Appendix B. Market Analysis

The competition of the products given with the Box are analysed in order to identify their weak points, strong points and opportunities for improvement.

The products are chosen with the following criteria:

- Consumer products: the products that are available to the consumers.
- They can be find in the same categories as the products given in the Box.
- The products provide enough information in order to compare the main parameters (price, height, weight, surface, application, certifications, technology used, vitals or measurements, etc...).
- They can be considered smart products or wearables, and at least have some sort of connectivity with a smartphone or computer.

Firstly, the amount of products on each category (BPM, smart scales, smart watches and ECG) available to the general population greatly varies, therefore it is difficult to determine an appropriate sample for each category. The following number of products are selected in each category following an overview of available products on the website amazon.com:

- **Smart scales**: 20 products.
- **Smart watches**: 31 products.
- **BPM**: 12 products.
- **ECG**: Not considered appropriate as the availability for consumers is too low. Some interesting products are mentioned in point 3.4.

Secondly, for the analysis, the box and whisker diagram is selected to visually display the variability without assumptions. Specific analysis will be done on the outliers as considered extraordinary. In addition, conventional bar charts will be used to assess the incidence of different technologies, colours, materials and vitals/measurements.

Finally, the analysis will be done using a developed application for this project that uses eCharts.js[1] to display and do the analysis, and MongoDB to store the results. This application is developed for convenience and speed, but it can also be useful for the hospital to evaluate new products.

3.1 Scales Market Analysis

20 smart scales are chosen for the market analysis. The number is a good representation of the population as the number of results in Google Shopping for the term “body weight scale” is 54 as 0f November 2018.

The scales are analysed in price, weight, length, surface, height, materials, colours, HL7 compliant, certifications, and other relevant parameters.

3.1.1 Scales prices

Figure 1. Scales price with outliers

Figure 1 shows the box plot of the scales with the outliers. Once the outliers are removed as seen in Figure 2, the main values are:

- Lower: 21.99.
- Q1: 47,97.
- Median: 69,95.
- Average: 70.52.
- Q3: 94,995.
- Upper: 149,99.

Figure 2. Scales price without outliers

Figure 3. Price outliers. Tanita RD-545IM Ironman[2], price $449,99 (left), Tanita RD-901 plus IRONMAN®[3], price $209,99 (right).

Both outliers shown in Figure 1, outstand for the price, being the Tanita RD-545IM triple than the maximum price once the box plot is analyzed without outliers. This products are extremely expensive due to the following reasons:

- Both products are targeted for elite athletes.
- Both have dual frequency analysis, which gives accurate information about muscle composition. The dual frequency analysis consists of applying electric currents of different radio-frequencies to obtain a more precise result of the body composition (fat, water, bone, etc.).
- Tanita is a renown brand in producing and selling scales.
- Tanita RD-545IM has clearance as a medical device, monitors heart rate and offers segmental analysis of legs and arms separately. It is the only product with such features. The segmental analysis provides fat and muscle measures separately for arms, legs and trunk. It uses electrodes that can read the electric radio-frequencies at each hand and leg.
- Materials, weight, maximum weight, width, length, height and the supported vitals are in line with the rest of the market.
- The design of both products stands out, it is more complex, suggesting to have more functions as well functions as well.

