ECODESIGN IN INDUSTRIAL DESIGN CONSULTANCIES – COMPARING AUSTRALIA, CHINA, GERMANY AND THE USA

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ABSTRACT

This paper presents the results of an empirical study, investigating the uptake of ecodesign by industrial design consultancies (ID consultancies) in Australia, China, Germany and the USA.
Designing products for a low environmental load, usually termed as ecodesign, offers high potential to reduce the environmental impact of our society, aiming for a sustainable development. However, there still appears to be no widespread uptake of ecodesign into product development praxis by industrial designers, with most ecodesign activity focusing on the engineering phase. Especially seldom are the necessary radical interventions to significantly improve the environmental performance of products. The literature review revealed that ID consultancies might be in a position to improve this situation. This paper presents the findings of a website content analysis, investigating the extent of ecodesign uptake by ID consultancies in Australia, China, Germany and the US. Those four countries were chosen to see if different, country specific frameworks impact on the attitude of ID consultancies towards ecodesign.
The paper verifies that ID consultancies have a high potential to improve ecodesign uptake by using their influence especially on early phases of the product development process and by addressing also non engineering related issues for ecodesign. This potential does not appear to be fully embraced yet. The paper concludes by identifying the highest representation of ecodesign on websites of Australian ID consultancies and the lowest on websites of Chinese ID consultancies. The way ID consultancies practice ecodesign is very country specific. Understanding the differences and developing recommendations how ID consultancies can better unfold their ecodesign potential requires deeper investigations in the case specific factors.

Keywords: Ecodesign practice, Industrial design consultancies, Australia, China, Germany, USA

THE CONCEPT OF ECODESIGN

This section outlines the potential of ecodesign within the context of sustainable development.
A reduction of our ecological impact is necessary to facilitate a sustainable development [1, 2]. Products make up a major share of this ecological impact. Our society directs significant effort towards remedial activities such as waste management of discarded products or cleaning up production sites. Whilst important, the potential of these activities to reduce the ecological impact of our society towards more sustainable development is limited [2, 3]. Several authors see designing products for a low environmental load by default as more promising [3-6]. Interventions in the product development process, following this line of thought are usually summed up under the terminology of ecodesign [3, 4, 6]. Design interventions facilitate innovations, which can be allocated on a scale, ranging from incremental to radical. On this scale, interventions, aiming at incremental innovations are usually associated with product benchmarking or a step by step redesign of existing products [7]. Several authors point out that benchmarking or step by step improvements have the lowest potential for the reduction of the environmental load whereas more radical innovations are seen as more promising [5, 7]. In the context of the goal of a sustainable development, there is disagreement which negative environmental impacts need to be reduced to what extent [8]. However a prominent goal within the sustainable design research community is to support the reduction of the negative environmental impact of products by a factor 10 [1]. To reach that goal, innovations on the incremental side of the scale are important but only radical innovations have sufficient potential in reducing the environmental load [5, 7]. This paper shows that industrial design consultancies (ID consultancies) can play an important role in that context.

AIMS OF PAPER

This paper addresses the question how far ID consultancies practice and promote ecodesign. It furthermore investigates which role ID consultancies are likely to play in the product development process to evaluate which leverage points they have to foster ecodesign uptake. The paper is structured in five sections. The first two sections review theoretical best praxis for ecodesign as well as reports about and critique on contemporary ecodesign practice. The third section elaborates if ID consultancies can theoretically comply with the recommendations and address the critique. The fourth section provides insight into the applied methodology to investigate ecodesign practice of ID consultancies. The fifth section presents the results.

ECODESIGN THEORY

Whilst the introduction has outlined the potential of ecodesign in the context of sustainable development, this section addresses theoretical suggestions for ecodesign practice. It is divided in two subsections of which the first concerns ecodesign interventions and the second outlines recommendations for its implementation into the product development process.

Ecodesign interventions

A broad range of interventions can be taken to reduce the environmental impact of products. In the academic literature, these interventions are often termed as ecodesign strategies. The most comprehensive collection of them is listed by Brezet et al. [4] This list is referred to widely throughout the ecodesign literature [3, 7, 9, 10]. Investigating into the ecodesign practice of ID consultancies, Behrisch et al. [11] identified an additional ecodesign strategy. This strategy aims at making existing ecofriendly solutions more attractive to the user. Considering the user perspective in the product development process is one of the core competencies of industrial design [12, 13]. Therefore, it is highly likely, that the identified ecodesign strategy is specific to industrial design. It has to be highlighted that the ecodesign strategies are not a check list that can be applied blindly in hope for an improved environmental outcome [14]. The negative environmental impacts of products happen along the whole product life cycle [6, 7]. They can be very complex and are often case specific. This makes it necessary to consider the whole product life cycle when selecting and following the ecodesign strategies. This approach usually gets referred to as life cycle thinking [14].

