HAL open science

Which hygienic products for which continent? Design for usage and sustainability

Yann Leroy, Bernard Yannou, Lakshmi Murthy, Amrine Lallmahomed, Gwenola Yannou-Le Bris

To cite this version:

Yann Leroy, Bernard Yannou, Lakshmi Murthy, Amrine Lallmahomed, Gwenola Yannou-Le Bris. Which hygienic products for which continent? Design for usage and sustainability. 14th International Design Conference, May 2016, Dubrovnik, Croatia. pp.311-320. hal-01444960v2

HAL Id: hal-01444960

https://hal.science/hal-01444960v2

Submitted on 29 Jan 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

INTERNATIONAL DESIGN CONFERENCE - DESIGN 2016
Dubrovnik - Croatia, May 16 - 19, 2016.

WHICH HYGIENIC PRODUCTS FOR WHICH CONTINENT? DESIGN FOR USAGE AND SUSTAINABILITY

Yann Leroy, Bernard Yannou, Lakshmi Murthy, Amrine Lallmahomed, Gwenola Yannou Le Bris

Keywords: design for sustainability, design for usage, multicriteria analysis, life cycle assessment, menstrual products

Abstract: All women have to deal with menstrual cycles.The paper proposes to investigate usage and sustainability performances of four hygienic solutions, i.e. environmental, economic, hygienic, comfort and social performances. Three different geographical contexts are also studied: Europe, United States and India, where product expectations, cultural aspects, production and logistic realities strongly differ and influence the purchasing choice. Products sustainable performances are fanally combined with client's preferences to identify the product that fit the best the clients' expectations.

1. Introduction

All women around the world have to deal with menstrual cycles. Different solutions exist at present to accompany them from disposable to reusable ones. This paper proposes to investigate usage and sustainability performances of major hygienic solutions, i.e. environmental, economic, hygienic, comfort and social performances. Four hygienic products are evaluated: tampon, sanitary napkin, Uger pad (reusable pad) and cup. Three different geographical contexts are also studied: Europe, United States and India, where product expectations, cultural aspects, production and logistic realities strongly differ and influence the purchasing choice.

This paper proposes a process for designing an everyday life product:

- well adapted to usage and habits where it is used: here needs linked to body hygiene and comfort,
- well adapted to sustainability, i.e. limiting environmental impact, at an affordable price and giving priority to local production and recycling as well as favoring people socialization.

The first section is dedicated to the environmental assessment performed through a Life Cycle Assessment. Then an economic indicator is introduced in section 3. Finally the more qualitative social, hygienic and comfort aspects are assessed in section 4. The aggregation of all indicators is proposed in section 5, functions of hygienic solution and location, and compared to clients' expectations. Finally, results, recommendations and perspectives are discussed in section 6.

2. Comparative Life Cycle Assessment of 4 hygienic products

In order to evaluate the environmental performances of the four hygienic products, a Life Cycle Assessment (LCA) is performed with respect to ISO 1404X standards [International Standards Organization 2006a; International Standards Organization 2006b]. The different steps of the LCA are described in the following sections.

2.1. Goal and scope definition

The main goal of the LCA is to define the most performant menstrual product according to different geographic locations. To do so, the four following solutions are investigated and compared: a tampon, a sanitary napkin, an Unger pad which is a reusable (washable) pad and the cup (illustrated in Figure 1). In addition, three geographical areas are considered. Europe and United States are industrialized areas where the use of tampons and sanitary pads is a common practice and where the cup and reusable pad were recently introduced. The third area of interest is India as a developing country. The focus is made on rural population for which menstruation is still a societal problem in term of accessibility to the solutions, hygiene and environment.