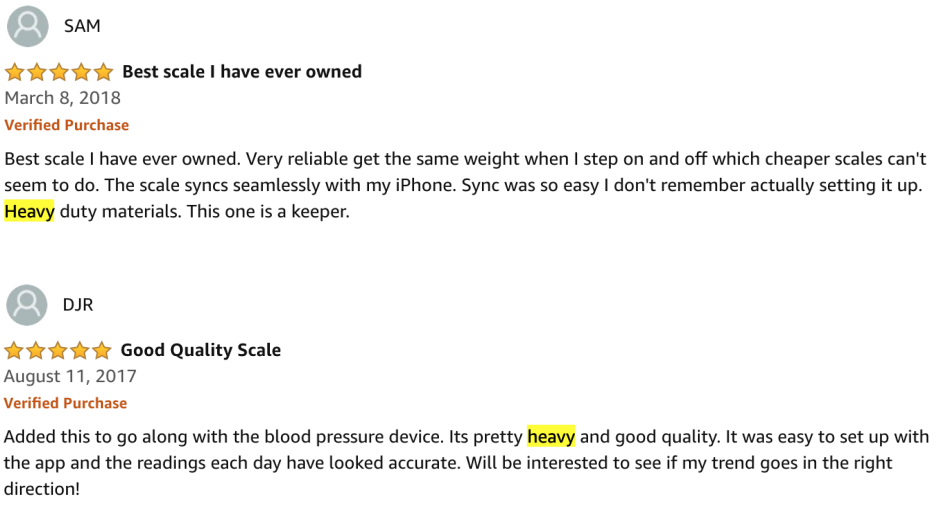
3.1.2 Scales Weight

Figure 4. Scales weight box plot

Figure 4 shows the weight of the scales, being the main values in kilograms as follow:

- Lower: 1,1.
- Q1: 1,70.
- Median: 2,475.
- Average: 2,34.
- Q3: 2,82.
- Upper: 4.

The weight is a parameter used to manipulate the perceived quality of a product. Consumers prefer heavy products implying they are of good quality. The comments in Figure 5 show this effect.


SAM

★★★★★ **Best scale I have ever owned**

March 8, 2018

Verified Purchase

Best scale I have ever owned. Very reliable get the same weight when I step on and off which cheaper scales can't seem to do. The scale syncs seamlessly with my iPhone. Sync was so easy I don't remember actually setting it up. Heavy duty materials. This one is a keeper.

DJR

★★★★★ **Good Quality Scale**

August 11, 2017

Verified Purchase

Added this to go along with the blood pressure device. Its pretty heavy and good quality. It was easy to set up with the app and the readings each day have looked accurate. Will be interested to see if my trend goes in the right direction!

Figure 5. Positive comments about weight[4].

3.1.3 Scales Width

Figure 6. Scales width box plot

No relevant information can be subtracted from the width, although an increase in surface may facilitate the usage for elderly people. The main values in centimeters are as follow:

- Lower: 28.
- Q1: 30.
- Median: 32,7.
- Average: 32,55.
- Q3: 35,125.
- Upper: 38.

3.1.4 Scales Length

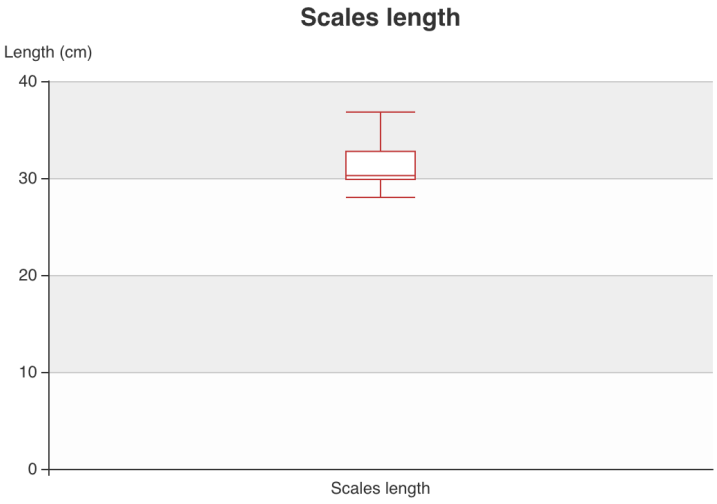


Figure 7. Scales length without outliers

There is one outlier with a length of 40.8cm. After removing the first outlier there is another outlier of 38cm. Once both are removed, the values are:

- Lower: 28; Q1: 29.85.
- Median: 30.25.
- Average: 32.75.
- Q3: 36.8.
- Upper: 31.25.

Both outliers receive good comments on the extra size. The scale from Welch Allyn is the same that is regarded as of superior quality due to the weight. Users also regard the length a help to stand, and the handle as useful.

Figure 8. Scales length outliers. Welch Allyn[4] (left) and Yunmai[5] (right).