Table 1: Ecodesign strategies

	Strategy	Sub-strategies
@*	New concept development	Dematerialization, shared use of product, integration of functions, functional optimization of product components
	Product component level	
1	Selection of low impact materials	Cleaner materials, renewable materials, lower energy content materials, recycled materials, recyclable materials
2	Reduction of materials usage	Reduction in weight, reduction in transport volume
	Product structure level	
3	Optimization of production techniques	Alternative production techniques, fewer production steps, lower/cleaner energy consumption during production, less production waste, fewer/cleaner production consumables
4	Optimization of distribution system	Less/cleaner/reusable packaging, energy-efficient transport mode, energy-efficient logistics
5	Reduction of impact during use	Lower energy consumption during use, cleaner energy source, fewer consumables needed, cleaner consumables, no waste of energy/consumables
	Product system level	
6	Optimization of initial lifetime	Reliability and durability, easier maintenance and repair, modular product structure, classic design, strong product-user relation
7	Optimization of end-of-life system	Reuse of product, remanufacturing/refurbishing, recycling of materials, safer incineration

* This strategy has been given the symbol '@' because it is much more innovative than the seven other strategies

8	Increasing the attractiveness of an eco friendly solution (additional strategy, added by Behrisch et al.)

Ecodesign implementation into the product development process

Through the progress of the product development process – from conceptual then detailed design through engineering to production – the properties of a product are becoming increasingly fixed and the ability to implement changes decreases [15, 16]. Most literature therefore suggests an integration of ecodesign strategies as early as possible [3, 16-18]. The model of the product development process by Roozenburgh and Eekels [19], which has been used various times throughout the academic literature [7, 10, 20], proposes that the product development process consists of two phases: the strategic phase, which determines what will be developed and for what reason and the operational phase, which works out a plan for doing so. An early implementation of ecodesign strategies in the product planning phase best facilitates mediating trade-offs with other requirements and exploiting win-win situations [18]. Some ecodesign strategies, like new concept development are even impossible to implement after the product development process has progressed to the strict development phase. Other strategies, such as the selection of low impact material or a reduction of material usage can in some cases also successfully be introduced during a later phase. Also in those cases, considering ecodesign as early as possible is most beneficial. Once ecodesign is taken up, it is necessary to fully incorporate it into all the later phases of the product design process as well [21].

Successful integration of ecodesign strategies requires the involvement of various stakeholders along the product design process. This makes a multidisciplinary approach for the implication of ecodesign strategies necessary [3, 22].

ECODESIGN PRAXIS

This section reviews literature about how far the theoretical ideals of ecodesign have been applied in practice to date.

Despite a lot of research and the development of support for ecodesign, the concept does not appear to be fully adapted in product development practice [23].

Various studies have been carried out in order to determine the extent to which ecodesign gets applied by manufacturing companies. Most of the studies are of rather qualitative nature and based on interviews with a selected number of companies [14, 24, 25]. The studies show country specific differences in the extent ecodesign is practiced. Some uptake of ecodesign is reported in developed countries [14, 24, 26]. The majority of the investigated ecodesign interventions do not reflect the multidisciplinary, early integration suggested by the theory. They rather take place only in later phases [24]. This is also observed by Bas de Leeuw who notes that ecodesign *"never really managed to escape the purely technical engineering spheres"*[8]. Progressive companies such as Phillips have already seized most of the obvious win-win opportunities of eco efficiency which are possible by incremental innovations [26]. Very few more radical ecodesign innovations are conducted by manufacturing companies in developed countries [24, 26]. There appears to be little uptake of ecodesign in developing countries like Vietnam or Thailand [25], whereas in emerging economies such as in Taiwan or China ecodesign is increasingly gaining momentum [27, 28], at least for incremental innovations which happen in the operational phase of the product development process. Several authors critique that only some aspects of ecodesign have made it into the praxis of product development [26, 29] and that the incremental innovation achieved by current ecodesign interventions will not be enough to sufficiently reduce our environmental impact [5]. As ecodesign currently appears to focus on the engineering phases, other aspects of ecodesign, for example, extending the emotional durability of products or influencing the user's behavior such as designing products for shared use or sufficiency, largely do not find application in practice [29]. These strongly user related aspects can have significant impact on the ecological performance of the product. For example, a large share of electronic appliances ends up in landfill long before the end of their useful life just because they are perceived as outdated [30].