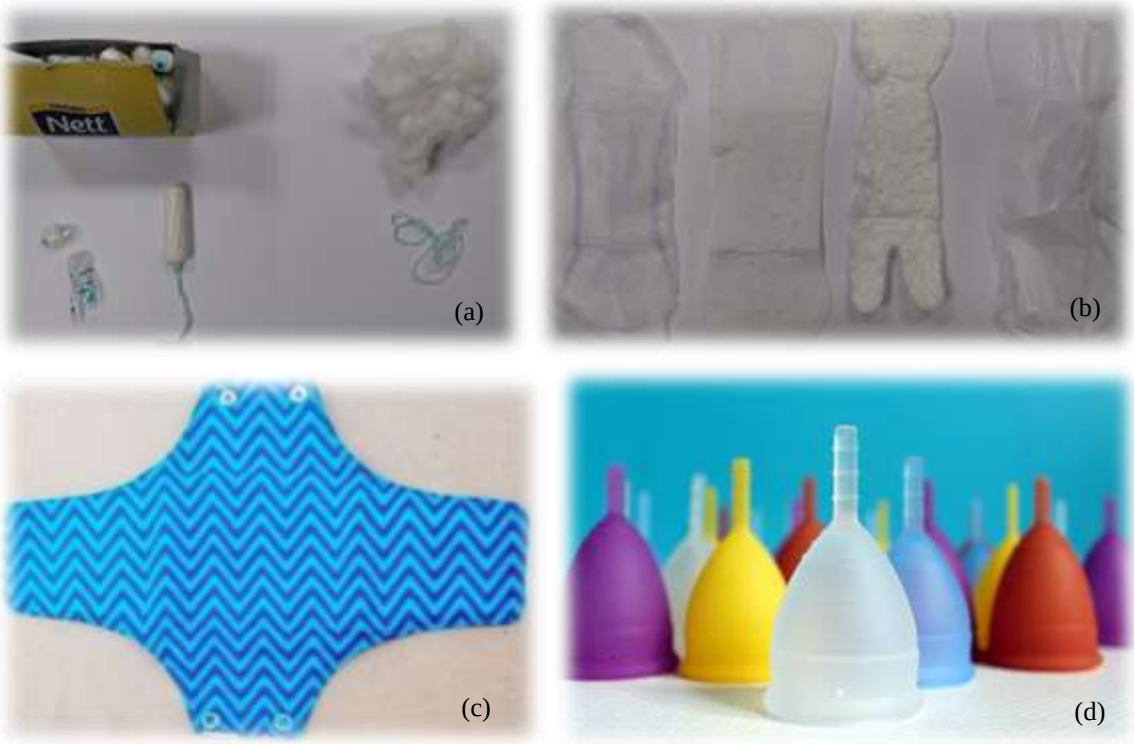

Figure 1. Pictures of the four hygienic products under study: the tampon (a), the sanitary napkin (b), the Uger pad (c) and the cup (d)

In the study, a life cycle perspective from cradle-to-grave is adopted. It includes the raw materials extraction and preparation, the production phase, the distribution comprising the secondary packaging, the use phase and finally products disposal. The functional unit used to compare the four hygienic products is defined as "to ensure menstrual protection for 50 women over a one year period". The reference stream is calculated for 13 4-days menstrual cycles per year. It is assumed that the product is changed 4 times a day. The reference streams satisfying the functional unit account for 7800 tampons, 10400 sanitary napkins, 300 Unger pads (50 envelops + 300 paddings) and 5 cups, its expected lifespan being reported as 10 years [Meluna.fr] (50 cups /10).

2.2. Life Cycle Inventory

Data gathering

Data related to the physical attributes of products were measured (weight). Data related to the material characterization and production processes were extracted from a dismantling process (products dissection), industrial reports, commercial websites and producers' associations. Secondary data related to other systems were extracted from the Ecoinvent V2 database [Frischknecht et al. 2005].

Product dissection

Except for the cup for which data related to the material characterization were extracted from commercial websites, each hygienic product was dismantled. Each component was weighted and materials were characterized. The composition of each product is reported in Tables 1-4. Conditioning is different from one product to another and influences the amount of packaging per product. Tampons are sold per 32 and sanitary per 16. The cup has its own packaging. Finally the Uger pads are assumed to be sold per 3 [Ugerpads.jimdo.com].

The entire Life Cycle Inventory (LCI) and main assumptions are reported in Table 5. The LCI is broken down according to the life cycle phases. While assumptions for the transportation distances and the amount of water consumed per activity, data related to the performances of end-of-life treatments were extracted from European statistical survey [Eurostats].

Table 1. Material content for the Tampon

Tampon (1 unit)	Mass (g)	Material
Secondary packaging	12	Cardboard
Tampon	2,5	Cotton
Notice	1,536	Paper
String	0,0176	Cotton
Primary packaging	0,000276	LDPE

Table 2. Material content for the Sanitary pad

Sanitary pad (1 unit)	Sub component	Mass (g)	Material
Secondary packaging		4	LDPE
Pad	Non woven polymer	0,31	Non woven polymer
	Cellulose	0,31	Cellulose
	Cellulose and polymer	3,11	Cellulose and polymer
	Silicone paper	0,93	Silicone paper
Secondary packaging		0,67	LDPE

Table 3. Material content for the Uger pad

Uger Pad (1 unit)	Sub component	Mass (g)	Material
Packaging		72,45	Cardboard
Pad	Ext. layer	11,72	Woven cotton (coloured)
	Int. Layer	7,7	Woven cotton (white)
	Absorbent	6,65	Woven cotton (white)