3.1.5 Scales height

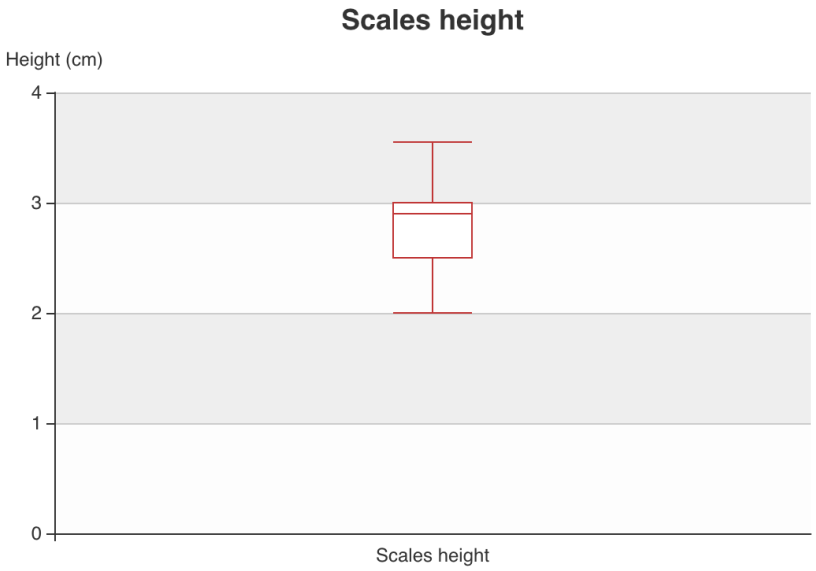


Figure 9. Scales height without outliers.

There are four outliers. Once removed, the main values in centimetres are:

- Lower: 2.
- Q1: 2.5.
- Median: 2.9.
- Average: 2.75.
- Q3: 3; Upper: 3.55.

The outliers regarding height on the upper side are not valued as positive, although, thin body scales are perceived as comfortable and versatile by the customers. It allows the users to hide the scale below the sofa or other furniture.

Figure 10. Height outliers. Tanita RD-545IM Ironman[2], 5.7cm(top-left). Fitbit Aria 2 Wi-Fi Smart Scale[6], 4cm (top-right). iHealth Core Wireless Body Composition Scale[7], 4.6cm (bottom-left). Phicomm S7[8], 1,52cm (bottom-right).

Buffy

★★★★★ **A stylish scale and a helpful tool in tracking both weight and body fat**

February 4, 2018

Vine Customer Review of Free Product (What's this?)

There was a lot of thought put into the design of this scale. It's very simple but still very chic and stylish. Clean white and silver give an attractive appearance if you keep it in sight. It's flat, slim and lightweight which I find makes it easy to slide under my bathroom cabinets. The connecting rod that comes with it to measure body weight plugs into the scale and if you are keeping the scale in sight without tucking under a cabinet or bed you can easily unplug the body fat measuring rod and tuck it away in a near by drawer.

Figure 11. Positive customer review featuring the height of the scale. Review about the Phicomm S7 scale on amazon.com.

3.1.6 Scales colour

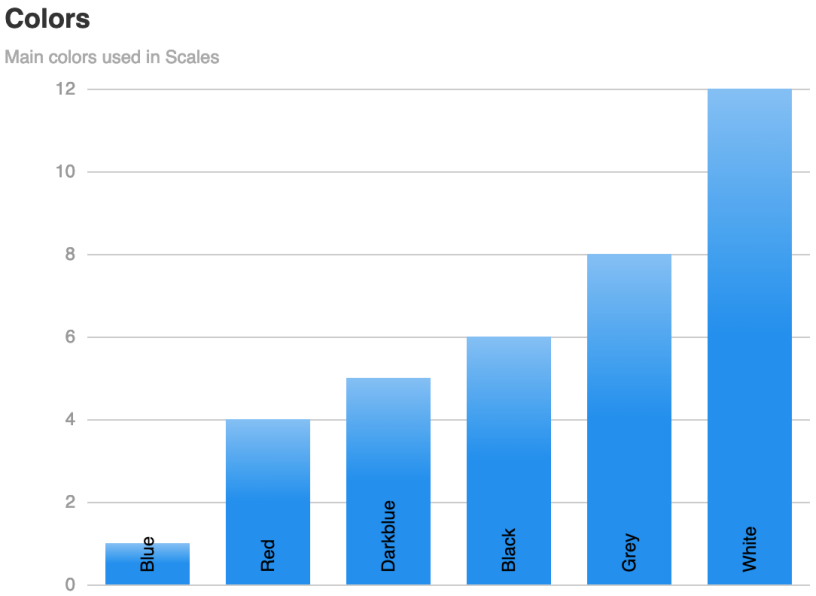


Figure 12. Colour incidence.