ID CONSULTANCIES AND ECODESIGN

This section identifies a high potential on the side of ID consultancies to foster ecodesign uptake and to address several shortcomings of current ecodesign practice.

Industrial design is involved in most product development processes [12]. The discipline of industrial design usually plays a key role in developing the product concept, and helps to carry it through the whole product development process. The international council of societies of industrial design defines the aim of design as follows: *"Design is a creative activity whose aim is to establish the multi-faceted*

qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange." [31] This statement sums up important characteristics of industrial design. In generating new solutions, industrial design considers the requirements of multiple stakeholders [32], involved in the product development process and adds the user perspective to those requirements [12, 13, 22]. Industrial design synthesizes all these requirements as early as possible by using prototyping and visualization techniques to make different possible solutions tangible and discussible [13, 33]. Cyclic models of the product design process show that this activity delivers feedback to the requirements formulated in the product planning phase and even has the potential to alter them [13, 34]. A case study by Feldman and Boult [35] shows that industrial designers, bringing forward attractive suggestions for more radical innovations in a project, initially targeting at incremental innovations can not only impact on the product requirements but even alter the scope of a project.

Table 2 sums up the relevant qualities of the discipline of industrial design and puts them next to suggestions for integrating ecodesign into the product development process and critique on contemporary ecodesign practice, reviewed earlier. Comparing the two columns, it becomes evident that industrial design can be a good agent for implementing ecodesign into the product development process and for addressing current deficits in ecodesign practice.

Table 2: Comparing requirements for ecodesign with the capabilities of industrial design

Suggestions for integrating ecodesign into the product development process	Qualities of industrial design
Early integration in the product development process to facilitate win-win situations and mediate potential trade offs	High potential to influence the early stages of the product development process
Requires innovation	Specialised in bringing up new solutions
Requires multi stakeholder approach	Specialized in synthesizing requirements from various stakeholders in suggestions for solutions
Critique on contemporary ecodesign practice	
Only incremental innovation	Capability to promote more radical innovation
No consideration of the user perspective	Specialised in bringing the user perspective into the product development process

This potential of industrial design has been realized by various authors [1, 12] and also by the ICSID who states *"enhancing global sustainability and environmental protection"* as one of the major goals of industrial design [31]. However, it is not clear how far this potential currently is used. Several factors might hinder industrial designers in embracing that potential such as the lack of a rigor life cycle thinking approach or their actual role in the product development process. Even though industrial design has a high potential to contribute to the product planning phase, Lofthouse [36], Sherwin [37] and Blaich and Blaich [12] find that industrial designers employed in product development departments of large companies are mainly active in the later phases of the product development process and have limited impact on the product planning phase. This reduces their capability to unfold their potential to foster ecodesign. This situation is likely to be different for ID consultancies [38]. Several authors observe that they increasingly take over strategic roles [13, 35, 39]. The extent to which they actually do so is not clarified yet. Also investigating extent they integrate ecodesign into their service portfolio is and use their potential role to foster ecodesign has not yet been addressed in detail. Vanchan, states that ID consulting praxis generally are a not extensively researched field [39].

METHODOLOGY

To gather the data about de ID consultancies, their corporate websites were reviewed, using content analysis after Krippendorff [40]. This approach already has been used successfully by Capriotti et al. [41] to investigate the communication of corporate social responsibility issues on company's websites. As a first step, it was investigated if the ID consultancies express any general environmental awareness. Thereafter the website, but especially the capability statement and the portfolio, was searched for evidence of ecodesign strategies. To gain clarity, if ID consultancies applied life cycle thinking to select and apply the ecodesign interventions evidence for the use of tools like life cycle assessment was captured. To allocate the role of the ID consultancy in the product development process, the services it offers were compared with the activities, necessary along the product development process, as described by Roozenburgh and Eekels [19]. The clear separation between

product planning and strict development phase made it possible to allocate the role of the ID consultancies to either one or both of the phases. Building on the terminology of Bakker [20], those ID consultancies that offer services in the strict development phase were classified as operational and those offering services for the product concept phase were classified as strategic. ID consultancies, covering services in both phases were classified as holistic. The data collection was conducted by three different researchers. To assure coherence of the data collection, a detailed procedure was set up.