Table 4. Material content for the Cup

Cup (1 unit)	Mass (g)	Material
Packaging	20	Cardboard

Cup	26,88	TPE

Table 5. Assumptions for the Life Cycles of the 4 hygienic products

Life Cycle Stages	Napkin	Tampon	Uger pad	Cup
Raw materials importation for product	India: ~0 km EU (Turkey): ~6500 km (sea) US: ~0 km	India: ~0 km EU (Turkey): ~6500 km (sea) US: ~0 km	India: ~0 km EU: 500 km (truck) US: 500 km (truck)	India: ~0 km EU: ~0 km US: ~0 km
Raw material importation for packaging	India: ~0 km EU:~0 km US: ~0 km	India: ~0 km EU:~0 km US: ~0 km	India: ~0 km EU:~0 km US: ~0 km	India: ~0 km EU: ~0 km US: ~0 km
Distribution from the factory to the sale point	India: 2000 km (truck) EU: 500 km (truck) US: 2500 km (rail)	India: 2000 km (truck) EU: 500 km (truck) US: 3000 km (rail)	India: ~0 km EU: 500 km (truck) US: 500 km (rail)	India: 600 km (truck) EU: 1500 km (truck) US: 4000 km (rail)
Use phase	Hand washing 2 Liters of water per use Soap 3 ml per use	Hand washing 2 Liters of water per use Soap 3 ml per use	India: 2 washing per cycle 5 liters of water per washing without detergent (hand washing) EU: 2 washing per cycle + detergent (washing machine) US: 2 washing per cycle + detergent (washing machine)	3 washing per day 1 liter of water per washing
Product disposal	India: Landfill EU: House hold waste US: House hold waste	India: Landfill EU: House hold waste US: House hold waste	India: Landfill EU: incineration 100% US: collection rate 50% (74% recycled, 26% compost)	India: Landfill 10% + reuse 90% EU: incineration 100% US: incineration 100%
Packagings disposal	India: Landfill (100%) EU: collection rate: 100% Recycling rate 46% US: Collection rate: 50% Recycling rate 100%	India: Landfill (100%) EU: collection rate: 75% Recycling rate 100% US: Collection rate: 50% Recycling rate 100%		India: Landfill (100%) EU: collection rate: 75% Recycling rate 100% US: Collection rate: 50% Recycling rate 100%

2.3. Life Cycle Impact Assessment (LCIA)

The LCIA was implemented with Simapro 7.2 software. Environmental impacts are assessed using the Impact 2002 + Characterization method (Jolliet et al. 2003). In order to facilitate the interpretation, four out of the fifteen impact categories were supervised: global warming, aquatic ecotoxicity, ozone layer depletion and carcinogens. Because these 4 impact categories are the ones selected in all the similar studies due to their substantial interest.

2.4. Environmental results

The results of the LCIA are presented in the Figures 2-4. Environmental impacts per impact categories are examined in relative values compared to the most impacting solution per geographical location.

The environmental evaluation of the cup essentially highlights, whatever the geographical location, the main contribution of the raw materials required to produce the packaging. The packaging is responsible for 73 to 99% of impacts according to the specific impact categories. Regarding aquatic ecotoxicity, the main contributor is still the production but the hand washing process becomes significant with up to 26 % contribution. Transportation is marginal since the weight transported is very low. Only the ozone depletion category is sensitive to this phase. The impact can account up to 13% of the whole impact in the Indian context. The root cause of aquatic ecotoxicity is the amount of water consumed to wash the cup.

Tampons and sanitary napkins are characterized by a similar ecoprofile. The environmental impact is distributed between raw materials and production processes for the product and the packaging respectively. The product account for 4 to 17% of impact while the packaging is responsible for 70 to 95% of the environmental impact with respect to the impact category.

The Uger pad provides a specific environmental impact according to the geographical location. Indeed, its performances highly depend on the sourcing of raw materials and washing habits. One should notice that all the raw material (100% cotton) is produced locally as well as the textile production that involves Indian women (co-operative factories). Consequently, neither additional packaging nor transportation are considered in India. The situation is radically different for Europe and United States for which the products are imported which implies additional packaging and long distance transportation. Finally, the last main variable is the way people wash the reusable pads. A scarce water and a low level of ownership for washing machine is assumed in India. In consequence, the amount of water and soap consumed during this process is restricted to the minimum. In opposition, Europe and United States are less impacted by such parameters. The water consumption might be higher and detergent consumption is higher.

