to-Cradle certifications serve as the *door opener for customers*;
- **Project Stakeholder Management:** Prior research indicates that another area where integration of sustainability is of major importance is stakeholder management (Bal, Bryde, Fearon, Ochieng, 2013; Martens and Carvalho, 2016; Silvius, 2017). As per study among project managers in construction industry, when it comes to sustainable project management stakeholder management is crucial and includes variables such as relationships with society, local community, suppliers and contractors, labor practices, engagement of stakeholders and so forth (Martens and Carvalho, 2016). Therefore, stakeholder engagement is fundamental when agreeing on the meaning of sustainable project (Achterkamp and Vos, 2006; Singh et al., 2007). However, Alwaer, Sibler and Lewis (2011) argue that reaching consensus on the sustainability matters among all stakeholders in a project is a major challenge due to the subjectivity of sustainability notion and difficulties related to prioritization of sustainability-related indicators. Thus, stakeholder involvement should be guaranteed, and the meaning of sustainable product or process should be agreed in order to ensure the aim of the project which aligns with the findings of current research (Achterkamp and Vos, 2006).

To sum up, Cradle-to-Cradle certification has significant impact on company's use of raw materials, stakeholder management and in particular in supply chain which is directly related to the use of "healthy" environmental materials, on communicating sustainability related achievements as company's competitive advantage in the market and raising awareness on sustainability matters among employees. However, based on the answers of company's sustainability manager, as well as document analysis the researcher can conclude that in the holistic view project management as a discipline cannot be considered as undergoing major influence from this certification. In fact, even if the term project was periodically used in studied documents, the matters of project management were reported superficially and not addressed specifically. In addition, the technical and environmental aspects required by Cradle-to-Cradle certification refer mainly to resource and quality dimensions of product development and this research did not identify more specific and detailed practices and considerations at project level.

CONCLUSION

The objectives of this research were to (1) identify the impact Cradle-to-Cradle certification has on company's project management activities and (2) to discover which project management knowledge areas are the most impacted as the result of this certification. The literature review shed the light on the current state in the process of integrating wider notion of sustainability into project management. When it comes to circular economy, Cradle-to-Cradle is among the concepts most applied as an alternative solution to linear industrial model. Previous studies have focused on the impact of Cradle-to-Cradle certification program on the environmental performance of products (Bach, Minkov and Finkbeiner, 2018). However, it was discovered, that no previous studies were held with regards to integrating sustainability into organization's project management through Cradle-to-Cradle certification. Therefore, this research can be considered one of the pioneering works in this perspective.

The critical case selected for this research is the frontrunner in the integration of sustainability in the product design and development through Cradle-to-Cradle certification. Selected company demonstrated the compliance with Cradle-to-Cradle Products Innovation Institute and accreditation of full product line in accordance with the Institute's requirements. Cradle-to-Cradle philosophy is employed by the company as the basis of its sustainability strategy, therefore, compliance with certification has a major implication on company's operational processes and procedures. As the company does not have a separate project management unit within organizational structure, the integration of Cradle-to-Cradle certification into project management was studied in accordance with wider project management knowledge areas. This enabled to identify the degree of impact this sustainable design framework has on each of ten knowledge areas. The analysis of available reports, company related news and press releases and the official company website as well as the open-ended questionnaire revealed the most critical knowledge areas impacted by this certification. These knowledge areas are: Resource, Integration, Quality, Communications and Stakeholders.

Through the findings of this research the domain of sustainable product design can gain insights into the impact areas a particular sustainability certificate can have for an organization's project management activities. Lastly, sustainable project management studies can further explore the alleys of integrating sustainability aspects into the processes and practices of companies striving to achieve and maintain specific sustainability certifications.

Although the objectives of this research were achieved, there are still certain limitations from the results of this study. First of all, as this study was exploratory and has focused on a single case, the findings from the research cannot be generalized. Therefore, more studies of Cradle-to-Cradle certified companies are required in order for the findings of this research to be further explored. Also, this study is limited to a single company in the Netherlands, and different organizational culture, national perception of sustainability issues, state's official position with regard to this matter and national legislation requirements may potentially have influence on the degree of integrating sustainability in an organization and in particular its project management processes.

It is also worth noticing that for studied company projects are mostly concentrated on product development and product innovation, and project management practices are not structured internally as part of organization, nor followed stringently. Therefore, it can be presumed that the respondent answered the questions from product development point of view rather than as a project management practitioner. Thus, the findings from this research illustrate the impact of Cradle-to-Cradle certification more on wider project management knowledge than on specific processes and practices within project management field.

When it comes to data collection methods, they were yet another limitation of this research. The company choice to complete the questionnaire rather than accommodate a semi-structured interview restricted access to more in-depth and rich primary data to investigate the levels of integration of sustainability aspects into company's project management activities. In addition, company press releases on its website and news on company activities in the field of sustainability used for document

analysis are limited to the media and company choices and thus can be biased. Plus, not all accessible documents explicitly describe the impact of the certification on company's internal operations and processes, including project management.

However, as the pressure to manage organizations and projects more sustainably increases and organizations are continuously under scrutiny for their impact on wider society and environment, the field of sustainable project management can contribute significantly in the transition of companies to more sustainable ways of leading business.

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