Sampling

As the literature review has indicated, country specific factors can play an important role in the uptake of ecodesign. To capture country specific differences, this study was conducted in Australia, China Germany and the USA. It was beyond the scope of this study, to cover the US in total. We focused on California, as a study, conducted by Vanchan [39] indicates California as the state with one of the highest design activity. The aim was to analyze at least 100 ID consultancies per country. The URLs of the websites were gathered from representative databases that are freely available via the internet. For all countries the database of Core77, the world's largest online industrial design magazine, was consulted. The data was supplemented with contact details of professional industrial design associations for each country.

The following section provides a brief overview about the different frameworks for ecodesign, practiced by ID consultancies.

Australia

Australia, as most industrialized countries has an active ID community. In the mid 90s, Australia received international attention by the ecodesign community: The EcoRedesign™ program, run by the Centre for Design at the Royal Melbourne Institute of Technology successfully showed that including life cycle considerations to reduce the environmental impact of products into product development process can be an opportunity and not a threat [42]. The program, which ended in 1997, was perceived as a success by its participants. Despite this positive experience, little progressive ecodesign practice happens in Australia today [43].

China

The rapid growth of China's economy boosts the development of its industrial design community [44, 45]. China has several laws, aiming at the reduction of the environmental impact of products such as the China RoHS (enforced 03/2007), or China WEEE (enforced 01/2011) [46]. Being a major exporter of manufactured goods, international regulation such as the European or the US also impact on ecodesign uptake in China [25, 27].

Germany

Germany has a long and rich tradition in industrial design, reaching back to the "German Werkbund", founded in 1907. German design is famous for being resource cautious and efficient. Products of German companies like Wilkhan are mentioned as positive examples in the ecodesign literature [4]. Green industries contribute an important, fast growing share to the German economy [47]. This development also gets supported by the German legislative framework which is regarded as progressive [24].

USA (California)

Also the US has released several environmental product policies, aiming at the reduction of the environmental load of products, especially Electronic and Electric appliances [48]. The IDSA (Industrial design society of America) puts a special focus on promoting ecodesign has an extensive section on its website devoted to ecodesign, were also numerous resources can be found [49].

Limitations of the website content analysis

Even though this study compares ID consultancies in 4 countries, and some of the framework for ecodesign, practiced by ID consultancies is addressed, it is to note that it was beyond the scope of this study to fully elaborate the context for the ID consultancies in the different countries. This context, such as the market that ID consultancies serve the education and cultural background of the designers and their interaction with their clients can have a significant impact and will need to be addressed for drawing further reaching conclusions about contemporary ecodesign practice and to formulate

recommendations for improvement. The chosen approach is capable allocate the potential role of ID consultancies in the product development process and to provide insight into their ecodesign activities. This study therefore should be seen as a first step in mapping the ecodesign activities of ID consultancies in the different countries as a basis for further research.

RESULTS AND DISCUSSION

Role
As shown in Figure 1, in all 4 countries, less than 8% of the ID consultancies represent themselves in a strategic role only. For every country, more than 90% of the ID consultancies announce capabilities to execute services in the strict development phase and are therefore classified as either holistic or operational. The share of ID consultancies that supplement these services with services in the product planning phase (i.e holistic) varies between the countries. The highest number of ID consultancies who represent themselves in an operational role only is found in Germany. The lowest share of ID consultancies, offering services for the strict development phase only was found in the US (California).

Figure 1: Role of the ID consultancies

Despite country specific differences, the results show two things:
1. A significant share (between 38% and 58%) of ID consultancies represent themselves in a strategic or holistic role that enables them to directly influence on the product planning phase, where it is crucial to implement ecodesign
2. The larger share of ID consultancies offers services at least for the strict development phase, highlighting their capability to carry the ideas through the whole product development process.

Compared with industrial designers who are employed in product development departments of large companies, who are predominantly active in the strict development phase only [36] , ID consultancies appear to have a greater potential to foster the uptake ecodesign in both phases of the product development process.

Environmental awareness
Figure 2 shows the environmental awareness and ecodesign activity of ID consultancies.