Figures 2-4 present results from LCIA for the four hygienic products according to the specific geographical location. Figures 2 and 4 related to Europe and United States are very similar. The solution with the highest performance is the cup, about 1% of impact of the Uger pad. This is essentially explained by its long expected lifespan reported as 10 years. Results for tampons and sanitary napkins are very close but still in favour of the sanitary napkins. In this case study, the difference between those two solutions comes from the amount of raw materials consumed especially for the secondary packaging. Finally the most impacting solution by far is the reusable pad (Uger pad). The combination of both a higher amount of raw materials required to produce products and packaging and the large amount of water and detergent needed for the washing cycles are responsible for this impact.

The particular case of India is exposed in Figure 3. In this context, the cup is still the most eco-friendly solution. However, the environmental impact of the Uger pad is reduced drastically. Tampon become the most impacting solution while the sanitary napkin has an intermediate position. As aforementioned, Uger pad is produced locally in co-operative factory. Consequently, transportation cost may be neglected and the packaging assumed absent.

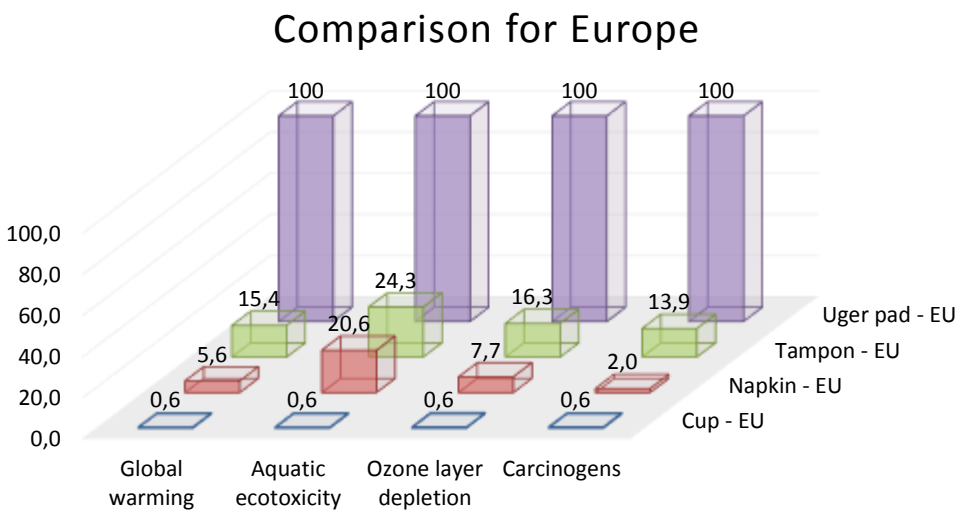

Figure 2. Environmental assessment of hygienic product for Europe

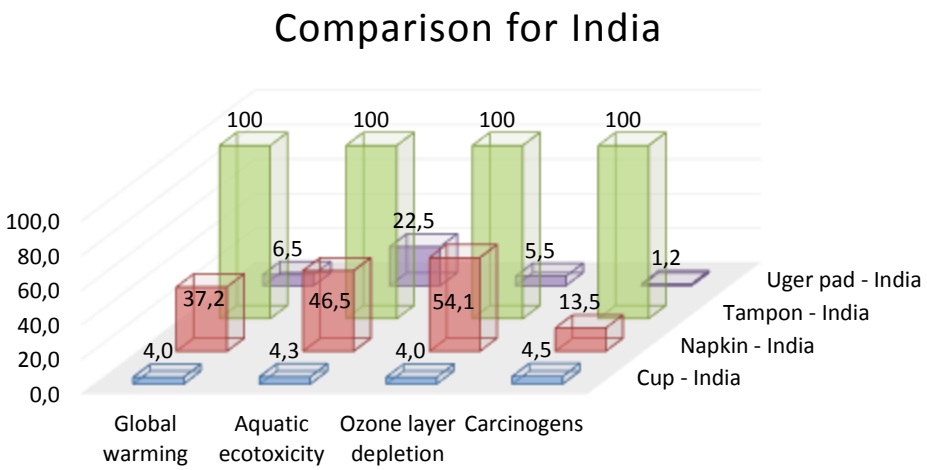

Figure 3. Environmental assessment of hygienic product for India

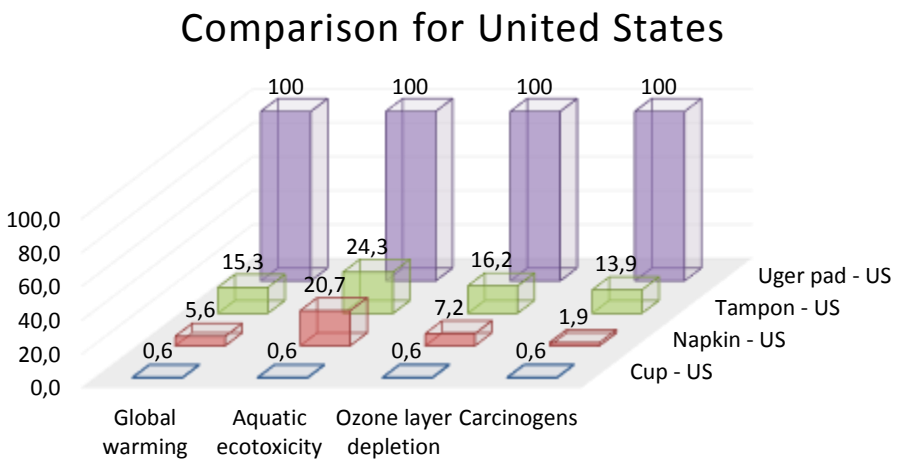

Figure 4. Environmental assessment of hygienic product for United States

3. Economic aspect

