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Analysis of the aesthetics of web sites on a mobile phone device

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1. Introduction

1.1 Problem statement

According to the fact that the world is changing and evolving continually and constantly, companies need to adapt themselves and find a new way to do business in order to stay competitive. There has seen a significant change in media consumption and in the use of online media over the last decade, which shows us that the Internet is becoming more and more important for all types of products and services. This way to do business is due to the development of technology and the new means of communication. We live more and more in a world of flows and less in a world of stocks. Since the early 2000's, companies try to do business online. It gives them the opportunity to expand their potential customer's data base, turnover and to have the possibility to find other markets. According to eMarketer's new report,[1] "*Worldwide Internet and Mobile Users: eMarketer's Estimates for 2016-2021, nearly 47% of the world's population will use the internet at least once a month in 2017 (either via desktop/laptop or mobile device), a 6.1% increase vs. 2016. eMarketer estimates internet adoption will surpass the halfway mark in 2019, when 50.6% of the worldwide population will use the internet, equating to 3.82 billion people".*

The subject that we care about here is the e-commerce. It allows them to sell their products all over the world. This service can bring to the companies a real added value which can significantly expand their profits. Today, almost every company has an online presence. The purpose here would be to find the best way to stand out from the competitors and get the best visibility. The e-commerce takes into account the GUI (graphical interface user). The purpose here is to develop the business online with the objective to attract some future and potential clients that could be concretized by a purchase act online. The main objective is to get the attention of the users. According to that, it is more than fundamental to develop and create an attractive web site which can satisfy the demand of the customers while maximising the aesthetics of interface.

[1] On line on the website Emarketer. https://www.emarketer.com/Article/eMarketer-Updates-Worldwide-Internet-Mobile-User-Figures/1015770

According to *Zettl* 1999," aesthetics concerns itself with beauty, and the judging thereof" [2](*quoted in A critical evaluation of literature on visual aesthetics for the web,2004, p.205*) . That being said, the attractiveness and the beauty's criteria related to the Global Interface User process and more globally the aesthetics of site web can be analysed with a subjective approach because this process is related to our own perception and based on our personal judgement. One of the objectives of this thesis is to try to measure the aesthetics and to find the best way to optimise the interface.

According to ZEN's thesis[3], *through several studies in multiple fields, researchers have shown that aesthetics have an impact on preferences, usability perception, credibility and performance. Not only interface design itself has an impact on its perceived usability but the design of the device displaying the interface as well. Moreover, GUI aesthetics has been studied and some studies provided empirical evidence that aesthetics influence user experience (Zen ,2017, p.46).* Talia Lavie and Noam Tractinsky claim that recent research suggests that the visual aesthetics of computer interfaces is a strong determinant of users' satisfaction and pleasure. The aesthetics of websites is a crucial factor for the successful development of man-machine interactions. This interaction is based on the social aspect. They also claim that the visual appearance in relation with computers can influence the decision of purchase of the consumers.

According to P. Bloch (*1995,19-29*), [4], "*The aesthetic quality of a product influences consumer's attitudes and is a major determinant of its marketplace success".* Beauty can be an important quality of a product; a recent research in the area of Information technology has also suggested that the visual aesthetics of user interfaces is a strong determinant of user's satisfaction and pleasure.

[2] - Hoffmann, R., and Krauss, K. (2004). *A Critical Evaluation of Literature on Visual Aesthetics for the Web,*205-209.
[3] - Zen, M., (2017). *A methodology for assessing aesthetics of a graphical user interface of an information system: visual measures-based automated evaluation,*46.
[4] Bloch, P. (1995). Seeking the ideal form: Product design and consumer response. *Journal of Marketing* ,59 ,16-29

The researches in the web design aesthetics area become more and more relevant over years because the presence of the online market is increasing exponentially. According to website Kantar World panel[5], "*e-commerce now accounts for 4.6% of global sales and the growth for 2017 is about 36 % and it will keep growing in the next decade*" (para. 1). The web design is now a fundamental part of the marketing because it is the main touchpoint that a company gets with the customers. According to this fact, our thesis will be focused on the impact that different graphical layouts can have in the analysis of the web site's aesthetics. In this thesis we will exclusively analyze the impact in the web site's aesthetic related to mobile platforms. The main reason is that the final objective is to implement a comparison between mobile platforms, tablet platforms and desktop platforms. The comparison will be focused on the different variables which impact the web site's aesthetics. The web site's aesthetics analysis related to the desktop was conducted by Charlotte Botermans last year and the topic about the tablet has not started yet.

1.2. Research question in management

How to measure the aesthetics of web site on a mobile device?

The web design topic and more globally the GUI are topics that become relevant in a marketing strategy. It is not a simple aspect of the marketing development process anymore but a crucial key point that the management needs to care about. According to David Robin and Jason Holmes[6]," *a high aesthetics treatment produces a high judgement of credibility, they conclude that there is a significant interaction between design and credibility" (Robin and Holmes,2007, p.386*). It means that the design is not only related to the decoration of the graphical interface, but it is also playing a role in the way the customers will judge the product or the company. Tracktinsky et al. came to the same conclusion.

Aesthetics can play a stronger role than brand name in terms of ratings and quality judgement (*Page and Herr, 2002, p.133-147*)[7]. Furthermore, Page and Herr (*2002, p.133-147*)[8]

[5] Kantar world panel (2017).*Le marché mondial du e-commerce croît de +30%*.On line on the website Kantar world panel. https://www.kantarworldpanel.com/fr/A-la-une/Ecommerce

[6] Holmes, J., Robin, D. (2007). *Information Processing and Management* 44, (2008) ;386–399

[7] Page, C., and Herr,P. M. (2002) . *An investigation of the processes by which product design and brand strength interact to determine initial affect and quality judgment*. Journal of consumer psychology,12, 133-147

[8] Page, C., and Herr,P. M. (2002) . *An investigation of the processes by which product design and brand strength interact to determine initial affect and quality judgment*. Journal of consumer psychology,12, 133-147

claim also that "*the aesthetics and design can impact the purchase's decision of a customer and can create a competitive advantage"*. Moreover, in 2017 the number of mobile devices per capita was almost equal to 1 which represents a penetration rate of 99.7 percent. All that being said, companies have assimilated the fact that the design process can be really valuable and relevant and can increase the turn over. Hypothetically, we can consider that this thesis can be used by companies to optimize their graphical interface. This statement is hypothetic because first, this work has not for objective to boost the web design implementation of any company, the goal is only academical. Secondly, I don't have the pretention to say that this thesis will have any impact on a design decision process, I am only a student and I don't pretend to find the good measurement to analyse. However, my studies and my academic curriculum are focused on economy and finance so according to that, it was important to mention the link we can make between this thesis and a potential marketing decision process.

1.3. Research's motivation

1.3.1. *Personal motivations*

The global interface user's analysis with an objective of aesthetics optimisation becomes a topic more and more relevant in the digital marketing world. I am born during the advent of internet and my generation is a witness of the fast development of the CPU. We realise that internet takes an increasingly important place in the current economic system. Consequently, the marketing follows this trend with the growing of the business online. As the young generation internet consumer that I am, I saw a good opportunity to learn more about this subject that concerns all of us. According to Internet World Stats[9] , in 2017, around 4.1 billion of people use internet in the world. According to Eurostat[10], more than 68 % of internet users in the EU make shopping online in 2017 and this figure will growth in the next years. I realized when I made some researches about the aesthetics of web site's topic that the documentation was available but not in abundant quantities. Moreover, most of the researches were implemented in the 2000s which means that knowledge we get about this topic are recent and not well thorough. For all these reasons, it appears to me as an evidence to write my thesis on this topic.

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[9] Internet World Stats (2018), *INTERNET USAGE STATISTICS. The Internet Big Picture. World Internet Users and 2018 Population Stats.* On line on the website Internet world Stats.
https://www.internetworldstats.com/stats.htm

[10] Eurostat (2018), *E-commerce statistics for individuals.* On line on the website Eurostat.
http://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics_for_individuals

The subject about desktop device has already been treated by Charlotte Botermans so I will focus on mobile device.

1.3.2. *Academical motivations*

As explained before, some studies and researches have been implemented in this area with different kind of process, but no one found a way to effectively measure the aesthetics of web site. Lavie and Tractinsky (*2004*)[11] claim that "*there is a lack of suitable concepts and measures of aesthetics, which might seriously limit future studies in this field"*. Moreover, in their study they conclude that "*while interest in all aspects of the human–computer interaction experience is emerging, relatively little is known about user's preferences about aesthetic"*. According to Ralf Hoffmann and Kirstin Krauss (*2004, p.205-209*)[12]," *there is a lack of literature on visual aesthetics for the web to build onto"*. We realise that the need of knowledge in this domain is crucial to better perceive the aspect and the component of the web site aesthetics.

1.3.3. Marketing motivations

As explained before, the development of the GUI brings a real added value to companies, this aspect should not be neglected at the risk of being out of the market. David Robin and Jason Holmes (*2007,p.386*)[13] claim "*that when you see a website, the first impression is probably made quite quickly, and the user will decide to stay or not based on many factors"*. One of the factors that can influence the user is the page aesthetics. The graphical user interface can get an impact on the marketing strategy for companies which are doing business online. Moreover, their study revealed that "*when the same content is presented but designed with different level of aesthetics treatment, the content with a higher aesthetics treatment will be having a higher credibility"*. We notice that there is a causal link between the

[11] Lavie, T.,Tractinsky, N.(2004). Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies*,*6* (3),269-298.
[12] Hoffmann, R., Krauss, K. (2004). *A critical evaluation of literature on visual aesthetics for the web*.On line on the website Research Gate.
https://www.researchgate.net/publication/234795460_A_critical_evaluation_of_literature_on_visual_aesthetics_for_the_web
[13] Holmes, J., Robin, D. (2007). *Information Processing and Management*, 44 ,(2008) ,386–399.

aesthetics and the perception the user gets about web site, but the knowledge is still insufficient to be able to draw a relevant theory.

1.3.4. *Historical motivations*

According to Jean Vanderdonckt and Matthieu Zen (*2004, p.3*)[14] "*aesthetics are often defined as a subjective matter related to the concept of "beauty", "visual design", "appealing", which are abstract concepts mainly studied in disciplines such as philosophy, psychology, social sciences, and arts".* They claim also that "*evaluation is by nature an objective process resulting into quantifiable result"*. The historical and general opinion makes us think that beauty and aesthetics are based on subjectivity and personal judgement. Furthermore, subjectivity is not a crucial factor for a human computer interaction decision process. This field requires decision and strategy based on objective observation. According to all these facts, even if the topic is quite relevant and some surveys were implemented, a small quantity of articles, reports or thesis are available about the aesthetics of web site and more globally about the Graphical user interface. So, new researches and studies would be helpful and relevant for this topic.

1.3.5. *Management motivations*

According to Gabriel Shaoolian, CEO and Founder of Blue Fountain Media (*2017*)[15], "*your entire website design, including messaging and creative aesthetics, should have a cohesive digital strategy that supports each elements of your website design" (Digital Strategies, Para. 8).* This statement brings us back to the fact that the main element which will be impacted by the manipulation in the design of GUI is the digital strategy and more globally the entire strategy of the company. We are evolving in a competitive market where the best marketing tool for presenting your value proposition is the website. From a financial point of view, it would be really helpful for a marketing financial officer to measure the gain or the loss of visits and the time spent on the website with the design transformation. It allows the manager to create a more accurate design according to attendance of the website. The final objective would be to find the best ratio (design investment/visit) and (design investment/visit duration).

[14] Vanderdonckt, J., Zen, M. (2016). Assessing User Interface Aesthetics based on the Intersubjectivity of Judgment .W*orking Paper,1.*

[15] Shaoolian, G. (2017). *The Value of a Website Strategy*. On line on the website Huffington post. https://www.huffingtonpost.com/gabriel-shaoolian/the-value-of-a-website-strategy_b_8807554.html?guccounter=1.t

We consider that the terms visit, or the time spent on the website would be correlated to the satisfaction of the customers. More you like a website more you spend time on it. According to Panalysis[16], a digital analytics consultancy company, "*time on site or visit duration can be an indication of the level of interest or involvement that a visitor has with the website. It is also a good indicator of the success of a campaign or other promotional activity that brings visitors to your website*" (para. 2).

1.3.6. *Methodological motivations*

As explained before, there is significant lack of study and literature about how measuring the aesthetics of website more precisely with mobile devices. It can lead us directly to the fact that there is not really an adequate and relevant methodologic process to conduct a study. There are studies implemented by different researchers which procured me plenty of useful and relevant information to progress in my study like Johanna Silvennoinen who is experiencing the visual usability and the aesthetics, Bo N. Schenkman & Fredrik U. Jönsson, Ralph Hoffmann and Kirstin Krauss, Aliaksei Miniukovich and Antonella de Angeli and many others. My goal here is not to criticise their work at all, I give them all my gratitude for the precious information I got by reading but from my point of view it was important to follow the methodology directed by the professor Jean Vanderdonckt and Mr. Nicolas Burny.

1.4. Relationship with the economic environment

It seemed important to me to explain the relationship that can exist between our topic's thesis and the economic environment because I am doing this thesis as a part of a master's degree in finance. We can demonstrate the link between these two subjects. A visually optimized website can be a powerful growth driver for a business. This attracts more customers thanks to the visual appeal of the web site. A customer being attracted by a website will surely be more inclined to make a transaction on this platform. A visual attractiveness can positively affect a business, thanks to an increase in its turnover.

[16] Panalysis (2018), *How to Interpret Time on Site.* On line on the website Panalysis. https://www.panalysis.com/resources/articles/understanding-time-on-site

1.5. Thesis structure

It is important to mention and explain the structure of the thesis to allow the reader to understand the course of the research. This thesis is divided into different sections.

The first chapter is dedicated to the introduction. A section used to lay the foundation of the research. This chapter explains the different motivations that brought us to the redaction of this thesis. Moreover, there will be a quick overview of the subject of research and the elements around it. It will be mentioned the link that aesthetics can have with business as well as the different questions, challenges and problems related to this subject.

The second chapter will be dedicated to literature review. It is a reference of existing knowledge on the subject. It will be question of the subject contextualisation as well as of more explication on certain elements as the GUI, aesthetic of web site… It allows the reader to better understand the topic.