The main colours are white and black for the full body and grey as a support for details. Other colours are red, dark blue and blue, used for details or for the LCD screen.

3.1.7 Scales technology

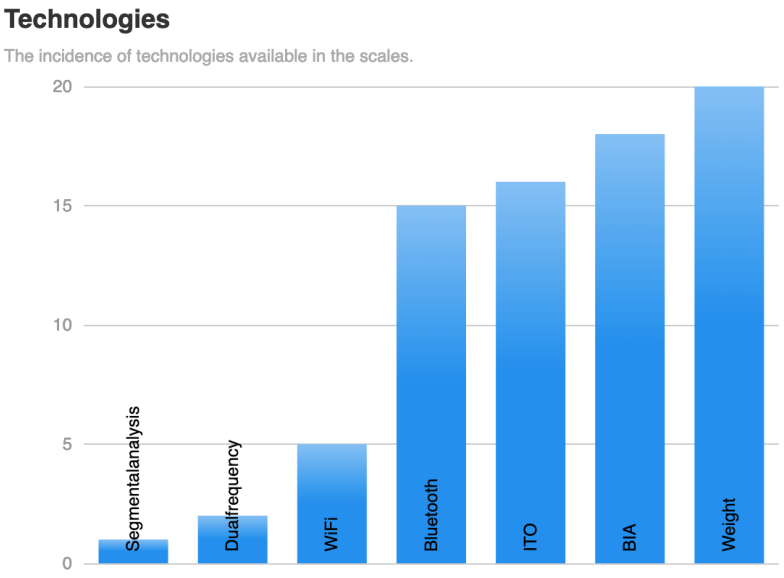


Figure 13. Scales technologies incidence and metrics incidence.

- All scales have 4 pressure sensors to calculate the weight, generally situated in the cavity of the pads.
- Most of them use Bluetooth technology for connection. Scales with WiFi are more expensive, they cost an average price of $95,26.
- 18 out 21 scales have bioelectrical impedance analysis (BIA), which provides body composition analysis.
- In order to provide BIA functionality, tempered glass scales make use of indium tin oxide coat to enable conductivity.
- The two scales from Tanita (outliers in the price box plot) are the only ones offering dual frequency BIA.
- Segmental body composition is only available from the Tanita RD-545IM.
- None of the products are compatible with HL7 protocols, or it is not mentioned in the product description.

3.1.8 Scales materials

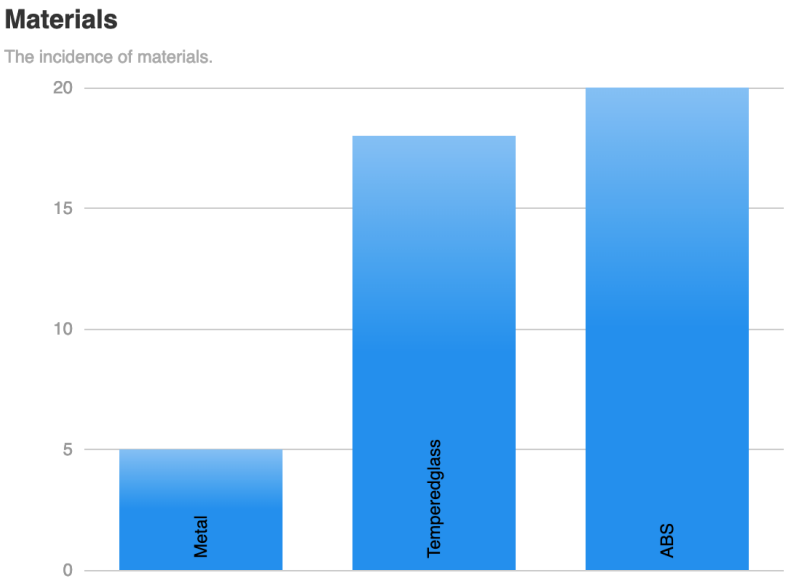


Figure 14. Scales materials incidence.