An economic indicator is added to complete the previous environmental assessment. To do so, the purchasing cost per unit is reported. Purchasing costs are extracted from commercial websites [www.amazon.com] and relate to the three geographical locations. Purchasing costs are presented in Table 6 and are expressed in US dollars. They reflect the direct costs induced for the menstrual protection per woman and per year.

Table 6. Purchasing costs per hygienic product and per geographical location

	Europe ($)	United States ($)	India ($)
Tampon	68.6	45.8	23.4
Napkin	39.0	39.0	16.6
Uger pad	114.6	108.0	6.2
Cup	1.8	3.1	0.9
Cup investment	18	31	9.2

Two prices are reported in Table 6 for the cup. The first one (cup) represents the yearly cost which is roughly a tenth of the purchasing cost (lifespan is assumed to be 10 years) while the second (cup investment) considers the total purchasing investment that might be a barrier in the purchasing decision process.

In order to also integrate the accessibility to hygienic products according to specific individual income per location, a ratio between purchasing costs per year and the minimum hourly wage (MHW) per location is introduced. MHW's used to calculate these ratio are 1.67$, 8.87$ and 7.25$ for India, Europe and United States respectively [wageindicator.org]. The lower the ratio, the more accessible the solution.

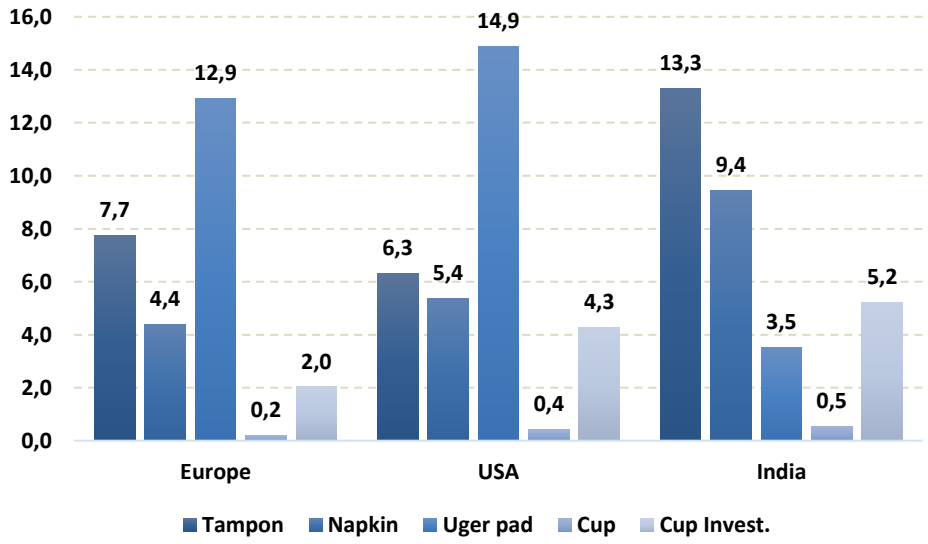

Figure 5. Purchasing cost according to the Minimum Hourly Wage per location

Figure 5 highlights that the most accessible product whatever the geographical location and covering women's need over a year is the cup with ratio values of 0.2, 0.4 and 0.5 for Europe, United states and India respectively. Nevertheless, the accessibility to this product is also conditioned by the investment cost which might be seen as prohibitive in India. Economic performances of tampons, sanitary pads and Uger pads follow the same profile in Europe and United States. The less accessible solution appears as being the Uger pads while the most accessible (the cheapest) is the sanitary napkin.