The highest share of environmental awareness amongst ID consultancies was identified in Australia, where almost half of the investigated websites (45%) showed some indication for the ID consultancies being cautious about their capability to positively impact on the environmental load of their products. The lowest awareness was found in China, followed by Germany. In the context of the progressive environmental product policies [24] and the importance of green technologies in the German economy [47], this is surprising. The applied methodology does not allow deep enough insight to draw conclusions why less German ID consultancies appear to be environmentally aware than ID consultancies in Australia or the US (California).

However, we assume that it either is seen as obligatory by German ID consultancies to apply ecologically cautious design or the interventions for environmental cautious products do not happen under the influence of ID consultancies, but other contributors to the product development process such as engineers.
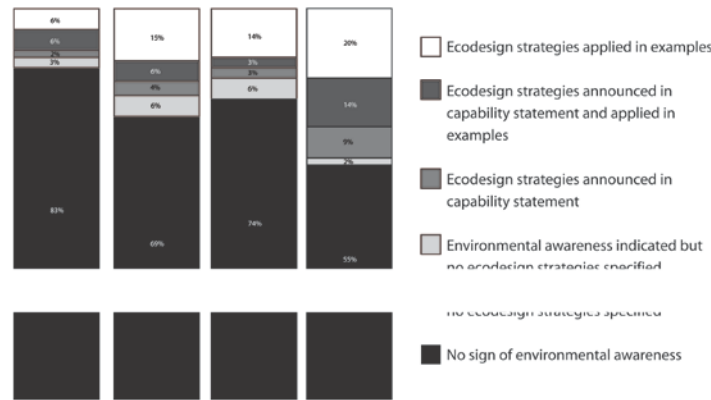
Figure 2: Environmental awareness amongst ID consultancies

This would align well with the statement of Bas de Leeuw who highlights that ecodesign mainly is practiced in the engineering phase [8]. The findings in all 4 countries show that ID consultancies who announce ecodesign as one of their capabilities do not necessarily show ecodesign examples in their portfolio and vice versa. The absence of mentioning ecodesign as a service on those websites of ID consultancies who show ecodesign examples can have two reasons: One might be that they see including environmental considerations as obligatory. The other might be that they do not see it as a service that is likely to be of high priority for the visitors of their website.

Life cycle thinking

As highlighted earlier, a rigor understanding of the product's life cycle is necessary for selecting and following the appropriate ecodesign interventions. Therefore, those websites which listed ecodesign in their capability statement were investigated closer if tools or approaches were used by the ID consultancies, allowing them to do so. No indication for those was found websites of Chinese ID consultancies. In Australia, 27% of the ID consultancies, listing ecodesign in their capability statement indicated the use of tools for life cycle thinking. Figure 3 shows the findings for each country.

The numbers in Figure 3 have to be interpreted carefully, as ID consultancies might not want to reveal the tools and support, they use for their services to their competitors. Therefore the absence of indications for life cycle thinking support does not necessarily mean that the ID consultancies do not practice it.
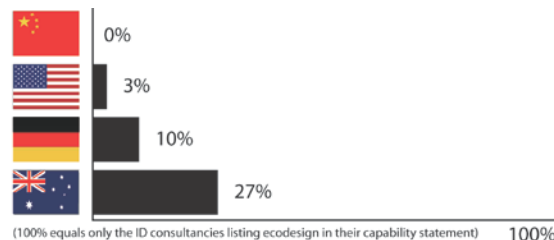

Figure 3: Indications for the use of tools for life cycle thinking

Ecodesign Strategies

Figure 4 shows the distribution of the popularity of different strategies per country.

When interpreting Figure 4, it is important to acknowledge that it indicates the uptake of the ecodesign strategies by the environmental aware ID consultancies only. 100% therefore represents a different share of ID consultancies per country. (See Figure 2: For Australia 45%, for China 17%, for Germany 26%, for the US (California) 31%). Therefore comparisons between the countries have to take into account the variations of ecodesign uptake in the different countries.

Except for the neglect of the strategy "making ecodesign solutions more attractive" in Australia, indications for the uptake of all previously introduced ecodesign strategies are found in all countries. The absence of the strategy "making ecodesign solutions more attractive" in Australia may be rooted in the fact that increasing the appeal of products is core to industrial design and therefore seen as obligatory and not explicitly mentioned in the context of ecodesign.