The third chapter reviews the research questions and the hypothesis for the statistical analysis.

The fourth chapter resumes the methodology. This section explained all the steps to achieve the analysis.

The fifth chapter explains the statistical analysis. It resumes the analysis of the data, the presentation and the explanation of the table.

The sixth chapter is dedicated to the results of the analyse

The seventh chapter explains the conclusions, the problems and the limits of the model.

2. Literature review

2.1. Contextualisation of the subject and history

2.1.1. *The aesthetics: evolution and definition*

To have a good comprehension of the subject we need to delimit the context of the study. We need to know where the term "aesthetics" comes from, how it has evolved with time. It is fundamental to define more precisely the topic in the history to reduce to the maximum the fields of application which can confuse the reader. I will start defining the term aesthetics by incorporating some authors from the intellectual society that tried to define this subject so many times debated and in the second part, I will explain the evolution of internet to finally end up with the subject we care about, the aesthetics of web site. The progression of the presentation based on a time scale will be exposed gradually.

What are the aesthetics? What are the origins of this word? What is the evolution of the meaning of this word? According to the Online etymology dictionary[17], the word aesthetics comes from the Greek αἰσθητικός which means aesthetics, sensitive. This term itself comes from the word αἰσθάνομαι (I perceive, I feel). According to Mathieu Zen (*2017, p.6*)[18], Socrate was a precursor in this field. Actually, the exact term was not aesthetics but beauty. During a reflection with Hyppias, his friends, he gave 3 meanings of the term of beauty. First, he sees it as a virgin, secondly as a convenience and thirdly as something both useful and pleasant. He ended up with the fact that beauty is hard to describe and will lead to discussion, debate and different points of view[19]. For Plato, beauty is the Idea (Form) above all other Ideas (-370)[20].. The point of view of Aristote is in opposite with Plato. According to the 1902 Encyclopaedia (*1892, Part 9, para 3*), Aristotle, "*ignores all conceptions of an absolute Beauty, and at the same time seeks to distinguish the Beautiful from the Good*"[21].

One of the first who cared about aesthetics was Alexander Baumgarten with his dissertation in 1735 during the age of Enlightenment" *Meditationes philosophicae de nonnullis*

[17] On line on the web site Online Etymology Dictionary. https://www.etymonline.com/word/aesthetic
[18] Zen, M. (2017). A *methodology for assessing aesthetics of a graphical user interface of an information system : visual measures-based automated evaluation.*Thesis,6.
[19] CROISET, A. Hippias Majeur.(1921) In Œuvres complètes, *tome II*, *Les Belles Lettres*, Ed.Paris,,8–43
[20] Plato. (-370).*Phaedrus.*
[21] Sully, J. (1892). *Aesthetics (Esthetics).* Part 9.

ad poema pertinentibus" which means Philosophical considerations of some matters pertaining the poem[22]. George. T Dickie suggests that Baumgarten selected "aesthetics" because he hoped to emphasize the experience of art to become a mean of knowing[23]. For him, aesthetics is not an intellectual field. This statement confirms what we said previously, the aesthetics was primarily recognized as a subjective topic more based on a personal feeling than on an objective reasoning.

Kant created the Critique of judgement (*1790, p41-97*)[24]. For him, the term aesthetics is associated to any sensual experience. The beauty is not inside of an object but is related to the pleasure we get while the object inspires us. In other words, the beauty is not correlated with the ability to serve as an end to mean. Kant claimed that the beauty is in the eyes of the beholder. For him, if something is beautiful for him, it is beautiful for everybody else. Finally, Kant suggested that the judgement of aesthetics should be all-time based on a singular object because he rejected the fact that the beauty can be resumed by a list of qualities. For him the beauty is a subjective notion.

Other philosophers tried to define and study this subject. Until the end of the 18th century, the general opinion was to think that the term aesthetics was a synonym for the philosophy of art. But Hegel and many others have different point of view. They say that "*aesthetic judgement refers to the sensory contemplation or appreciation of an object, while artistic judgement refers to the recognition, appreciation or criticism of art or an art work" [25]*.

We realise that the word aesthetics has several meanings according to the different point of view. Moreover, this definition induces often the term of subjectivity. It is difficult to analyse the aesthetics of somethings without taking into account our personal opinion. In 2004, Reber (2004, p.364-382)[26] tried to explain of beauty through 3 different visions:

- The objectivism view sees beauty as a property of an object that produces a pleasurable experience in any suitable perceiver. It means that the elements of the beauty are perceivable. It was the dominant way of thinking during the 16th century for the artist

[22] Baumgarten, A. (1735). *Meditationes philosophicae de nonnullis ad poema pertinentibus.*Ed. F.Meiner.
[23] Baumgarten, A. (1735). *Meditationes philosophicae de nonnullis ad poema pertinentibus.*Ed. F.Meiner.
[24] Kant, I. (1790). *Critique of judgment.* Ed.Hackett Publishing Company, 41-97.
[25] Quoted on the website Course Lumen Learning.https://courses.lumenlearning.com/boundless-arthistory/chapter/what-is-art/
[26] Reber, R., Schwarz, N., AND Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and social psychology review* 8,4(2004),364–382

because this view gave the possibility to the artists to create beauty thanks to the pictorial element that artists could copy and combine.

- The subjectivist view sees beauty as a function of idiosyncratic qualities. This position refers to the statement of Kant "beauty is in the eyes of the beholder". He rejects the existence of universal law of beauty. We can resume it by the fact that the beauty will be effectively recognisable by a kind of collective aggregate from the viewers.
- The interactionist view defines beauty as a result from the interaction of stimulus properties and perceivers cognitive an effective process. This view suggests that the beauty can be result of a series of patterns.

Reber, Schwarz and Winkielman discussed some study through their research about processing fluency and aesthetics pleasure (*2004, p.364-382*)[27]. Their objective was to find which stimuli can influence the aesthetics pleasure. The process is simple, the perceivers will have a repeated exposure to the stimuli to see which one has an influence. The stimuli's selected here for the experience are all objective stimuli's because there are parameters that are quantifiable, we can classify by order of magnitude. Four variables were selected: the amount of information, symmetry, contrast and clarity. These variables are selected because their influence comes from the fact that they facilitate the processing of a stimulus. Furthermore, all along their research, they made the connection with other authors who studied the same variable than them. For example, they mention Garner[28] who found that the judgement of aesthetics was better, the less information people had to extract from a stimulus to get it. More over these results are corroborated by his other finding who's suggesting that people are inclined to choose symmetric shapes because they have less information than asymmetric shapes.

Regarding the symmetry, Reber claims that all results converge to the same statement, symmetrical pattern has positive impact on the beauty perception and symmetry facilitates fluent processing. We can cite some authors who came to the same conclusion. For example, "*symmetry has been used to influence the perceived attractiveness of human faces"* (*Gangestad, Thornhill, & Yeo,1994[29]; Rhodes,Proffitt, Grady, & Sumich, 1998[30];Rhodes, Sumich, & Byatt,*

[27] Reber, R., Schwarz, N., Winkielman, P. (2004). Processing Fluency and Aesthetic Pleasure: Is Beauty in the Perceiver's Processing Experience? *Personality and Social Psychology Review* , Vol. 8, No. 4, 364–382.
[28] Garner,W.R.(1974).*The processing of information structure* .Potomac, MD: Lawrence Erlbaum Associates, Inc.
[29] Gangestad, S. W., Thornhill, R., & Yeo, R. A. (1994). Facial attractiveness, developmental stability, and fluctuating asymmetry. *Ethology and Sociobiology*, 15, 73–85.
[30] Rhodes, G., Proffitt, F., Grady, J. M., & Sumich, A. (1998). Facial symmetry and the perception of beauty. *Psychonomic Bulletin and Review*, 5, 659–669.

1999[31]).Or , "*symmetrical patterns also have less information and are hence easier to process* "(*Garner,1974*) [32] .Or, *"symmetric patterns are preferred even if they do not serve any biologically relevant function, both in humans"* (*Humphrey, 1997*[33]*; R. Reber & Schwarz,* in press).

For contrast and clarity, Reber claims that according to Gombrich (*1984*)[34], Maritain (*1966*)[35] and Solso (1997)[36], the fact that contrast and clarity were objective determinant was a well-established opinion. To corroborate that, Reber used especially the result of the studies implemented by different researchers. The first was the study of Whittlesea et al. (*1990*)[37], in their experiment, experiencers saw a list of words quiet rapidly. Then a word with higher or lower visual clarity was presented to them. The goal for the participant is to say if the word was present on the list or not. Results show that a word with a higher visual clarity has more chance to be erroneously selected while it was not on the list.

To see the effect of the contrast variable, Reber studied the impact of the variation of the figure-ground contrast on circle presented for one second. The result shows that circles with high figure–ground contrast were considered as prettier than circles with low figure–ground contrast. Moreover, the result also shows that increasing fluency provides a judgement of higher beauty. This study is implemented with the assumption that it is the contrast variable which influences the valuation. However, if we make the assumption that fluency is the element who impacts the most the valuation, Reber claims that the duration of the stimuli's can impact the perception of the beauty. According to him and Schwarz, if perceptual fluency is a pertinent variable of the preference, figure–ground contrast should have more impact during short presentations times and less impact during long presentations times. To proof their reasoning, Reber and Schwarz made an experiment. They manipulated the figure ground contrast of

[31] Rhodes,G.,Sumich,A.,&Byatt,G.(1999).Areaveragefacialconfigurations attractive only because of their symmetry? Psychological Science, 10, 52–58.
[32] Garner,W.R.(1974).*The processing of information structure* .Potomac, MD: Lawrence Erlbaum Associates, Inc.
[33] Humphrey,D.(1997).Preferences in symmetries and symmetries in drawings: Asymmetries between ages and sexes. *Empirical Studies of the Arts*, 15, 41–60.
[34] Gombrich, E. H. (1984). *A sense of order* (2nd ed.). London: Phaidon.
[35] Maritain,J.(1966).Beauty and imitation .InM. Rader (Ed.),*A modern book of Esthetics* (3rd ed., pp. 27–34). New York: Holt, Rinehart & Winston
[36] Solso, R. L. (1997). Cognition and the visual arts. Cambridge, MA: MIT Press.
[37] Whittlesea,B.W.A.,Jacoby,L.L.,&Girard,K.(1990).Illusions of immediate memory: Evidence of an attributional basis for feelings of familiarity and perceptual quality. *Journal of Memory and Language*, 29, 716–732

different circle for different periods of time (0.3,1,3 and 10 seconds). As expected, the figure ground contrast has an impact on aesthetics judgement only during short period of time[38].

Another author who tried to define the term aesthetics is Mary Mothersill (*2004, p.152-166*)[39]. She defines the aesthetics as "*a judgement based on the senses, emotions, intellectual opinions, will, desires, culture, preferences, values, subconscious behaviour, conscious decision, training, instinct, sociological institutions, or some complex combination of these, depending on exactly which theory one employs".*

2.1.2. *The globalisation*

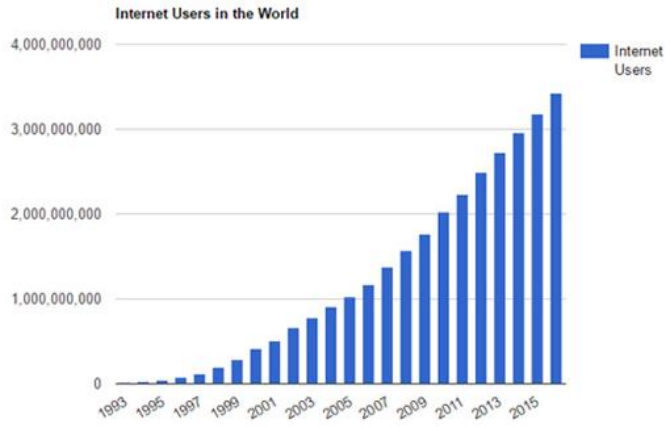
Now we have a clearer idea and vision of what currently aesthetics is meaning and what was the evolution of his sense through centuries. The objective now is to understand how this topic became a such important part of the strategy and marketing development of a company. We suggest starting with the globalisation. Indeed, globalisation is what allows the advent of internet. We live in a world where the growth of the market is in perpetual evolution and where global goods and global services become more and more important. Moreover, because of the increase in the consumer market, the competition and the concurrence become more and more aggressive. According to Yip (1995)[40] "*the globalisation of the marketplace is arguably the most important challenge facing companies today*" (quoted in Identifying Spatial Segments in International Markets,2002, p.161)[41]. The globalisation of the economy is possible thanks to the fast development of the telecommunication technologies and the digitalisation of the society. Consumers of today can buy and compare products coming from all over the world, they are no longer restricted to the domestic market anymore. Consequently, the level of competitiveness is increasing, and company must be innovative and must stand out from the competition.

2.1.3. *The computer system*

Another consequence of the development of the technology is the appearance of the computer system in the sixties with practical applications of the us military technology (implemented in the end of the fifties) made by American scientists and the creation of the World Wide Web in the 1990s, with the popularization of the foundations of the modern

[38] Reber, R., Schwarz, N., Winkielman, P. (2004). Processing Fluency and Aesthetic Pleasure: Is Beauty in the Perceiver's Processing Experience? *Personality and Social Psychology Review* , Vol. 8, No. 4, 364–382.
[39] Mothersill, M. (2008). Beauty and the Critic's Judgment. *The Blackwell Guide to Aesthetic*, chapter 8,152-166.
[40] Yip, G. S. (1995). *Total Global Strategy*. Prentice Hall, Englewood Cliffs, NJ.
[41] Hofstede, T., Wedel, M., Steenkamp, J. (2002). Identifying Spatial Segments in International Market. *MARKETING SCIENCE*,10 (2), 161.

Internet. The fast-growing development of the computer processor unit lead to the democratization of this technology with the consequence of a beginning of a private, public and commercial using.