4. Social, hygienic and comfort aspects

Additional aspects may influence the purchasing decision. The three following aspects are retained as being significant. First, the social aspect relates to the interactions and relations between people. It focuses on how people live, organize and interact with and within communities and the society. Second, the hygienic aspects refer to the way people tend to promote or preserve health and cleanliness. A hygienic attitude prevents diseases and infections. Third, a comfort aspect defined as state of ease or well-being is retained. It covers both physical and emotional aspects.

The four hygienic solutions were evaluated considering these three additional criteria. To do so, maturity scales from 0 to 10 were adopted to position each solution per geographical location. 10 represents an aspect which is completely fulfilled while 0 highlights the absence of value added for the criterion. The scores were filled by the authors using secondary data from literature review and NGO's reports [Borowski 2011; AVAG Auroville Village Action Group 2011; Larsson & Olsson 2014]. Due to the lack of data, information score for the cup were filled through subjective judgement and web customer's reviews. Results from this process are presented in Table 7.

Table 7. Evaluation of Social, Comfort and Hygiene aspects per location

	Cup			Sanitary napkin			Tampon			Uger pad		
	EU	US	India	EU	US	India	EU	US	India	EU	US	India
Hygiene	9	9	5	5	5	5	4	4	4	8	8	6
Confort	5	5	5	5	5	5	7	7	7	6	6	6
Social	3	3	0,5	6	6	5	6	6	2	3	3	7

The same scores are shared between Europe and United states for the three criteria. The lifestyle and the purchasing decision processes were assumed as being similar. In opposition, the scores for India are different, especially for the cup and the Uger pad. Secondary data used to evaluate the hygienic products are extracted from a survey realized by Auroville Village Action Group and are specific to rural population (AVAG 2011). The study was conducted with 300 women of Villipuram district, rural Tamil Nadu in 2010. The aim was to determine rural Indian women's practices towards menstrual hygiene management. While the hygiene aspect is well scored in Europe and United States (9), a lower score (5) is observed in India. In the survey 17 women among the 300 interviewed declared they had no access to water. 33% also pointed out they had not enough access to private space. As the cup requires clear water to be washed several times a day, the hygiene score is consequently lowered. Similarly, the social aspect in India is very low. The reason is more cultural than social as it relates to beliefs and the specific relation of Indian people with blood. As an example, Murthy highlights that because of beliefs, men are supposed to turn blind if they see menstrual bool [Murthy 2015].

Tampon is also pointed out with a low score for the social criteria in India. The reason is the same, integrating both the relation to blood and the fact that this solution requires to be inserted into the body. Finally, the social aspect score is highest in India than in Europe and United States for the Uger pad. As the production of this solution involves local Indian women in Co-operative fabric, it reinforces social tissue and provides areas to share information and experience towards the menstruation management.

5. Multicriteria analysis

5.1. Multiciteria analysis and semi-aggregation process

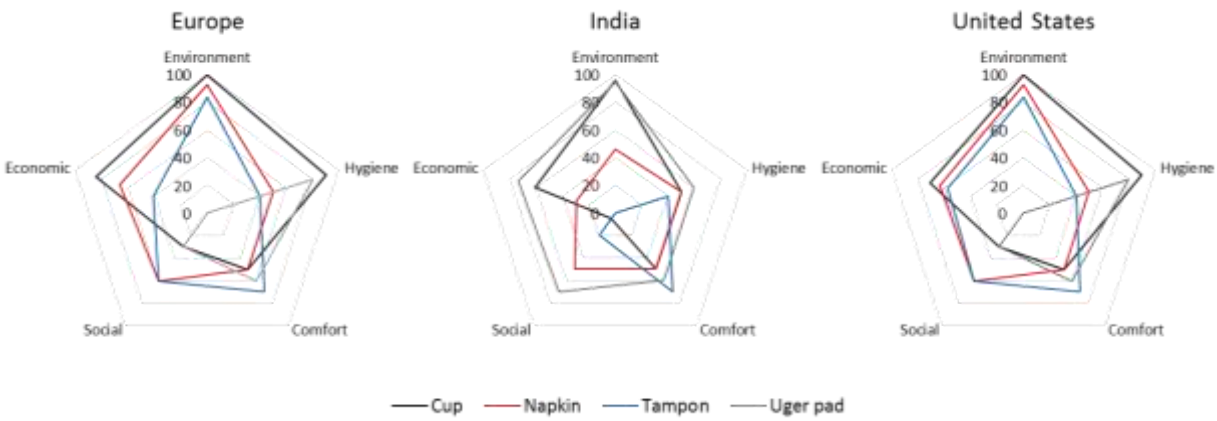

Figure 6. Multicriteria assessment of the four solutions in Europe, India and United States