Despite this exception, the broad coverage of ecodesign strategies underlines the capability of ID consultancies to practice ecodesign. Especially the strategy "New concept development", which is

associated with more radical innovations [3], makes it obvious that ID consultancies are indeed capable of contributing more than just incremental ecodesign innovations. Despite this potential, the majority of the examples in the portfolios of the industrial design consultancies represent incremental innovations.
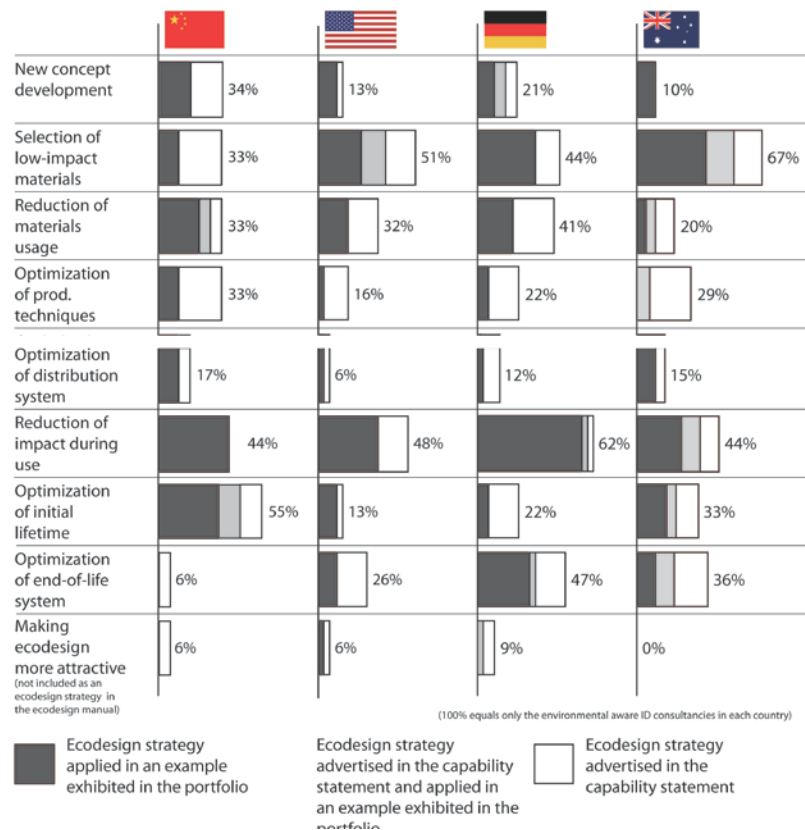

Figure 4: Popularity of ecodesign strategies amongst the ID consultancies

ID consultancies prove capable of using their expertise in considering the user perspective for ecodesign. Examples for this capability are designing for a long term emotional durability of products (the product enables a *"strong product-user relation",* the product *"encourage*(s) *people to 'own' and re-use the"* product), influencing user behavior through design ("*To make recycling simple and rewarding"; "motivate users to become more responsible with resource usage"*) and making eco friendly solutions more attractive to the user *("Make energy saving devices more aesthetically pleasing",* the ecofriendly solution *"aligns with the current perceptions").*

The popularity of different ecodesign strategies and therefore the way ID consultancies practice ecodesign varies significantly from country to country. As compliance with legislative demand or other local factors are rarely mentioned as supporting arguments for their ecodesign services on the websites of the ID consultancies, it is beyond this study to draw further conclusions about the popularity of the different ecodesign strategies. The variations might be due to cultural reasons, the market for ID consultancies or even in the educational background of the designers, working in the ID consultancies.

CONCLUSION

The uptake of ecodesign by ID consultancies and the way they practice ecodesign varies significantly between the countries. ID consultancies in all countries appear to be capable to contribute to the uptake of ecodesign by applying various ecodesign interventions. Still the majority of ecodesign practice amongst ID consultancies appears to be focused on incremental innovations. However some uptake of the ecodesign strategy "new concept development" which requires more radical innovations was identified in all countries. ID consultancies also proved capable to make use of their skills in considering the user perspective in the context of ecodesign. At least 38% of the ID consultancies represent themselves in a role that gives them the possibility to impact on the product planning phase of the product development process, where it is crucial to implement ecodesign. ID consultancies

therefore have proven to potentially be good agents to promote and practice ecodesign more actively and to address the critique currently expressed on ecodesign practice. They currently do not appear to fully embrace that potential. It therefore is suggested to investigate in greater detail, how to get them to unlock this potential, embrace ecodesign as a new service and contribute to a sustainable development.

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