Graph 1- Historical representation of the number of internet users in the world

Computer system's development proceeded as described now. Before the advent of the network connections that led the development of the internet that we know today, most of the networks communication were reduced to manage communication only with processor from the same network. In 1950, the common process was to implement a central computer system connected to different terminals. This process, called the RAND[42] project (research and development), allows the collaboration between researchers located in different location (Pittsburgh, Santa Monica). In 1960,a scientist called J.C.R. Licklider directed the office of the information treatment of the DARPA (Defense Advanced Research Project Agency) under guardianship from the department of the United States 's defence. He created a group which got for objective to develop computer process and to implement a global network. In his paper Man -computer Symbiosis (*1960*) he said, *"A network of such centers, connected to one another by wide-band communication lines [...] the functions of present-day libraries together with anticipated advances in information storage and retrieval and symbiotic functions"*[43] . However, he didn't succeed in his task to create a global network, the problem of inter connection was still present. A solution was proposed especially by Donald Davies[44]. The idea

[42] Rand Org. *History and Mission.* On line on the website https://www.rand.org/about/history.html.
[43] Licklider, J. C. R. (1960). Man-Computer Symbiosis. *IRE Transactions on Human Factors in Electronics*, 1, 4-11,
[44] Harris, T. *Who is the Father of the Internet? The case for Donald Watts Davies.* 6-10.

was the packet switching. This process is grouping data that are transported by a network in the form of packet. The fact that the creation of internet got for objective to survive and to communicate to a nuclear attack is a little bit exaggerated and it is more fantasy than real. The real objective of the implementation of the ancestor of internet was rather the economic advantage and to prevent the disruption or damage of the military network in case of attack.

In 1969, thanks to the collaboration of different researchers like Lawrence Roberts, Frank Heart, Robert Taylor or Matt Racoon, the ARPANET[45] was implemented between the university of Los Angeles in California and the Stanford Research Institute. It was the first interconnected network, but the official apparition of the Arpanet was in 1972. The network kept developing itself the next decade. During the 70's[46], in the other side of the globe, the Europeans were working in a project called X.25. This network was primarily created for the private sector like communication companies in order to develop public phone network. In 1976, the first X.25 network is launched by the International Union of Communication.

Because of the huge number of different kinds of protocol of network communication, the need was to find a way to harmonize it. Robert E. Kahn and Vinton G Cerf were working on this project and found a way to reduce the difference between the protocols. Thereafter, with the contribution of Hubert Zimmermann and Louis Pouzin , they became able to merge networks regardless the specificity of each protocol. In 1977 the first TCP/IP protocol (Transmission Control Protocol/Internet Protocol) was in use and in 1983 the TCP/IP protocol became the only active protocol on the Arpanet[47].

In the start of the 80's, the American government partnered with National Science Foundation (another part of the American administration) in order to keep developing the research in the military field and in the university because the first objective of the Arpanet was to develop the research in those two areas and not to create the telecommunication network. One of their main objectives was to develop the next generation of the Arpanet. It is during the merge of the Arpa network and the National Science Foundation in the end of the 80's that the term "Internet" took the signification of a global network using TCP/ IP protocol. In 1984, the

[45] Congressional Digest. (2004). Internet history: From ARPANET to broadband, 86, (2),35-37.
[46] Mitchell, B. (2018). A Guide to X.25 in Computer Networking. On line on the website Life Wire. https://www.lifewire.com/x-25-816286
[47] *TCP/IP* On line on the website History of computer. http://history-computer.com/Internet/Maturing/TCPIP.html

European countries started their reconversion followed by the Australian in 1989 with the AARNET and by the Asian in the end of the 80's. The use of internet for commercial purpose started with the appearance of the first company's providers of networks[48].

All that being said, we realized the increase of the role and the democratization of the use of internet this 50 last years. Now, companies are completely dependent of the computer assistance. "*It's true that our jobs and lives are becoming ever more automated, and It seems a sure bet that the trend will continue.* "(*Nicholas Carr',2009*)[49]. The current business cycle motivates today the use of automatization process to improve the quality and the accuracy. The purpose is to incorporate the computer system in all areas of the company. The expected result can manifest itself in several forms: more accurate commercial strategy, reaching more customers all around the world, automatization of the process, more accurate analyses of the data, improvement communication process... The main objective is to properly implement communications and information technologies. Information technology (computer system) positions itself as a key factor of success in the enlarging market.

2.1.4. *The information system and the website*

An important term to define is "the information system ". Today it is a key factor of the success of a company. According to the Encyclopaedia of Britannica[50], we can define the information system as "*an integrated set of components for collecting, storing, and processing data and for providing information, knowledge, and digital products. Business firms and other organizations rely on information systems to carry out and manage their operations, interact with their customers and suppliers and compete in the marketplace. Information systems are used to run interorganizational supply chains and electronic markets. For instance, corporations use information systems to process financial accounts, to manage their human resources, and to reach their potential customers with online promotions. It can provide a really added value for the company for whom it is operating".* "*Information systems are one of the major tools available to business managers for achieving operational excellence, developing*

[48] Korporaal, G. (2009). *Aarnet 20 years of the internet in Australia*, .18-32
[49] Carr, N. (2009). *'Are we becoming too reliant on computers?'*. On line on the website The Guardian. https://www.theguardian.com/books/2015/jan/17/nicholas-carr-are-we-becoming-too-reliant-on-computers
[50] Zwass, V. *Information system*. On line on the website Encyclopaedia of Britannica. https://www.britannica.com/topic/information-system.

new products and services, improving decision making, and achieving competitive advantage" (*Laudon and Laudon ,2004*)[51].

As explained before, information system can be used for the online promotion. This leads us to another fundamental concept that we need to clarify to well understand our subject, the website. According to Rosen and Purinton (*2004*), *a website includes "texts, pictures, graphics, layout, sounds, motions and, someday, even smell* "(quoted *in Advances in Advertising Research,2013, p.142*)[52]. Today, implementing a relevant website is a factor of success. This is a crucial element needed to optimize the visibility of the company and the products you want to promote. In their study in 2009," Attention web designers", Alsudani and Casey argue that" *First impressions of viewing a web site's home page affect a user's decision as whether to continue viewing that web site or move to another one"*[53]. Moreover, according to WebSiteOptimisation.com[54] "*First impressions affect user's judgments on different aspects of web site design including usability, credibility or purchasing intentions*". It illustrates the importance of the concept. The online promotion and the E-commerce are real means to reach your objective of sell. We can define the E-commerce as "*a method of buying and selling products and services electronically on computer*" (*Muhammad Ali, 2000*)[55]. The e-commerce can include: using the Internet to purchase goods and services online or selling goods and communicating with other businesses through the Internet. The primary objective for the marketers would be to find the right content to add and find the good balance between the architecture design and the content to get a successful web interface design.

2.1.5. *The GUI*

A website functions through a web interface called the graphical user interface. According to Petkovic (quoted in the Shihong Huang's lecture), "*GUI is a part of Human-Computer Interaction (HCI) which is the study, planning and design of how people and computers work together and User Interface (UI) is what users see, hear, touch, talk to or control and direct*"[56].

[51] Laudon, K., Laudon, J. (2004). *Management Information System*,12, 26.
[52] Rosengren, S., Dahlén, M. (2013). *Advances in Advertising research, European Advertising Academy*4,142.
[53] Alsudani, F., Casey F. (2009). The Effect of Aesthetics on Web Credibility. *People and Computers XXIII,1*.
[54] Web Site Optimization (2006). *First Impressions Count in Web Design*. On line on the website Web site optimization. http://www.websiteoptimization.com/speed/tweak/blink/
[55] Muhammad, A. (2000). *E-commerce/E-business Definition ,Scopes and Uses*, 31(11),5.
[56] Huang, S. *Usability and GUI design Principles.* Dia. 4

According to Zen's thesis (*2017*)[57] , "*The Graphical User Interface (GUI) is probably the most frequently used interaction modality of all interactive systems, including information systems, ranging from mobile applications to interactive services. While the information contents of these GUIs are of high importance, their presentation is recognized as an essential factor that determines the GUI quality that is impacted by several determinants such as, but not limited to: Visual design, aesthetics, pleasurability, arousal, and fun.".* The importance of the GUI is no longer to demonstrate. Galitz (*2007*)[58] claims that "*The user interface is the most important part of any computer system. Why? It is the system to most users use*". Furthermore, Galitz distinguished 2 components in the user interface, the input and the output. The input is defined as the way the people communicate their needs to the computer and the output is defined as the way the computer will transmit the result of the computation to the user.

2.1.6. *The web mobile*

The GUI leads us to another concept that we need to clarify to be in line with the main subject of this thesis: internet in a mobile phone device also called web mobile. Historically speaking, the web mobile appeared in 1999 with the WAP (Wireless Application Protocol), it is a language derived from the HTML. The first mobile device which used the WAP was the Nokia 7110[59]. "*Because of its wireless nature, the mobile phone is much less tied to specific physical locations than the (wired) Internet and is likely to reduce spatial constraints to a much stronger degree"* (*Schwanen and Mei-Po Kwan, 2007*)[60]. This sentence illustrates the main advantage of the use of internet on a mobile phone device, it is the fact that internet on a mobile phone modifies the way we interact and the shopping behaviour. This allows us to see a lot of perspective as there is no more physical limit.

This leads us to the concept that we are trying to understand in this thesis; the aesthetics of web site through a mobile device. More specifications will be done throughout the end of this section.

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[57] Zen , M. (2017). *A methodology for assessing aesthetics of a graphical user interface of an information system : visual measures-based automated evaluation*.Ed : Dial.
[58] Galitz, W. (2007). *The Essential Guide to User Interface Design. An Introduction to GUI Design Principles and Techniques.* Ed. 2,1.
[59] On line on the website Wikipédia. https://fr.wikipedia.org/wiki/Web_mobile
[60] Schwanen, T., Kwan, M. (2007). The Internet, mobile phone and space-time constraint. *Geoforum 3*,1370.

2.2. The Graphical User Interface

The graphical user interface is a fundamental concept of our analysis. We already described previously the concept in the contextualisation, but it seemed necessary to us to define more precisely the term and describe the evolution of the concept.

2.2.1. *The evolution of Graphical User Interface*

The premises of the Graphical User Interface started in 1962 with Douglas Egelbart who conducted research about the augmentation of human intellect at the Standford Research institute in California. He developed with his team the On-Line System. His purpose was to advance the research in human- computer interaction. The On Line System was composed of a television monitor called the screen and a cursor called the mouse for pointing and selecting items on the screen[61]. The process was based on the child learning technique according to the eye-hand coordination.

Those researches led to the first application with a GUI created at the Xerox Palo Alto Research in 1977, the Xerox Star. The Xerox Star was computed in two times. First the researcher designed the computer human interface and then they designed the internal structure of the application. Unhopefully, the system was too slow and not really designed for a commercial objective (*Baudelaire,2016, Jansen ,1998*)[62] [63].

Then Steve Jobs visited the Palo Alto research Center and saw the future potential of system. When he came back to the Apple company, he decided to hire the designers of the Xerox Star. At first, they created the Apple Lisa, a system based on the Xerox Star but it was a commercial disaster like the Xerox Star. The success came in 1984 with the creation of the first Apple Macintosh. All the GUI of today are based on the development of the GUI process of the Macintosh. (*Baudelaire,2016, Jansen ,1998*)[64][65].

[61] Doug Engelbart Institute. *The Dawn of Interactive Computing.* On line on the website Doug Engelbart. http://dougengelbart.org/firsts/interactive-computing.html
[62] Baudelaire, P. (2016). The Xerox Alto Font Design System. *Visible Language,* 50 (2).13-25.
[63] Jansen, B. (1998).*The Graphical User Interface. An Introduction*,30 (2),22-26.
[64] Baudelaire, P. (2016). The Xerox Alto Font Design System. *Visible Language,* 50 (2).13-25.
[65] Jansen, B. (1998).*The Graphical User Interface. An Introduction*,30 (2),22-26.

Another application which greatly helped the development of GUI is the IBM-SAA, launched in 1987. It is a whole system more complete than the GUI of Macintosh, it includes networking and data base tool. Moreover, a mouse is not needed anymore for the interaction with the machine, everything is done with a keyboard. The last precursor of the GUI is the MIT X-Windows System. This system can be used as a kind of library for the GUI. (*Jansen 1998*[66]*).*

2.2.2. More specifications about the GUI

We described previously what the Graphical User Interface means and what was the evolution of this concept through the time. However, it should be mentioned what is the real utility of the GUI. With an appropriate GUI, it allows the designer to create a huge number of different layouts for a web page. If the implementation is well done, the way the system interacts with the user should be simple and the visual aesthetic should be enough completed to please to the user. Moreover, the information included in the web page does not overload the display and allows a perfect understanding for the users.

However, we can mention a disadvantage inherent to the GUI. The GUI process can be integrated to a product to get more features and more control, for example semi-automated industrial equipment. The main issue is that the control and the interaction that a user can have with the machine trough GUI will depend on the way the user interacts with the system. The manoeuvring will be limited by the mechanism that allows to interact with the machine. To illustrate the word, let imagine driving a plane with a cursor and a mouse. Therefore, all the functionalities should be added to the display.

2.3. The concept of Web site's aesthetic on a mobile phone device

There is no much of reference articles explaining this aspect of the E-commerce. According to Karvonen (*2000*)[67], despite the fact that some studies have been conducted about the relation between interface and web site, taking to account the aesthetics in the mobile domain has been most of time set aside because cultural divergences make the comprehension

[66] Jansen, B. (1998).*The Graphical User Interface. An Introduction*,30 (2),22-26.
[67] Karvonen, K. (2000). *The Beauty of Simplicity,*1-3.

of aesthetics more problematic. The role of the aesthetics is crucial for trust and loyalty of consumer. The aesthetic of web site has a strong effect on the trust in the Web.

Two of the authors who brought probably one of the biggest contribution are Yung-Ming Li and Yung-Shao Yeh through their research. In their article "*Increasing trust in mobile commerce through design aesthetics*"[68], their study was focused on how trust can be built on a mobile device. The purpose was to analyze the relationship between the aesthetic of a mobile website and the trust of customer in mobile commerce. The study was structured as follow: they selected fifty students from three universities in the northern part of Taiwan. Certain conditions were required to participate: the participants must a least have used their mobile phone for one year and at least did one transaction with their mobile. The objective was to analyze three principal elements of the aesthetic of web site which can involve the trust in mobile commerce. The first task for them was to select a mobile website of sale among three different snapshots of website: one selling camera, one renting a car and one booking an hotel. This website of services will be used for the study.