Purchasing decision is a multicriteria decision as supported by AVAG [AVAG Auroville Village Action Group 2011]. In order to take all these dimensions into account, some aggregations are performed. First, environmental impacts are aggregated through the normalization process provided in the Impact 2002+ characterization method. The single score obtained is then normalized compared to the most impacting solution. The higher the score, the lower the environmental impact. The economic aspect is assessed through the ratio between the purchasing cost over a year and the MHW per geographical location. Finally, the social, hygiene and comfort scores are evaluated through literature review and the perception of the evaluation group. Results are represented as a spider diagram representing the five criteria. Each of them is assessed using a relative value compared to the most impacting solution. The larger the covered area, the more the corresponding solution is performing compared to the worst one. As an example, results for India are illustrated by Figure 6.

5.2. Clients' profiles with personas method

The identification of the solution that fits the best with client's profile is performed thanks to persona method. Personas preferences are elaborated through environmental and socio-economic expectations towards the hygienic products. As an example, three personas named Kelly, Marie and Abhiruchi were developed integrating culture and sensitivity towards each of the 5 criteria (Environment, Hygiene, Comfort, Social and purchasing costs).

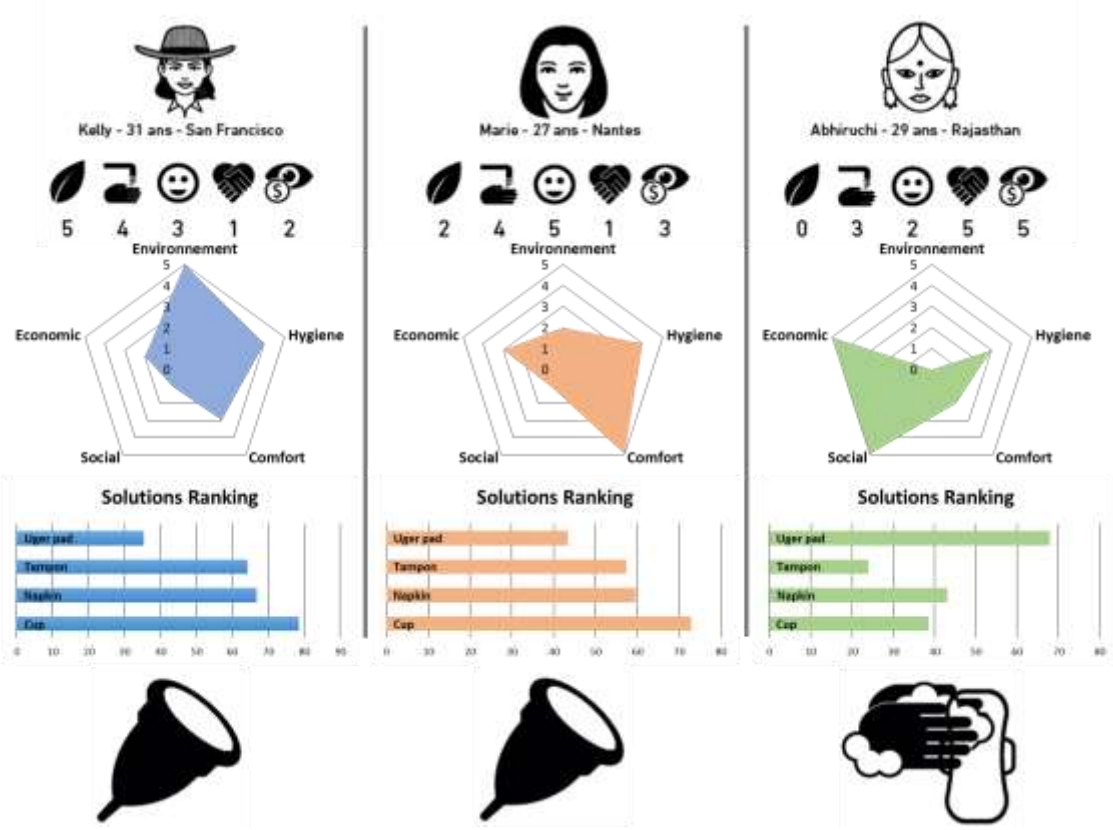

Figure 7. Solutions ranking combining products' performances and personas' preferences

Kelly is 31 years old and lives in San Francisco (United States). She is very sensitive to Environment (5) and hygienic aspects (4). In opposition, the social aspect (1) is not significant for her. Purchasing costs (2) and comfort aspects (3) are revealed as necessary with an average level of performance. Marie, 27 years old, is a French woman who lives in Nantes. Her profile highlights high expectations towards hygiene (5) and comfort (4). Cost (3) is still of preoccupation while Environment (2) and social aspect (1) are of lower interest. Finally, Abhiruchi is 29 and lives in Rajasthan (India). Her profile points out costs (5) and social aspects (5) as her main expectations. Hygiene (3) is quite important but the environmental aspect (0) is excluded from her purchasing decision process.