Most of the scales are built in ABS and have a surface made of tempered glass, only five scales are made or have metal parts in them.

3.1.9 Scales measured vitals

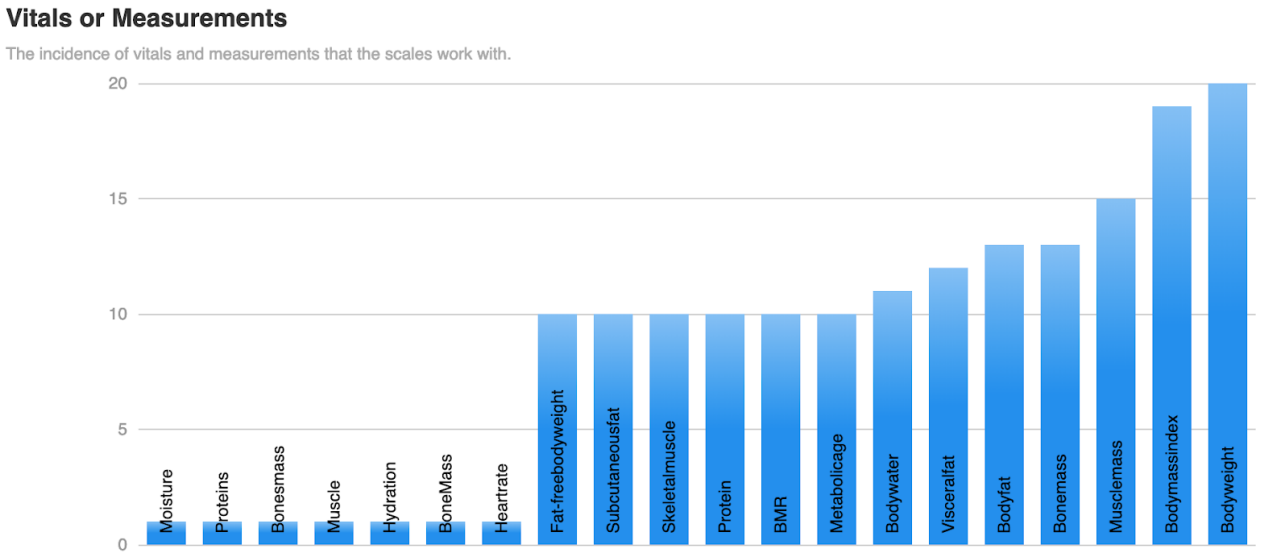


Figure 15. Scales vitals incidence.

Most of the analysed scales can give the BMI together with weight and keep records in the users phone making use of an application. 15 of the analysed scales feature BIA, which enables users to obtain the following body composition measurements:

- Body mass index.
- Body fat.
- Fat-free body weight.
- Subcutaneous fat.
- Visceral fat. Body water.
- Skeletal muscle.
- Muscle mass.
- Bone mass.
- Protein.
- BMR.
- Metabolic age.

3.2 Watches Market Analysis

12 products are chosen for the market analysis. The number is a good representation of the population as many of the self-called smartwatches or fitness trackers are the same brand with different colour or completely lack a proper description of their features.

The watches are analysed in price, weight, length, surface, height, materials, colours, HL7 compliant, certifications, and other relevant parameters.

3.2.1 Watches Price

Figure 16. Watches price box plot.

There are no outliers. The main values in dollars are:

- Lower: 29.99.
- Q1: 79.74.
- Median: 99.
- Average: 135.52.
- Q3: 205.24.
- Upper: 294.

3.2.2 Watches Weight

Figure 17. Watches weight box plot without outliers.

There are three outliers analysed below, once removed, the main values in grams are:

- Lower: 20.
- Q1: 31.8.
- Median: 36.3.
- Average: 41.05.
- Q3: 59.
- Upper: 68.