The participants chose the website selling the camera. The next step consisted in asking to the participants to discover the web site and to try to buy a camera. It should be mentioned that the participants never saw the camera service before, the interest is to see how the participants will make their purchase decision. The second task was to complete a questionnaire about the phone simulation. In order to answer to the global question, the author made different hypothesis to test about the different variables.

H1. Higher level of design aesthetics of a mobile website will result in higher m-trust.
H2. Higher level of design aesthetics of a mobile website will result in higher perceived usefulness of the mobile website.
H3. Higher level of design aesthetics of a mobile website will result in higher perceived ease of use of the mobile website

[68] Yung-Ming, L., Yung- Shao,Y. (2010). Increasing trust in mobile commerce through design aesthetics. *Computers in Human Behavior*, 26 (4),673-684.

H4. Higher level of design aesthetics of a mobile website will have a higher impact on the customization of the mobile website.
H5. Higher perceived usefulness of a mobile website will result in higher level of m-trust.
H6. Higher perceived ease of use of a mobile website will result in higher level of m-trust.
H7. Higher customization of a mobile website will result in higher level of m-trust.

The results show that the coefficient of usefulness, ease of use and customisation were respectively 0.40, 0.16 and 0.41 with ($p < 0.01$). According to that, we can support hypotheses 1,2,3 and 4. Moreover, usefulness ($B = 0.19$, $p < 0.01$), ease of use ($B = 0.28$, $p < 0.01$) and customization ($B = 0.29$, $p < 0.01$) have a strong impact on the mobile trust. These statement supports hypothesis 5,6 and 7. The results showed also that the variation of design aesthetic, usefulness, ease of use and customisation affects 37 % of the variation in mobile trust. In addition, the study revealed that perceived usefulness and ease of use have a strong impact on mobile trust. This impact is quite similar for the both ($b = 0.20$ and $b = 0.19$). However, Yung-Ming Li and Yung-Shao Yeh noticed that the impact of those variable is less strong than in other studies as in Koufaris's study (*2002*)[69] or in Cyr et al's m-loyalty study (*2006*)[70], but the effect is going in the same way. These two studies were implemented in similar conditions with the same independent variable to analyse. Moreover, the experimental process to conduct the study was similar too.

The supporting of the hypothesis as well as the result from the both other studies suggest that we can conclude that the beauty of a web site can affect the trust in mobile commerce. The aesthetic can facilitate the information transmission and processing, in other words, increases the usability of the website. The definition of usability in the ISO 9241 standard is[71]: *"The*

[69] Koufaris, M. (2002). Applying the Technology Acceptance Model and Flow Theory to Online Consumer Behavior. *Information Systems Research , 13 (2)*

[70] Cyr, D., Head, M., Ivanov, A. (2006). Design Aesthetics Leading to m-Loyalty in Mobile Commerce", *Information & Management*, 43(8), 950-963.

[71] Organisation International de Normalisation. *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*.On line on the website Iso. https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-1:v1:en

extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". The ease of use and the usefulness are directly related to the usability. We can consider that the aesthetic aspect of a website is directly correlate to the usability of the website.

3. Research's questions and hypothesis

In other to keep focus on our topic, it is crucial to set up some research questions and the hypothesis that relate to it. It allows us to look for precise answers by using specific tool to obtain the result. The research question and the hypothesis were articulated around the general question: "How to measure the aesthetics of web site on a mobile device?" This question was acting as a guidance and a reference during all the conception of this thesis. The validation or not of the hypothesis will allow to formulate the statement about the measure of the aesthetics.

The elaboration of research question and hypothesis is a classic process in the conception of a scientific reasoning. We follow a hypothetic deductive approach, it means that we verify the hypothesis by the observation. We formulate questions and assumptions and we test them with the analyse of the data extracted.

Research Question 1: Are variables computed by Questim able to judge the aesthetics?

Hypothesis 1: All variables have an effect on the visual appeal.

Hypothesis 2: The variables can influence the score with accuracy.

Research Question 2: Is the aesthetics judged the same way by a human and by a semi-automated software?

Hypothesis 3: The variables computed in each study impact the score in the same way.

4. Methodology

To understand the statistical analysis, it is important to describe the methodology we followed to understand the results we got about the Graphical user interface aesthetics. It is fundamental to produce a good reading material to well understand all the steps of the research for a better comprehension of the subject. According to Keith Lenz and Ph. D. (para.3)[72] ,"*reading comprehension is also affected by the quality of the reading material. Some writers are better writers than others, and some writers produce more complex reading material than others. Text that is well organized and clear is called "considerate text," and text that is poorly organized and difficult to understand can be called "inconsiderate text." The more inconsiderate the text, the more work will be required of a reader to comprehend the text."*

4.1. Research and investigation method

According to Creswell (*2013, p.4*)[73], there are two different types of researches and investigation methods: Quantitative and Qualitative approach. The method that we followed to investigate is the Quantitative method. This method is described as follow. The purpose of this mechanism is verifying a theory with the implementation of some assumptions. The second step is to collect a large number of data from different sources and then analyze it with mathematical and statistical tools to test the hypothesis. The ultimate purpose is to verify the hypothesis by cross and comparing them with the results of the analyses. This investigation process is the best way to deal with the research question according to the fact that the objective and the topic of this thesis is to get a clearer idea of which parameter can affect the aesthetic of web sites on a mobile phone device.

Our analysis will follow not completely but precisely enough the experience of Katharina Reinecke et al. (2013) [74], a German teacher in computer science at the University of Washington. She conducted three experiments with 548 participants about 450 different website screenshots. The first task consisted in extracting how the participants perceive the complexity variable and the colourfulness variable. They must rate each image on a scale considering the level of colourfulness and the level of complexity. The exposure to the images

[72] Lenz, K., D, PH. Reading Comprehension. On line on the website of the university of Kansas. http://www.specialconnections.ku.edu/?q=instruction/reading_comprehension
[73] Creswell, J. (2013). Research Design. Qualitative Quantitative and Mixed Method. *Sage.*4
[74] Reinecke, K., et al. (2013). *Predicting Users' First Impressions of Website Aesthetics With a Quantification of Perceived Visual Complexity and Colorfulness.*

is short to extract only the first impression. The second experience is similar to the first one, but the websites are presented in a different order to verify the stability of the judgement of the participants. The third experience consisted in asking to the same participants to rate the websites according to their perceived visual appeal. The final objective being to compare the results to see if there is a correlation between the colourfulness and complexity variable and the score of the website's visual appeal. After our analysis, it will be useful for us to compare our results with those obtained during the Reinecke experiment.

4.2. Data collection

For this study, the data collection mechanism is a crucial step of the process because it represents the public's opinion. To get a more accurate representation of the population, there is no selection criteria because the conclusions hold from this thesis may apply for people from every types of environment, from all ages and from all sex gender. All this is due to the fact that the digitalisation of the society and the new global marketing digital process is applied to all types of consumers. Here, the data collection process consisted in selecting 180 screenshots of the first page of websites on a mobile device. The main problem was to select screenshots able to be analyzed in the Questim program[75]. Some screenshots did not allow to get the metrics for the Balance component. The reason of this failure for those screenshots is still unknown to us now. The Balance component refers to the weight of the objects in the screenshot and an object is defined as a text or a picture, everything that fills the place. Our first hypothesis is that the internet connection was too slow. Our second hypothesis is that the picture was too poorly structured or too much complex to analyze this component. However, this is not our current topic, so we decided to make abstraction of those pictures. Here, there are some illustrations of screenshots analyzed.

[75] http://questimapp.appspot.com/

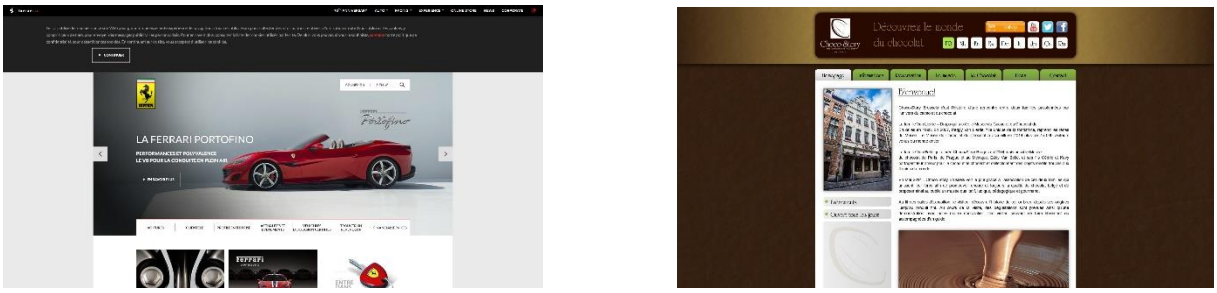


Figure 1- Illustration of some screenshots

The next step was to select a panel of 20 different persons without any restriction of selection and to ask them to score all the screenshots website. This step was feasible thanks to the application of Nicolas Burny. The principle is simple, applicants must evaluate the aesthetic and visual beauty of the 180 pictures on a scale of 0 to 5, 5 referring to a screenshot with a great aesthetic beauty and 0 referring to a screenshot with no aesthetic beauty. The screenshots were exposed during less than a half of a second. As in the Reinecke's experience, the objective of this small period is to capture only the initial reaction of the participants instead of a thoughtful reasoning. This allows to have no alteration of the perception. The judgment remains objective. The application was also intended to collect the age and the sexes gender of the applicants as well as their smartphone usage frequency, their tablet usage frequency and their desktop usage frequency. The result created is in the form of an excel spreadsheet referencing all the scores related to the applicants.

Figure 2- Illustration of the software Questim

The next phase consists in analysing all the screenshots in a software called Questim. This software has been created by Mathieu Zen from the Louvain School of management. The purpose of the software is to analyze all the metrics in correlation with the layout, beauty and aesthetic aspects of a picture or a screenshot. To get these metrics, we have also to define the zones in the screenshots. We can extract from the software different kind of files for every screenshot analysed: one csv Excel files containing all the metric results, a json files (JavaScript Object Notation) for the coordination of the selected zones and PNG files (Portable Network graphics), the screenshot with the defined zones required for the analyse.

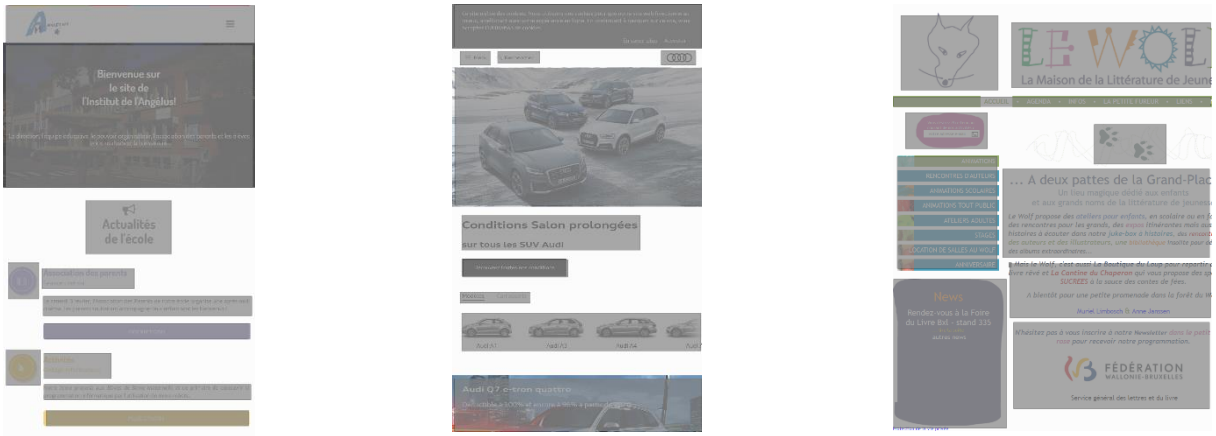


Figure 3- Illustration of the zone definition in Questim

Before starting any analysis, it is crucial to define and well understand what each different variable extracted from Questim means. It is fundamental because some of them will affect with a strong effect the aesthetic result of the different screenshots. The data extracted from Questim are computed by using mathematical algorithms, it is a software-based approach. We decided to analyze all the variables obtained from Questim because we consider that to have a better comprehension of the subject, we must take into account the totality of the variables even if certain have an insignificant effect. It does not mean that our conclusion will suggest using all of them, however it was relevant for us to analyze the intercorrelation between the different variables, in other words, analysing the behaviour of a variable according to another one.

Score

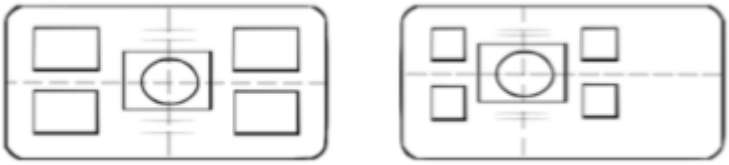
The score refers to the rating given by the applicants based on the aesthetics of the screenshot. The score is based on a scale from 0 to 5.

Balance

According to Ling Ngo, Seng Teo and G.Byrne[76] , the balance refers to the distribution of optical weight. It is related to the perception of some objects in the picture. It takes into account the shape, colour, size of the object.

Equilibrium

According to Ling Ngo, Seng Teo and G.Byrne, the equilibrium refers to the distribution of the objects on the picture. According to the authors, the way to obtain the equilibrium is to centralise the layout, the disposition of the objects. You can also define as the difference between the centre of mass of the object and the centre of the screen.



Symmetry

Symmetry analyzes the replication of one side of the screen to the other side. It allows us to know if one side of the screen is exactly replicated to the other side.

[76] Chek Ling Ngo, D., Seng Teo, L., Byrne, G.*A Mathematical Theory of Interface Aesthetics.*

Simplicity

According to Ling Ngo, Seng Teo and G. Byrne[77], simplicity refers to the directness and the singleness of form. You can increase the simplicity by optimising the number of objects on a screen and reduce the alignment.

Density

According to Ngo, Seng Teo and G.Byrne[78], the density is defined as the number of objects covering the screen. Tully defined the measure of density; it is the percentage of character position on the frame containing data.

Vertical Balance

Vertical balance refers to the balanced disposition about same objects on a vertical axis. The analysis of the replication is computed from the left to the right or the opposite.