Personas' profiles are presented in Figure 7. Personaes' preferences are set for each criterion and summarized in a radar diagram. In order to define the most appropriate solution according to personal expectations, personas' preferences are combined with the products' evaluations (Figure 6). To do so, products' scores per criterion are weighted by the personas' expectations values. Weighted scores are then averaged to provide a single score per product and per personae. The higher the score, the higher the fit between the solution performances and personae's preferences. The solutions ranking per personae is presented in Figure 7 as the solution with the highest score. Results from the aggreagtion process highlight the cup as being the solution that fit the best with both Kelly's and Marie's preferences whereas the Uger pad is retained for Abhiruchi.

6. Discussion and conclusions

In this paper, four menstruation products are assessed on aspects referring to Environmental, Economic, Social, Hygiene and Comfort aspects. The environmental assessment pleads in favour of the cup whatever the geographical location. Tampons and sanitary napkins are then the second eco-friendliest solution in industrialized countries while it is the Uger pad in India. Economic, social, hygiene and comfort aspects are then introduced to match customer's expectations and constraints. The combination of both expectations and inherent limitations due to geographical location helps to define the most performing and adpated solution. While the cup seems to be the best solution in Europe and United

States, the Uger pad, reusable solution, appears as the most promising solution in India integrating socio-economic issues.

Social, hygienic and comfort aspects are extracted from surveys related to rural population. Results can not be generalized to Indian country since the surveys used to rank solutions focused only on rural population. However this situation is already observed in developing countries such as Ghana, Ethopia or Malawi.

The hygienic aspect is also underestimated, as most of Indian women have no access to menstrual information, the introduction of reusable pad is expected to drastically lower the risk of diseases and infections which should increase this solution's utility. Finally, the communication supporting the use of reusable pad all around the world is different according to the geographical areas. While hygiene and waste management (Sanitary and Environmental aspect) is of interest in India, the promotion of such a solution in Europe and United States essentially focuses on waste management and the way to reduce externalities and operational cost for municipalities [Borowski 2011].

Finally, socio-economic aspects are evaluated through qualitative way in this study. Several aspects such as employment, social tissue enhancement, and decease frequency reduction have to be accounted to provide a good sustainable evaluation of existing solutions to help customer's decision process or to influence Indian governmental policy.

7. References

Amazon.com, . Available at: http://www.amazon.com [Accessed November 3, 2015].

AVAG Auroville Village Action Group. Report on Rural Menstrual Hygiene Managment in Villipuram District, Tamil Nadu, India, 2011

Borowski, A.M. Are American women turning to reusable and greener menstrual products due to health and environmental pollution concerns ? Rochester Institut of Technology, 2011.

Eurostats, ., European statistics. Available at: http://ec.europa.eu/eurostat/fr/home [Accessed November 4, 2015].

Frischknecht, R. et al.. ecoinvent : Introduction The ecoinvent Database : Overview and Methodological Framework. International Journal Of Life Cycle Assessment, 10(1) , 2005, pp.3 – 9.

International Standards Organization, ISO 14040: Environmental management - life cycle assessment - principles and framework. ISO 14040:2006(E), 2006a.

International Standards Organization, ISO 14044: Environmental management - life cycle assessment - requirements and guidelines. ISO 14044:2006(E), 2006b.

Jolliet, O. et al. Presenting a New Method IMPACT 2002 + : A New Life Cycle Impact Assessment Methodology. International Journal, 8(6), , 2003 pp.324 – 330.

Larsson, L. & Olsson, M. A Conceptual Female Hygiene Product Developed from needs and prerequisites in an agricultural east african context, Linkoping University, 2014.

Meluna.fr, Coupe menstruelle. Available at: http://www.meluna.fr/ [Accessed June 3, 2015].

Murthy, L. Green is the new colour for menstruation . Uger fabric pads show the way through a sustainable perspective . International conference on Research into Design - ICoRD, Vol 35, 2015, pp 213-225.

Ugerpads.jimdo.com, ugerpads.jimdo.com. Available at: http://ugerpads.jimdo.com/price-list/ [Accessed June 3, 2015].

wageindicator.org, No Title. Available at: http://www.wageindicator.org/main [Accessed November 3, 2015].