The weight of the outliers is due to the materials in the Fossil Q and Fitbit Versa Watches. Amazfit may be due to the battery size, as it lasts 30 days, although more information would be required to confirm it.

Figure 18. Watches weight outliers. Fossil Q[9] (left), Amazfit[10] (middle) and Fitbit Versa[11] (right).

3.2.3 Watches Battery

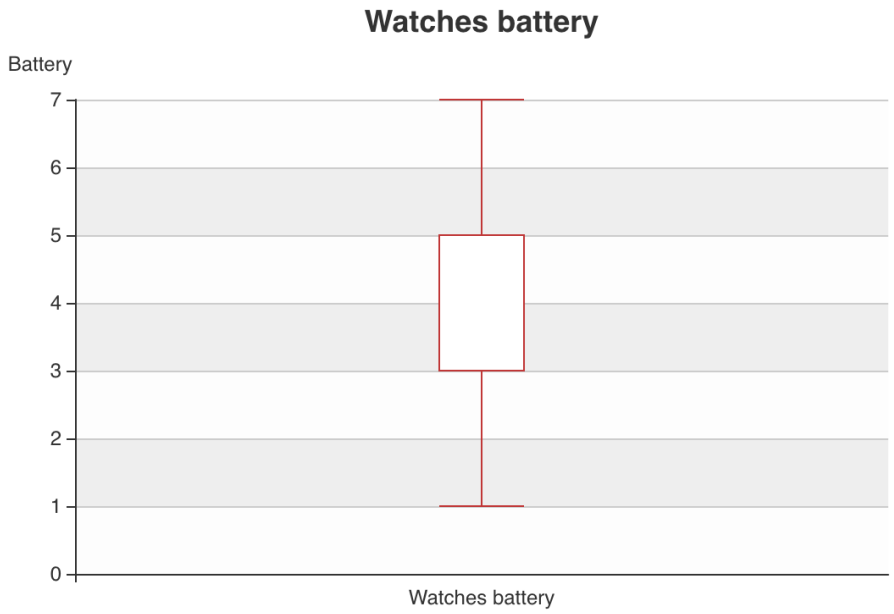


Figure 19. Watches battery box plot without outliers.

There are two outliers, the main values in days after removing them are:

- Lower: 1.
- Q1: 3.
- Median: 3.
- Average: 3.45.
- Q3: 5.
- Upper: 7.

The outliers are the Amazfit watch (Figure 18. Middle), which lasts 30 days. It has an e-ink screen which gives it longer lifespan. The other is the Nokia Steel watch included in the box, which lasts 234 days (8 months).