Horizontal Balance

The horizontal balance is defined as the balanced disposition about same elements on a horizontal axis. The comparison is computed between the higher side and the lower side.

Center Alignment

Center alignment is defined as the way the elements are dispatched around the centre of the screen. More the object will be centralised more the centre alignment rating will be high.

[77] Chek Ling Ngo, D., Seng Teo, L., Byrne, G.*A Mathematical Theory of Interface Aesthetics.*
[78] Chek Ling Ngo, D., Seng Teo, L., Byrne, G.*A Mathematical Theory of Interface Aesthetics.*

External Alignment

External alignment refers to the distance of the disposition of the elements from the border of the screen. Less element near to the centre, more the external alignment rating will be high.

Concentricity

According to Mathieu Zen (2017)[79], the concentricity measures the concentration of the element in the centre of the picture.

Colourfulness

The colourfulness is the capacity of the image of being colourful

Saliency Balance

According to Shen and Zhao (2014, quoted in M. Zen and J. Vanderdonckt's lecture)[80], this variable refers to the computation of the balance according to the saliency. The saliency refers to something which is prominent.

For the next variables, we didn't find any right definitions. As consequences, we tried to extrapolate the meaning without any guarantee of defining correctly the term.

Border Density

Border density is defined as the number of elements covering the border of the screen.

[79] Zen, M. (2017). A methodology for assessing aesthetics of a graphical user interface of an information system : visual measures-based automated evaluation.*Dial*.135

[80] Vanderdonckt, J., Zen, M. (2016) *Assessing User Interface Aesthetics based on the Intersubjectivity of Judgment*,12.

Border Balance

We can define the border balance as the distribution of the optical weigh in the border of the picture.

Colour Density

The colour density refers to the intensity of colour covering the screen.

Compression Complexity

According to Tuch et al. (2012)[81], the mechanism of the compression complexity variable is to measure visual complexity according to the compression level of a picture. Complexity is defined as the sophistication of the image. It includes the number of elements, the disposition…The compression level refers to the compressed picture.

Now we have a defined the methodology and the different variables, we can move to the next step, the statistical analysis. However, an intermediate step is required. It is necessary to merge the data extracted from the rating's software and from Questim. The goal being to reference all of them in Excel spreadsheet. This is fundamental because this file is the necessary support for further researches. The statistical analysis will run on the software SPSS (statistical Package for the Social Science), created by IBM. This software allows statistical analysis, data management and data documentation. We will be able to test our hypothesis.

[81] Tuch, A. N., E. E. Presslaber, M. Stöcklin, K. Opwis, and J. a. Bargas-Avila (2012). *The role of visual complexity and prototypicality regarding first impression of websites: Working towards understanding aesthetic judgments*.70 (11), 794–811.

5. Statistical analyse

This section will be dedicated to the statistical analysis. We will focus on the research questions and the hypothesis to conduct this research. All the analysis will expand around the global topic: "How to measure the aesthetics of web site on a mobile device?" This study will focus principally on the analysis of the multiple linear regression. To compute it, we will use the IBM software SPSS, specialised in statistical analysis and data management. The files merged to the software is a csv excel file containing a spreadsheet including all the aesthetics metrics of each screenshots, the information about the participants and score given by each participant for each screenshot. Before starting, we should be precise the type of variables we used to compute the analysis. Almost all the variables were encoded as string which is usual for alphanumeric format. To stay consistent with our analysis it was recommended to use numeric variables, this kind of variables is more appropriate for quantitative analysis. The analysis of the multiple linear regression extracted from SPSS is computed according to the book *An Introduction to Statistical Learning* (Gareth, J., et al.)[82].

The last part of our analysis will be dedicated to the comparison between our results and the result extracted from the Reinecke's experiment. The purpose is to compare the judgement about aesthetic by humans with the judgment about aesthetic by an automated software (Questim).

5.1. Research Question 1: Do variables computed by Questim are able to judge the aesthetics?

For this first question, the objective is to identify the variables that can influence aesthetics of an image on a mobile device. To achieve it, we identified different hypothesis that include the important factor to analyze, in order to obtain pertinent results able to bring the answer needed. Here, we will use the multiple linear regression. This research will give a clearer idea about the effect of each variable, the variability of those variable, the relationship with the dependant variable as well as between them, the pertinency of those variables, the correlation between independents variables, the Cohen indicator, ... To compute the regression, we assumed that the dependant variable would be the score of each screenshot given by each applicant. The independent variables are the 21 variables described in the methodology section. It should be mentioned again that those variables are derived from Questim and from the

[82] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*.59-102.

application to rate the screenshots. This statement seems to be logical because the main purpose is to analyse the fluctuation of the score according to the independent variables

Hypothesis 1: All variables have an effect on visual appeal.

For this hypothesis, we decided to analyze different statistical variables from the multiple linear regression. The first relevant factor to analyze is the coefficient of regression of each variable. This coefficient can give an insight about the influence on each variable. This coefficient shows how strongly a variable influences the score. The computation produces a statistic table with the independent variable on the left and the statistic factor on the top of the table. The first column corresponds the coefficient of regression of all variables.

Coefficients[a]

Modèle		Coefficients non standardisés		Coefficients standardisés		
		B	Erreur standard	Bêta	t	Sig.
1	(Constante)	-43,876	13,459		-3,260	,001
	age	,012	,002	,135	6,170	,000
	gender	-,296	,046	-,122	-6,462	,000
	smartphoneUsageFrequency	,007	,059	,003	,118	,906
	tabletUsageFrequency	-,014	,020	-,014	-,720	,472
	desktopUsageFrequency	,397	,058	,137	6,792	,000
	VerticalBalance	-,215	,119	-,037	-1,812	,070
	HorizontalBalance	,868	,160	,122	5,431	,000
	Equilibrium	,726	,255	,059	2,851	,004
	Density	-1,181	,300	-,152	-3,932	,000
	CenterAlignment	,929	,226	,101	4,120	,000
	ExternalAlignment	,732	,246	,067	2,973	,003
	Concentricity	-,285	,332	-,019	-,857	,391
	Simplicity	-,884	,522	-,071	-1,693	,091
	Density_1	43,267	12,984	,168	3,332	,001
	Symmetry	-,147	,993	-,005	-,148	,882
	saliencyBalance	,410	,194	,037	2,116	,034
	borderBalance	-,015	,168	-,002	-,092	,927
	borderDensity	1,298	,626	,080	2,072	,038
	colorDensity	,996	,180	,121	5,530	,000
	Colorfulness	,303	,118	,051	2,567	,010
	compressionComplexity	,061	,371	,004	,166	,868

a. Variable dépendante : score

Figure 4- Table of coefficients

The table of the coefficients of regression shows that some variables have an influence on the score variable. We can quote the variables that have strong positive effects: the variables color density (B =0.996), border density (B= 1.298), external alignment (B 0.732), center alignment (B =0.929), horizontal balance (B= 0.86), equilibrium (B= 0.726) and Density_1 (B= 43.257). The explanation is simple, if we increase the color density for example, the score will

increase by 0.996. On the other hand, there are also some variables that have strong negative effect on the score variable: the variables density (B = -1.181) and simplicity (B= -0.884).

The second relevant factor to analyse is the R Square. The R square statistic provides an alternative measure of fit. It takes the form of a proportion, the proportion of variance explained and so it always takes on a value between 0 and 1." *The R square measures the proportion of variability in Y that can be explained"* (*Gareth James et al., 2017*)[83]. In other words, the R square tells how many percent of the variation of the dependant variable are explained by the variation of the independent variable. We are going to analyse the adjusted R square, this factor is quite similar to the R square but it takes into account the number of different predicators in the model instead of the R square. We use the R square adjusted because the answer will be a little bit more accurate than with the simple R square. The R square has an advantage on the Residual Standard Error because the interpretation is better.

Récapitulatif des modèles

Modèle	R	R-deux	R-deux ajusté	Erreur standard de l'estimation
1	,348[a]	,121	,115	1,137

a. Prédicteurs : (Constante), compressionComplexity, gender, HorizontalBalance, age, saliencyBalance, VerticalBalance, CenterAlignment, Colorfulness, desktopUsageFrequency, borderBalance, Concentricity, tabletUsageFrequency, Equilibrium, Symmetry, ExternalAlignment, colorDensity, Density, smartphoneUsageFrequency, borderDensity, Simplicity, Density_1

Figure 5- Table of R-square adjusted

The table shows us that only 11.5 % of the variation of the score is explained by the variation of the independent variables. This is pretty low.

The third element to take in consideration is the RSE (the Residual Standard Error). The RSE provides a measure of the lack of fit of the model to the data, The RSE is an estimation of the standard deviation of E. "*Roughly speaking, it is the average amount that the response will deviate from the true regression line"*. (*Gareth James et al 2017*)[84].

[83] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*,70.
[84] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*,69.

Récapitulatif des modèles

Modèle	R	R-deux	R-deux ajusté	Erreur standard de l'estimation
1	,348[a]	,121	,115	1,137

a. Prédicteurs : (Constante), compressionComplexity, gender, HorizontalBalance, age, saliencyBalance, VerticalBalance, CenterAlignment, Colorfulness, desktopUsageFrequency, borderBalance, Concentricity, tabletUsageFrequency, Equilibrium, Symmetry, ExternalAlignment, colorDensity, Density, smartphoneUsageFrequency, borderDensity, Simplicity, Density_1

Figure 6- Table of the Residual Standard Error

The Residual Standard Error for the regression is equal to 1. 137. It means that the actual score for each screenshot can deviate on average by 1.137 unit of score from the regression. Moreover, we know by calculation that the average score given for all the screenshot by all the participant is equal to 3.87. The percentage error is about 1.137/3.87 = 29%.

We can also analyze the residual standard error of each variable.

Test T

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne erreur standard
VerticalBalance	3181	.7334779747	.2066113548	.0036632989
smartphoneUsageFrequency	3539	4,64	,483	,008
gender	3539	1.521	.4996	.0084
age	3539	32,45	13,960	,235
desktopUsageFrequency	3539	4,78	,416	,007
tabletUsageFrequency	3539	2,07	1,178	,020
Balance	3181	.7937216745	.1403029954	.0024876261
HorizontalBalance	3181	.8539653744	.1774027598	.0031454192
Equilibrium	3181	.9603210932	.0969774868	.0017194482
CenterAlignment	3181	.3823122000	.1306975271	.0023173175
Density	3181	.6566918636	.1572564961	.0027882182
ExternalAlignment	3181	.1688948984	.1096015758	.0019432781
Concentricity	3181	.4626438664	.0789361090	.0013995676
Density_1	3181	.9996595662	.0046450968	.0000823594
Simplicity	3181	.3124822348	.0973441407	.0017259491
Symmetry	3181	.4518154144	.0422567996	.0007492293
saliencyBalance	3181	.7663399049	.1094302932	.0019402412
borderDensity	3181	.0915135063	.0747223304	.0013248557
borderBalance	3131	.7053587939	.1305799496	.0023336459
Colorfulness	3181	.4937194422	.2012510664	.0035682589
compressionComplexity	3181	.3447150348	.0842647439	.0014940463
colorDensity	3181	.3562860721	.1469431609	.0026053588

Figure 7- Table of the representation of the T-test

We notice that the residual standard error of each variable individually is quite small, almost without any effect.

The last factor to analyze is the Cohen's kappa coefficient. This coefficient is used to analyze the effect size. It allows us to measure the impact of one variable on another one. We are going to test it for the impact of each variable on the score.

Test T

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne erreur standard
VerticalBalance	3181	.7334779747	.2066113548	.0036632989
smartphoneUsageFrequency	3539	4,64	,483	,008
gender	3539	1.521	.4996	.0084
age	3539	32,45	13,960	,235
desktopUsageFrequency	3539	4,78	,416	,007
tabletUsageFrequency	3539	2,07	1,178	,020
Balance	3181	.7937216745	.1403029954	.0024876261
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borderBalance	3131	.7053587939	.1305799496	.0023336459
Colorfulness	3181	.4937194422	.2012510664	.0035682589
compressionComplexity	3181	.3447150348	.0842647439	.0014940463
colorDensity	3181	.3562860721	.1469431609	.0026053588

Figure 8- Table of the representation of the T-test

To compute the Cohen's d coefficient, we need the mean and the standard deviation of the both variables that we want to test. The table above shows the standard deviation and the mean of each variable. The mean and the standard deviation of the variable score are respectively 3.87 and 1.137. In order to compute the Cohen's coefficient, we use an effect size calculator from the University of Colorado's website[85]

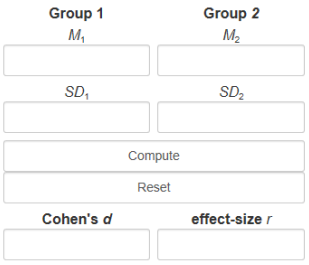

Figure 9- Illustration of the effect size calculator

The Cohen's d coefficients of score with each variable are:

[85] *https://www.uccs.edu/lbecker/.*

Vertical Balance: 3.84	Density:3.97
Smartphone usage frequency: -0.88	External alignment:4.59
Genre: -2.88	Concentricity:4.23
Age: -2.88	Simplicity:4.41
Desktop usage frequency: -1.06	Symmetry:4.25
Tablet usage frequency:1.56	Saliency balance:3.85
Balance:3.80	Border density:4.69
Horizontal balance: 3.71	Border balance: 3.91
Equilibrium:3.60	Colorfulness:4.14
Center alignment:4.31	Compression complexity:4.37
Color density:4.34	

The rule for the interpretation is simple: -if the coefficient is located between -0.5 and -0.2 or between 0.2 and 0.5, the effect is small.

-if the coefficient is located between -0.8 and -0.5, the effect is moderate or between 0.5 and 0.8, the effect is moderate.

- if the coefficient is located below -0.8 or above 0.8, the effect is large.

We can notice that all the coefficients are below -0.8 or above 0.8. It means that according to the Cohen's coefficient, all the variables computed have a large impact on the visual appeal.

Now, with all that information we can answer to the first hypothesis: All variable has an effect on visual appeal? Yes, however our opinion is still mixed and some elements must be considered. Despite the fact that all variables have an impact on visual appeal, that the individual Residual Standard Error is almost without any effect and the Cohen's d coefficient shows that all variables have an impact on the score, it seems obvious that some of them have a negative effect on the score, for example the variable border balance (B= -0.015) or compression complexity (B= 0.061). Secondly, the variation of all the variables included in the

model explains only 11.5% of the variation of the score. To finish, the percentage of error is about 29%.

Hypothesis 2: The variables can influence the score with accuracy.

The purpose here is to know how accurate the predictions of the model are and how accurate the predictions of the variables on the variation of the score are. The objective is to test the significance of the model and the variables. We want to see if there is an association between the different variables and the response. To test the hypothesis, we can use and analyse the p-value statistic. "*Roughly speaking, we interpret the p-value as follows: a small p-value indicates that it is unlikely to observe such a substantial association between the predictor and the response due to chance, in the absence of any real association between the predictor and the response. Hence, if we see a small p-value, then we can infer that there is an association between the predictor and the response"* (*Gareth et al., 2017*)[86].

Coefficients[a]

Modèle		Coefficients non standardisés		Coefficients standardisés		
		B	Erreur standard	Bêta	t	Sig.
1	(Constante)	-43,876	13,459		-3,260	,001
	age	,012	,002	,135	6,170	,000
	gender	-,296	,046	-,122	-6,462	,000
	smartphoneUsageFrequency	,007	,059	,003	,118	,906
	tabletUsageFrequency	-,014	,020	-,014	-,720	,472
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	VerticalBalance	-,215	,119	-,037	-1,812	,070
	HorizontalBalance	,868	,160	,122	5,431	,000
	Equilibrium	,726	,255	,059	2,851	,004
	Density	-1,181	,300	-,152	-3,932	,000
	CenterAlignment	,929	,226	,101	4,120	,000
	ExternalAlignment	,732	,246	,067	2,973	,003
	Concentricity	-,285	,332	-,019	-,857	,391
	Simplicity	-,884	,522	-,071	-1,693	,091
	Density_1	43,267	12,984	,168	3,332	,001
	Symmetry	-,147	,993	-,005	-,148	,882
	saliencyBalance	,410	,194	,037	2,116	,034
	borderBalance	-,015	,168	-,002	-,092	,927
	borderDensity	1,298	,626	,080	2,072	,038
	colorDensity	,996	,180	,121	5,530	,000
	Colorfulness	,303	,118	,051	2,567	,010
	compressionComplexity	,061	,371	,004	,166	,868

a. Variable dépendante : score

Figure 10- Table of the representation of the individual significance

[86] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*.67

Hypothesis test

$H0: \beta = 0$

$H1: \beta \neq 0$

This hypothesis test is computed for all the 21 variables so X = (1…,21). The rule is defined as follow: if Sig. < 0.05, we reject the nul hypothesis. We can reject the nul hypothesis for the variables age, gender, desktop usage frequency, horizontal balance, equilibrium, density, center alignment, external alignment, saliency balance, border density, color density and colourfulness. It means that all those variables are significant. We can consider that those variables are related and contribute to the score. The variables that have a Sig. above 0.05 are not significant.

We can also analyse the significance of the model. The interpretation is similar than with the individual significance of each variable: test the significance of the model and the association between the predictor and the response. The rule is also the same than with the individual p-value.

ANOVA[a]

Modèle		Somme des carrés	ddl	Carré moyen	F	Sig.
1	Régression	554,291	21	26,395	20,431	,000[b]
	de Student	4015,143	3108	1,292		
	Total	4569,434	3129			

a. Variable dépendante : score

b. Prédicteurs : (Constante), compressionComplexity, gender, HorizontalBalance, age, saliencyBalance, VerticalBalance, CenterAlignment, Colorfulness, desktopUsageFrequency, borderBalance, Concentricity, tabletUsageFrequency, Equilibrium, Symmetry, ExternalAlignment, colorDensity, Density, smartphoneUsageFrequency, borderDensity, Simplicity, Density_1

Figure 11- Table of the representation of the global significance

Hypothesis test

$H0: \beta = 0$

$H1: \beta \neq 0$

We can notice that the significance is below 0.05. According to that we can reject the nul hypothesis. Therefore, we can consider that the all model is significant. There is a relationship between the predictors and the response.

Another relevant factor is the F-statistic associated with the p-value of the model. The F statistic has the same objective than the p-vale associated: to determine if the model is significant or not. The advantage of the F- statistic in comparison with the p value is the fact that if the number of predictors is huge, even if the individual p-value of the predictors are small, there is a chance to make an incorrect conclusion about the relationship between the predictor and the response. Therefore, it is important to analyze it because the number of predictors for the model is 21.

ANOVA[a]

Modèle		Somme des carrés	ddl	Carré moyen	F	Sig.
1	Régression	554,291	21	26,395	20,431	,000[b]
	de Student	4015,143	3108	1,292		
	Total	4569,434	3129			

a. Variable dépendante : score

b. Prédicteurs : (Constante), compressionComplexity, gender, HorizontalBalance, age, saliencyBalance, VerticalBalance, CenterAlignment, Colorfulness, desktopUsageFrequency, borderBalance, Concentricity, tabletUsageFrequency, Equilibrium, Symmetry, ExternalAlignment, colorDensity, Density, smartphoneUsageFrequency, borderDensity, Simplicity, Density_1

Figure 12- Table of the representation of the F-statistic

Hypothesis test

$H0: \beta = 0$

$H1: \beta \neq 0$

The interpretation is described as follow: if the F-statistic is bigger than one, we can consider that the model is significant. Moreover, we must take into account the number of observations in the analysis. If the number of observations is huge, only a F-statistic just a little bit bigger than 1 is required. If the number of observations is small, a F-statistic much higher is required to reject H0. Here, the F-statistic is equal to 20.431 which is above 1. We can reject the nul hypothesis. Therefore, the model is significant. There is a relationship between the predictor and the response.

Another relevant factor to analyze to determine the significance of the model is the t statistic associated with the individual p-value. The rule and the interpretation are similar than with the F-statistics.

Hypothesis test

$H0: \beta = 0$

$H1: \beta \neq 0$

This hypothesis test is computed for the 21 variables, so X= (1…,21).

Coefficients[a]

Modèle		Coefficients non standardisés		Coefficients standardisés		
		B	Erreur standard	Bêta	t	Sig.
1	(Constante)	-43,876	13,459		-3,260	,001
	age	,012	,002	,135	6,170	,000
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	Equilibrium	,726	,255	,059	2,851	,004
	Density	-1,181	,300	-,152	-3,932	,000
	CenterAlignment	,929	,226	,101	4,120	,000
	ExternalAlignment	,732	,246	,067	2,973	,003
	Concentricity	-,285	,332	-,019	-,857	,391
	Simplicity	-,884	,522	-,071	-1,693	,091
	Density_1	43,267	12,984	,168	3,332	,001
	Symmetry	-,147	,993	-,005	-,148	,882
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	borderBalance	-,015	,168	-,002	-,092	,927
	borderDensity	1,298	,626	,080	2,072	,038
	colorDensity	,996	,180	,121	5,530	,000
	Colorfulness	,303	,118	,051	2,567	,010
	compressionComplexity	,061	,371	,004	,166	,868

a. Variable dépendante : score

Figure 13- Table of the representation of the t statistic

According to this table, we can reject the nul hypothesis for the variables age, desktop usage frequency, horizontal balance, equilibrium, center alignment, external alignment, saliency balance, density_1, saliency balance, border density, color density and colorfulness. Therefore, we can conclude that these variables are significant. Those variables contribute to the score. However, we notice that two variables are not significant according to the t statistic's interpretation but are significant according to the p-value interpretation. Moreover, it seems obvious that the value of the t statistic is much lower than 1. Therefore, we can conclude that the variables density and genders are not significant.

We can also make an interpretation about the confidence interval. Here, we use a 95 % confident interval. Standard errors can be used to compute confidence intervals. *"A 95% confidence interval is defined as a range of values such that with 95% probability, the range will contain the true unknown value of the parameter. The confidence interval is used to quantify the uncertainty surrounding the average score over a large number of screenshots* "(*Gareth James et al 2017*)[87].

Test sur échantillon unique

	Valeur de test = 0					
	t	ddl	Sig. (bilatéral)	Différence moyenne	Intervalle de confiance de la différence à 95 % Inférieur	Supérieur
VerticalBalance	200,223	3180	,000	.7334779747	.7262953070	.7406606424
smartphoneUsageFrequency	571,730	3538	,000	4,642	4,63	4,66
gender	181,070	3538	,000	1.5208	1.504	1.537
age	138,266	3538	,000	32,445	31,99	32,91
desktopUsageFrequency	683,391	3538	,000	4,783	4,77	4,80
tabletUsageFrequency	104,545	3538	,000	2,070	2,03	2,11
Balance	319,068	3180	,000	.7937216745	.7888441605	.7985991886
HorizontalBalance	271,495	3180	,000	.8539653744	.8477981186	.8601326301
Equilibrium	558,505	3180	,000	.9603210932	.9569497535	.9636924329
CenterAlignment	164,981	3180	,000	.3823122000	.3777686119	.3868557881
Density	235,524	3180	,000	.6566918636	.6512249755	.6621587516
ExternalAlignment	86,912	3180	,000	.1688948984	.1650846931	.1727051038
Concentricity	330,562	3180	,000	.4626438664	.4598997199	.4653880130
Density_1	12137,778	3180	,000	.9996595662	.9994980833	.9998210490
Simplicity	181,050	3180	,000	.3124822348	.3090981487	.3158663209
Symmetry	603,040	3180	,000	.4518154144	.4503463927	.4532844360
saliencyBalance	394,971	3180	,000	.7663399049	.7625356540	.7701441558
borderDensity	69,074	3180	,000	.0915135063	.0889158482	.0941111645
borderBalance	302,256	3130	,000	.7053587939	.7007831625	.7099344252
Colorfulness	138,364	3180	,000	.4937194422	.4867231204	.5007157640
compressionComplexity	230,726	3180	,000	.3447150348	.3417856428	.3476444268
colorDensity	136,751	3180	,000	.3562860721	.3511777183	.3613944258

Figure 14- Table of the representation of the 95% confidence interval

We notice that all confidence intervals of each variable are really small. The difference of value between the both extremities is most of time smaller than 0.1. Obviously, the value of the parameter is located between the both extremities of the interval. That suggests a small variability in the parameters which is a sign of good prediction of the model.

We can also use a 99% confidence interval. The interpretation is the same, but we changed the percentage of confidence. "*A 99% confidence interval is defined as a range of values such*

[87] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*. 66.

that with 99% probability, the range will contain the true unknown value of the parameter" (*Gareth et al 2017*).

Test sur échantillon unique

Valeur de test = 0

	t	ddl	Sig. (bilatéral)	Différence moyenne	Intervalle de confiance de la différence à 99 % Inférieur	Supérieur
VerticalBalance	200,223	3180	,000	.7334779747	.7240362753	.7429196741
smartphoneUsageFrequency	571,730	3538	,000	4,642	4,62	4,66
gender	181,070	3538	,000	1.5208	1.499	1.542
age	138,266	3538	,000	32,445	31,84	33,05
desktopUsageFrequency	683,391	3538	,000	4,783	4,76	4,80
tabletUsageFrequency	104,545	3538	,000	2,070	2,02	2,12
Balance	319,068	3180	,000	.7937216745	.7873101261	.8001332230
HorizontalBalance	271,495	3180	,000	.8539653744	.8458584456	.8620723031
Equilibrium	558,505	3180	,000	.9603210932	.9558894283	.9647527581
CenterAlignment	164,981	3180	,000	.3823122000	.3763396010	.3882847990
Density	235,524	3180	,000	.6566918636	.6495055762	.6638781509
ExternalAlignment	86,912	3180	,000	.1688948984	.1638863396	.1739034573
Concentricity	330,562	3180	,000	.4626438664	.4590366542	.4662510787
Density_1	12137,778	3180	,000	.9996595662	.9994472951	.9998718372
Simplicity	181,050	3180	,000	.3124822348	.3080338146	.3169306550
Symmetry	603,040	3180	,000	.4518154144	.4498843685	.4537464602
saliencyBalance	394,971	3180	,000	.7663399049	.7613391733	.7713406365
borderDensity	69,074	3180	,000	.0915135063	.0880988548	.0949281579
borderBalance	302,256	3130	,000	.7053587939	.6993440526	.7113735351
Colorfulness	138,364	3180	,000	.4937194422	.4845226965	.5029161878
compressionComplexity	230,726	3180	,000	.3447150348	.3408643153	.3485657544
colorDensity	136,751	3180	,000	.3562860721	.3495710822	.3630010620

```
MEANS TABLES=score BY gender age Balance VerticalBalance HorizontalBalance Eq
uilibrium Density
    CenterAlignment ExternalAlignment Concentricity Simplicity Density_1 Symm
etry saliencyBalance
    borderBalance borderDensity colorDensity Colorfulness compressionComplexi
ty smartphoneUsageFrequency
  /CELLS=MEAN COUNT STDDEV.
```

Figure 15- Table of the representation of the 99% confidence interval

We notice that all confidence intervals of each variables are really small. However, the average size of the intervals has increased with the 99% confident interval. The difference of value between the both extremities is most of time smaller than 0.2. This statement is logical because if the size of the interval is bigger, there are more chances, more probability to catch the true value of the parameter. Nevertheless, the intervals are still small enough, it suggests a small variability in the parameters what is a sign of good prediction of the model.

Analyzing the correlation of the variables is useful too. We must consider the fact that the effect of some variables on the score can be affected by the presence of another variable. To detect the correlation, we must analyze the correlation table. The whole correlation table will be showed in the appendix because the table is too large to insert it here.

Corrélations

		age	gender	smartphoneUsageFrequency	tabletUsageFrequency	desktopUsageFrequency	Balance
age	Corrélation de Pearson	1	-,030	-,601**	,192**	-,218**	,006
	Sig. (bilatérale)		,079	,000	,000	,000	,749
	N	3539	3539	3539	3539	3539	3180
gender	Corrélation de Pearson	-,030	1	-,152**	-,346**	-,223**	,002
	Sig. (bilatérale)	,079		,000	,000	,000	,927
	N	3539	3539	3539	3539	3539	3180
smartphoneUsageFrequency	Corrélation de Pearson	-,601**	-,152**	1	,003	,443**	-,006
	Sig. (bilatérale)	,000	,000		,849	,000	,716
	N	3539	3539	3539	3539	3539	3180
tabletUsageFrequency	Corrélation de Pearson	,192**	-,346**	,003	1	-,200**	,002
	Sig. (bilatérale)	,000	,000	,849		,000	,928
	N	3539	3539	3539	3539	3539	3180
desktopUsageFrequency	Corrélation de Pearson	-,218**	-,223**	,443**	-,200**	1	-,008
	Sig. (bilatérale)	,000	,000	,000	,000		,646
	N	3539	3539	3539	3539	3539	3180
Balance	Corrélation de Pearson	,006	,002	-,006	,002	-,008	1
	Sig. (bilatérale)	,749	,927	,716	,928	,646	
	N	3180	3180	3180	3180	3180	
VerticalBalance	Corrélation de Pearson	,007	,002	-,004	,006	-,004	,776**
	Sig. (bilatérale)	,709	,922	,801	,721	,831	,000
	N	3180	3180	3180	3180	3180	3181
HorizontalBalance	Corrélation de Pearson	,001	,001	-,005	-,005	-,008	
	Sig. (bilatérale)	,943	,976	,779	,785	,632	,000
	N	3180	3180	3180	3180	3180	3181

Figure 16- Table of correlation

Due to the large number of variables, it would have been very laborious to analyze the correlation of the 21 variables with each variable. What we can do is explaining the reasoning and the interpretation. To know if some variables are correlated to each other, we must consider the coefficient of Pearson Correlation and the level of significance. The coefficient of Pearson Correlation quantifies the correlation between two parameters and the level of confidence tells if there is a correlation between the both parameters. The rule is described as follow: if the level of significance is lower than .0.05, there is a correlation between the both parameters.

Hypothesis test

$$H0: \rho = 0$$

$$H1: \rho \neq 0$$

For example, if we analyze the correlation between the variables vertical balance and balance, the table enable us to claim that both variables are correlated because the level of significance is below 0.05 (0.000). Therefore, we can reject the nul hypothesis. Moreover, we observe that the coefficient correlation of Pearson is equal to 0.776. It implies a strong positive correlation between these two variables. For the interpretation, we can say that in presence of the vertical balance parameter, the effect of the balance parameter on the visual appeal is stronger than without the presence the vertical balance variable. This statement is also valid in the opposite direction.

On the other hand, if the coefficient of Pearson Correlation is negative, it implies a negative correlation between the both variables.

,035*	-,224**	-,024
,048	,000	,175
3181	3181	3181
,228**	-,196**	-,123**
,000	,000	,000
3181	3181	3181
,153**	-,640	,059**
,000	,000	,001

Figure 17- Table of correlation

Here, we can see that the coefficient of Pearson Correlation between the variables equilibrium and simplicity is negative (-0.196). It implies a negative correlation between the both variables. For the interpretation, we can say that in presence of the equilibrium variable, the effect of the simplicity variable on the visual appeal is weaker than without the presence of the equilibrium variable. This interpretation can be applicable to all other pairs variables with the same rules.

In order to answer to the second hypothesis: “Can the variables influence the score with accuracy?”, we analyzed different statistical variables. Even though the variables have some effects on the visual appeal, some of them are not significant. It means that some variables influence the score, but the effect is not accurate, it does not predict the score with accuracy. However, the result enables us to claim that when the model is analyzed as a whole, the model is significant. In addition, the computation of the confident interval tells us that there is a small variability in the coefficient of the parameters. However, we must be careful about the correlation that exists between the variables because it can modify completely the effect of every variables.

5.2. Research question 2: Is the aesthetic judged the same way by a human and by a semi-automated software?

The objective here is to make a comparison between the results we obtained from Questim and the results obtained during the Reinecke's experience[88]. As a reminder, the Reinecke's experience consists is analyzing the effect of the variables complexity and colorfulness on the visual appeal based on a human judgement. This is the big difference with our analysis because the metrics of the screenshots are computed by the software Questim while the Reinecke's experience is using the perception of human to compute the metrics.

Hypothesis 3: The variables computed in each study impact the score in the same way.

In order to answer to this hypothesis, we need to make a comparison between the effect of the variables complexity and colorfulness on the visual appeal form Questim and from a human-base. Before starting the comparison, we need to clarify one point. The variable analyzed in the Reinecke's experiment is the visual complexity while Questim analyses the compression complexity. However, the visual complexity is defined as the number of elements in a picture and according to Tuch et al. (2012)[89], the mechanism of the compression complexity variable is to measure visual complexity according to the compression level of a picture. Complexity is defined as the sophistication of the image. It includes the number of elements, the disposition… These two statements suggest us that both complexity variables analyzed seem to be similar. Therefore, we can compare them

[88] Reinecke, K., et al. (2013). *Predicting Users' First Impressions of Website Aesthetics With a Quantification of Perceived Visual Complexity and Colorfulness.*

[89] Tuch, A. N., E. E. Presslaber, M. Stöcklin, K. Opwis, and J. a. Bargas-Avila (2012). *The role of visual complexity and prototypicality regarding first impression of websites: Working towards understanding aesthetic judgments*.70 (11), 794–811

Coefficients[a]

Modèle		Coefficients non standardisés		Coefficients standardisés		
		B	Erreur standard	Bêta	t	Sig.
1	(Constante)	-43,876	13,459		-3,260	,001
	age	,012	,002	,135	6,170	,000
	gender	-,296	,046	-,122	-6,462	,000
	smartphoneUsageFrequency	,007	,059	,003	,118	,906
	tabletUsageFrequency	-,014	,020	-,014	-,720	,472
	desktopUsageFrequency	,397	,058	,137	6,792	,000
	VerticalBalance	-,215	,119	-,037	-1,812	,070
	HorizontalBalance	,868	,160	,122	5,431	,000
	Equilibrium	,726	,255	,059	2,851	,004
	Density	-1,181	,300	-,152	-3,932	,000
	CenterAlignment	,929	,226	,101	4,120	,000
	ExternalAlignment	,732	,246	,067	2,973	,003
	Concentricity	-,285	,332	-,019	-,857	,391
	Simplicity	-,884	,522	-,071	-1,693	,091
	Density_1	43,267	12,984	,168	3,332	,001
	Symmetry	-,147	,993	-,005	-,148	,882
	saliencyBalance	,410	,194	,037	2,116	,034
	borderBalance	-,015	,168	-,002	-,092	,927
	borderDensity	1,298	,626	,080	2,072	,038
	colorDensity	,996	,180	,121	5,530	
	Colorfulness	,303	,118	,051	2,567	,010
	compressionComplexity	,061	,371	,004	,166	,868

a. Variable dépendante : score

Figure 18- Table of coefficients

The results of the Reinecke's experiment showed that the variables complexity and colorfulness have an impact on the visual appeal. The variable complexity impacts strongly negatively the visual appeal while the variable colorfulness impacts positively the visual appeal. However, the effect of the variable complexity on the score is stronger than the effect of variable colorfulness.

According to the table from SPSS exposed above, the variable colorfulness and the variable complexity impact positively the visual appeal and the variable colorfulness has a stronger effect than the variable complexity. However, we notice that the variable complexity is not significant.

Récapitulatif des modèles

Modèle	R	R-deux	R-deux ajusté	Erreur standard de l'estimation
1	,348[a]	,121	,115	1,137

a. Prédicteurs : (Constante), compressionComplexity, gender, HorizontalBalance, age, saliencyBalance, VerticalBalance, CenterAlignment, Colorfulness, desktopUsageFrequency, borderBalance, Concentricity, tabletUsageFrequency, Equilibrium, Symmetry, ExternalAlignment, colorDensity, Density, smartphoneUsageFrequency, borderDensity, Simplicity, Density_1

Figure 19- Table of the R-square adjusted

	B
(Constante)	-43,876
age	,012

Figure 20- Table of the age's coefficient

The Reinecke's experience also showed that the impact of the variables colorfulness and complexity on the first impression is not universal. Indeed, the experience showed that the age has a significant effect on the variation of the visual appeal. We can see on the table from Questim just above that the age doesn't have a big impact on the visual appeal. Secondly, the Reinecke's experience claims that the model explains 48% of the variation of the visual appeal while the model from Questim explains only 11.5%.

Colorfulness	Corrélation de Pearson	,001
	Sig. (bilatérale)	,954
	N	3180
compressionComplexity	Corrélation de Pearson	,001
	Sig. (bilatérale)	,934
	N	3180

Figure 21- Table of the colorfulness and compression complexity's correlation

The Reinecke's experience showed a strong correlation between the age and the variable complexity but not with the variable colorfulness. It means that the perception of the complexity is strongly impacted by the age of the participants. In the SPSS experiment, the table shows that both variables are not correlated with the age of the participants.

According to those results, we can refute the third hypothesis because the elements obtained from both experiments clearly demonstrate that the variables computed from each experiment don't impact the visual appeal in the same way. We have several assumptions to explain the difference between our results and the Reinecke's results. Firstly, the interpretation of the different variables can be different from a human being point of view and from a software point of view. Secondly, the number of metrics analyzed is much bigger for the Questim's analysis than for the Reinecke's analysis and we saw previously that the number of variables can impact the effect that each variable can has. Thirdly, the sample size and the number of screenshots can impact the accuracy of the model.

5.3. Box and Whisker

A box and whisker plot is a graphical representation of the data. In this analysis, we use the box and whisker plot to analyze the dispersion of the average score's rating of each screenshot.

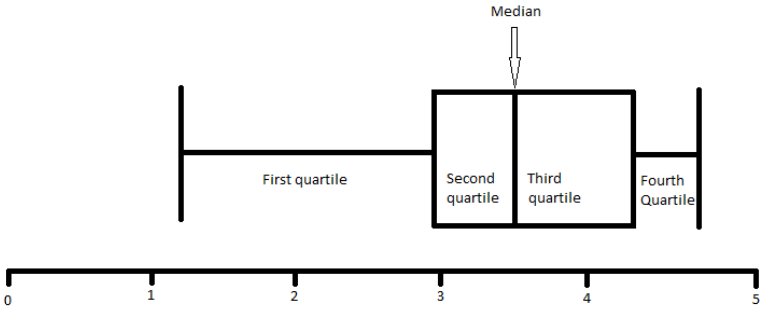

Figure 22- Illustration of a box and whisker plot

We can now interpret the graph of the box and whisker plot just above. The smallest score is equal to 1.18 and the biggest score is equal to 4.73. 25% of the screenshots have a score between 1.19 and 2.93, this is the first quartile. 25% of the screenshots have a score located between 2.93 and 3.49, this is the second quartile. Therefore, the median is located on the scale at 3.49, it means that there 50% of the screenshots that have a score below 3.49 and 50% of the screenshots that have a score above 3.49. 25% of the screenshots have a score between 3.49 and 4.36, this is the third quartile. The last 25% of the screenshot have a score located between 4.36 and 4.71, this is the fourth quartile. We notice that there is no score below 1 and 75% of the scores are located between 2.93 and 4.71. It means than on average, the screenshots are visually beautiful for the participants.

6. Results

To analyze the effects of aesthetics parameters on the visual appeal, we used a statistical software in order to analyze the data obtained from Questim. The results showed us that even though all the variables have an influence on the visual appeal, it is clearly shown that the model explains only 11.5% of the variation of the visual appeal. Moreover, the standard error of the model is about 1.137 which equates to a percentage error of 29%. Though, the model reveals that the residual standard error of each variables is very weak. Furthermore, the Cohen's coefficient indicates that all the variables have a large impact on the visual appeal.

We also notice that according to the p-value and the F-statistic, whole the model is significant. Yet, the t-statistics and the individual p-value show us that only the half of the variables are individually significant. Thirdly, the analysis of the 95% and 99% confident interval reveals a small variability of the parameter's coefficient. The model suggests also that there is a correlation effect between every variable with a weak or a strong intensity. However, sometimes there is no correlation effect between two variables because the level of significance is too high.

The comparison with the Reinecke's experiment shows that the variables complexity and colorfulness don't impact the visual appeal in the same way if you analyze it from a human point of view or from a software point of view.

The box and whisker plot show that 75% of the visual appeal rating are located above 3.18 on a scale of 5. It must be mentioned that the statistical sample used for the graph is representative of the whole sample.

Finally, we can now compute the multiple linear regression:

Score = -43.876 + 0.012 × ***age*** - 0.296 × ***gender*** + 0.007 × ***smartphone usage frequency*** - 0.014 × ***tablet usage frequency*** + 0.397 × ***desktop usage frequency*** - 0.215 × ***vertical balance*** + 0.868 × ***horizontal balance*** + 0.726 × ***equilibrium*** - 1.181 × ***density*** + 0.929 × ***center alignment*** + 0.732 × ***external alignment*** -0.285 × ***concentricity*** - 0.884 × ***simplicity*** + 43.267 × ***density_1*** – 0.147 × ***symmetry*** + 0.410 × ***saliency balance*** - 0.015 × ***border balance*** + 1.298 × ***border density*** + 0.996 × ***color density*** + 0.303 × ***colorfulness*** + 0.061 × ***compression complexity*** + Error.

7. Conclusions, limits and problems

7.1. Conclusions

Even though there exist several articles, literature reviews and documents written by brilliant academicians about the Graphical User interface and aesthetic, we realise that the domain of the aesthetic of web site is still quite unknown, even more in the domain of the aesthetic of web site on a mobile phone device. Trough the different authors, there are many different points of view about the aesthetic and the GUI. Moreover, from a marketing point view, the aesthetics of web site and the GUI turn out to be crucial element to consider for companies and even more in the future due to the new spending habit. Indeed, the e-commerce is developing and more and more on a platform device. Throughout the redaction of this thesis, we realized that there were a lot of parameters to consider in the analysis.

To answer to the first research question: **Are variables computed by Questim able to judge the aesthetics?** Our answer is: not all of them. According to the results extracted from the analysis, we can select some parameters that seem to be more relevant than others: Color density, border density, external alignment, center alignment, horizontal balance and equilibrium. We selected those parameters for their strong influence on the visual appeal but also because they are significant according to the t-statistic and to the p-value. However, even if the model is significant and has a small variability in the data, we must pay attention to the correlation effect and considered that the whole model explains only 11.5 % of the regression and has a standard error of 29%.

To answer to the second research question: **Is the aesthetic judged the same way by a human and by a semi-automated software?** Our answer is: no. The results from the comparison clearly showed that the variables tested don't impact the visual appeal in the same way from a human point of view and from a software point of view.

7.2. Limits and problems

The are several limits that we must consider when we analyze the regression. Firstly, a change in the size of the statistical sample can cause a fluctuation in the variability of the data statistic

(RSE, adjusted R quare...). The accuracy and the significance of the model can be strongly impacted by the sample size also. For a multiple linear regression of a sample size of 30 screenshots, the RSE is equal to 1.092, the adjusted R square is equal 0.229, the p-value is equal to 0.000 and the F-statistic is equal to 6.997 (see *Box and whisker plot).* For a multiple linear regression of a sample size of 180 screenshots, the RSE is equal to 1.137, the adjusted R square is equal 0.115, the p-value is equal to 0.000 and the F-statistic is equal to 20.431. Therefore, we can notice a difference in the results.

Secondly, "*the presence of collinearity can pose problems in the regression context, since it can be difficult to separate out the individual effects of collinear variables on the response"* (*Gareth et al. 2017*)[90]. "*Moreover, the collinearity reduces the accuracy of the model* "(*Gareth et al.2017*)[91]. This problem is more recurrent when the number of variables analysed is huge. Therefore, we must take it into to account seriously when analysing the regression. The collinearity is directly linked to the correlation and we can detect it with the correlation statistic.

Thirdly, there is also another element to consider, the interaction or the correlation effect. The correlation effect: the effect of one independent variable on the dependant variable can be affected by the presence of another independent variable. We analyzed it previously and saw that the impact can be huge. This correlation can have an impact on the value of the coefficient of the parameter as well as on the statistical data (RSE, adjusted R square, p-value…). The challenge would be to find the best mix possible to reach the higher score possible.

To finish, the last potential problem is associated to the behaviour of the participants linked to the organisation of the experience. Rating 180 screenshots on a scale of 0 to 5 is really laborious and takes time. We can consider the fact that after a certain number of screenshots rated, there is maybe a tendency from the participants to not participate seriously to the experience. The principal reason would be the tiredness. This statement is only hypothetical because we cannot verify this information.

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[91] Gareth, J., et al. An Introduction to Statistical Learning. *Springer*.101.

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9. Appendix

Appendix 1- The table correlation of the different variables.

Corrélations

		age	gender	smartphoneUsageFrequency	tabletUsageFrequency	desktopUsageFrequency	Balance	VerticalBalance	HorizontalBalance	Equilibrium	Density	CenterAlignment	ExternalAlignment	Concentricity	Simplicity	Symmetry	saliencyBalance
age	Corrélation de Pearson	1	-,030	-,601**	,192**	-,218**	,006	,007	,001	-,008	,000	-,003	,000	-,019	-,004	-,004	-,002
	Sig. (bilatérale)		,079	,000	,000	,000	,749	,709	,943	,653	,997	,854	,989	,289	,843	,838	,902
	N	3539	3539	3539	3539	3539	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180
gender	Corrélation de Pearson	-,030	1	-,152**	-,346**	-,223**	,002	,002	,001	-,005	-,003	-,009	,003	-,009	-,001	,001	,003
	Sig. (bilatérale)	,079		,000	,000	,000	,927	,922	,976	,785	,882	,625	,864	,601	,960	,967	,851
	N	3539	3539	3539	3539	3539	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180
smartphoneUsageFrequency	Corrélation de Pearson	-,601**	-,152**	1	,003	,443**	-,006	-,004	-,005	,006	-,001	-,002	,010	,007	-,001	,004	,006
	Sig. (bilatérale)	,000	,000		,849	,000	,716	,801	,779	,727	,934	,928	,583	,698	,957	,827	,725
	N	3539	3539	3539	3539	3539	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180
tabletUsageFrequency	Corrélation de Pearson	,192**	-,346**	,003	1	-,200**	,002	,006	-,005	,006	,006	,002	,002	-,003	-,009	-,001	,007
	Sig. (bilatérale)	,000	,000	,849		,000	,928	,721	,785	,747	,729	,908	,910	,886	,597	,942	,695
	N	3539	3539	3539	3539	3539	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180
desktopUsageFrequency	Corrélation de Pearson	-,218**	-,223**	,443**	-,200**	1	-,008	-,004	-,008	,002	-,009	-,001	,004	,008	,005	,000	,001
	Sig. (bilatérale)	,000	,000	,000	,000		,646	,831	,632	,892	,622	,933	,829	,646	,783	,982	,957
	N	3539	3539	3539	3539	3539	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180	3180
Balance	Corrélation de Pearson	,006	,002	-,006	,002	-,008	1	,776**	,678**	,297**	,620**	,187**	,046**	,080**	-,360**	-,074**	-,017
	Sig. (bilatérale)	,749	,927	,716	,928	,646		,000	,000	,000	,000	,000	,009	,000	,000	,000	,339
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
VerticalBalance	Corrélation de Pearson	,007	,002	-,004	,006	-,004	,776**	1	,062**	,277**	,433**	,072**	,105**	,079**	-,296**	-,080**	,022
	Sig. (bilatérale)	,709	,922	,801	,721	,831	,000		,000	,000	,000	,000	,000	,000	,000	,000	,225
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
HorizontalBalance	Corrélation de Pearson	,001	,001	-,005	-,005	-,008	,678**	,062**	1	,148**	,477**	,213**	-,049**	,035*	-,224**	-,024	-,052**
	Sig. (bilatérale)	,943	,976	,779	,785	,632	,000	,000		,000	,000	,000	,005	,048	,000	,175	,003
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Equilibrium	Corrélation de Pearson	-,008	-,005	,006	,006	,002	,297**	,277**	,148**	1	,267**	,225**	,119**	,228**	-,196**	-,123**	,063**
	Sig. (bilatérale)	,653	,785	,727	,747	,892	,000	,000	,000		,000	,000	,000	,000	,000	,000	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Density	Corrélation de Pearson	,000	-,003	-,001	,006	-,009	,620**	,433**	,477**	,267**	1	,118**	,150**	,153**	-,640**	,059**	-,097**
	Sig. (bilatérale)	,997	,882	,934	,729	,622	,000	,000	,000	,000		,000	,000	,000	,000	,001	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
CenterAlignment	Corrélation de Pearson	-,003	-,009	-,002	,002	-,001	,187**	,072**	,213**	,225**	,118**	1	,395**	,121**	,373**	,193**	,059**
	Sig. (bilatérale)	,854	,625	,928	,908	,933	,000	,000	,000	,000	,000		,000	,000	,000	,000	,001
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
ExternalAlignment	Corrélation de Pearson	,000	,003	,010	,002	,004	,046**	,105**	-,049**	,119**	,150**	,395**	1	,336**	,255**	,300**	,158**
	Sig. (bilatérale)	,989	,864	,583	,910	,829	,009	,000	,005	,000	,000	,000		,000	,000	,000	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181

borderDensity	Corrélation de Pearson	,006	,002	-,005	-,002	-,011	,105**	,037*	,123**	-,050**	,175**	,290**	,450**	,316**	,318**	,696**	,102**
	Sig. (bilatérale)	,753	,898	,771	,924	,517	,000	,038	,000	,005	,000	,000	,000	,000	,000	,000	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
borderBalance	Corrélation de Pearson	,015	,007	-,006	,001	-,015	,234**	,147**	,203**	,015	,076**	,035	,060**	,056**	,010	,053**	,098**
	Sig. (bilatérale)	,405	,675	,725	,964	,417	,000	,000	,000	,408	,000	,053	,001	,002	,585	,003	,000
	N	3130	3130	3130	3130	3130	3131	3131	3131	3131	3131	3131	3131	3131	3131	3131	3131
colorDensity	Corrélation de Pearson	,006	-,005	-,007	,006	-,010	,195**	-,021	,333**	-,117**	,240**	,130**	,205**	,103**	,059**	,216**	,035*
	Sig. (bilatérale)	,728	,776	,685	,721	,571	,000	,245	,000	,000	,000	,000	,000	,000	,001	,000	,049
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Colorfulness	Corrélation de Pearson	,001	-,002	-,008	-,009	,001	,084**	-,025	,162**	-,069**	,075**	,006	,025	,028	,090**	,159**	-,101**
	Sig. (bilatérale)	,954	,909	,648	,620	,959	,000	,166	,000	,000	,000	,737	,152	,110	,000	,000	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
compressionComplexity	Corrélation de Pearson	,001	-,001	,004	,008	,000	,121**	,162**	,003	-,111**	,274**	,155**	,314**	,295**	,085**	,395**	,042*
	Sig. (bilatérale)	,934	,956	,807	,634	,980	,000	,000	,869	,000	,000	,000	,000	,000	,000	,000	,018
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Density_1	Corrélation de Pearson	-,001	-,001	-,001	,001	,003	-,075**	-,072**	-,034	,018	-,130**	-,311**	-,513**	-,440**	-,470**	-,841**	-,114**
	Sig. (bilatérale)	,977	,951	,966	,965	,858	,000	,000	,055	,306	,000	,000	,000	,000	,000	,000	,000
	N	3180	3180	3180	3180	3180	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181

borderDensity	borderBalance	colorDensity	Colorfulness	compression Complexity	Density_1
,006	,015	,006	,001	,001	-,001
,753	,405	,728	,954	,934	,977
3180	3130	3180	3180	3180	3180
,002	,007	-,005	-,002	-,001	-,001
,898	,675	,776	,909	,956	,951
3180	3130	3180	3180	3180	3180
-,005	-,006	-,007	-,008	,004	-,001
,771	,725	,685	,648	,807	,966
3180	3130	3180	3180	3180	3180
-,002	,001	,006	-,009	,008	,001
,924	,964	,721	,620	,634	,965
3180	3130	3180	3180	3180	3180
-,011	-,015	-,010	,001	,000	,003
,517	,417	,571	,959	,980	,858
3180	3130	3180	3180	3180	3180
,105**	,234**	,195**	,084**	,121**	-,075**
,000	,000	,000	,000	,000	,000
3181	3131	3181	3181	3181	3181
,037*	,147**	-,021	-,025	,162**	-,072**
,038	,000	,245	,166	,000	,000
3181	3131	3181	3181	3181	3181
,123**	,203**	,333**	,162**	,003	-,034
,000	,000	,000	,000	,869	,055
3181	3131	3181	3181	3181	3181
-,050**	,015	-,117**	-,069**	-,111**	,018
,005	,408	,000	,000	,000	,306
3181	3131	3181	3181	3181	3181
,175**	,076**	,240**	,075**	,274**	-,130**
,000	,000	,000	,000	,000	,000
3181	3131	3181	3181	3181	3181
,290**	,035	,130**	,006	,155**	-,311**

,000	,053	,000	,737	,000	,000
3181	3131	3181	3181	3181	3181
,450**	,060**	,205**	,025	,314**	-,513**
,000	,001	,000	,152	,000	,000
3181	3131	3181	3181	3181	3181
,316**	,056**	,103**	,028	,295**	-,440**
,000	,002	,000	,110	,000	,000
3181	3131	3181	3181	3181	3181
,318**	,010	,059**	,090**	,085**	-,470**
,000	,585	,001	,000	,000	,000
3181	3131	3181	3181	3181	3181
,696**	,053**	,216**	,159**	,395**	-,841**
,000	,003	,000	,000	,000	,000
3181	3131	3181	3181	3181	3181
,102**	,098**	,035*	-,101**	,042*	-,114**
,000	,000	,049	,000	,018	,000
3181	3131	3181	3181	3181	3181
1	,216**	,370**	,148**	,627**	-,829**
	,000	,000	,000	,000	,000
3181	3131	3181	3181	3181	3181
,216**	1	,094**	,074**	,217**	-,131**
,000		,000	,000	,000	,000
3131	3131	3131	3131	3131	3131
,370**	,094**	1	,449**	,325**	-,289**
,000	,000		,000	,000	,000
3181	3131	3181	3181	3181	3181
,148**	,074**	,449**	1	,206**	-,161**
,000	,000	,000		,000	,000
3181	3131	3181	3181	3181	3181
,627**	,217**	,325**	,206**	1	-,515**
,000	,000	,000	,000		,000
3181	3131	3181	3181	3181	3181
-,829**	-,131**	-,289**	-,161**	-,515**	1
,000	,000	,000	,000	,000	
3181	3131	3181	3181	3181	3181

Appendix 2- Summery of information processing

Moyennes

Récapitulatif de traitement des observations

	Observations					
	Inclus		Exclu		Total	
	N	Pourcentage	N	Pourcentage	N	Pourcentage
score * gender	3539	95,6%	161	4,4%	3700	100,0%
score * age	3539	95,6%	161	4,4%	3700	100,0%
score * Balance	3180	85,9%	520	14,1%	3700	100,0%
score * VerticalBalance	3180	85,9%	520	14,1%	3700	100,0%
score * HorizontalBalance	3180	85,9%	520	14,1%	3700	100,0%
score * Equilibrium	3180	85,9%	520	14,1%	3700	100,0%
score * Density	3180	85,9%	520	14,1%	3700	100,0%
score * CenterAlignment	3180	85,9%	520	14,1%	3700	100,0%
score * ExternalAlignment	3180	85,9%	520	14,1%	3700	100,0%
score * Concentricity	3180	85,9%	520	14,1%	3700	100,0%
score * Simplicity	3180	85,9%	520	14,1%	3700	100,0%
score * Density_1	3180	85,9%	520	14,1%	3700	100,0%
score * Symmetry	3180	85,9%	520	14,1%	3700	100,0%
score * saliencyBalance	3180	85,9%	520	14,1%	3700	100,0%
score * borderBalance	3130	84,6%	570	15,4%	3700	100,0%
score * borderDensity	3180	85,9%	520	14,1%	3700	100,0%
score * colorDensity	3180	85,9%	520	14,1%	3700	100,0%
score * Colorfulness	3180	85,9%	520	14,1%	3700	100,0%
score * compressionComplexity	3180	85,9%	520	14,1%	3700	100,0%
score * smartphoneUsageFrequency	3539	95,6%	161	4,4%	3700	100,0%