3.2.4 Watches Technology

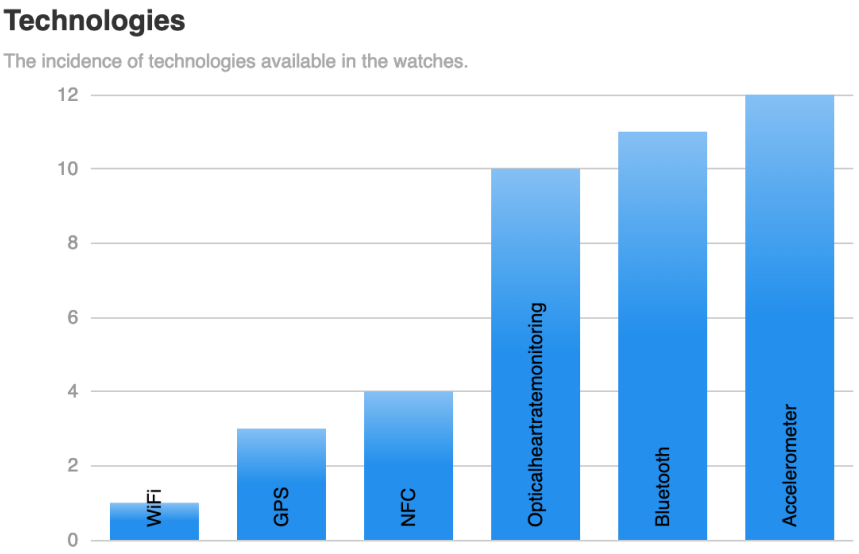


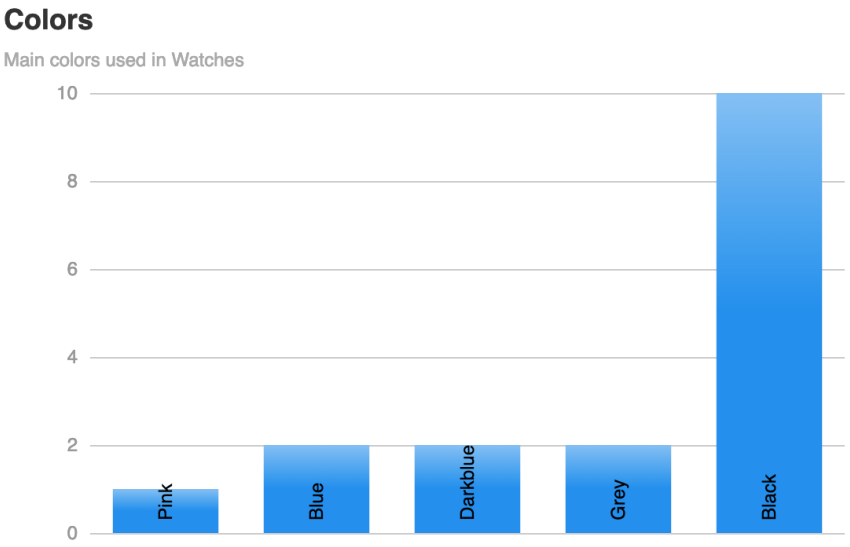
Figure 20. Technologies incidence.

Most of the watches use:

- Step counting based on an accelerometer
- Optical heart rate monitoring based on photoplethysmogram (PPG).
- For connection the preferred technology is Bluetooth.

The high variability in prices is mainly due to screen technology and branding, the underlying technologies are the same. It is important to notice that accuracy is expected to be the same in most of the watches because the readings are affected by physiology of the user, the location of the device on the user body, and the movement performed at the time of measuring.

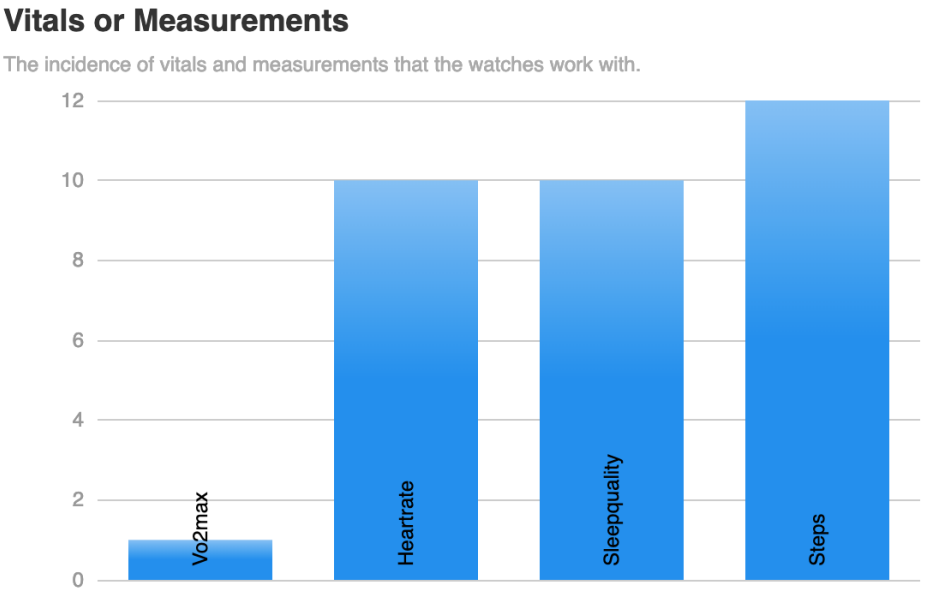
3.2.5 Watches Colours



Figures 21. Colours incidence.

The black colour is dominant. It is used for the band as well as for the body. Some watches stand out offering colour alternatives.

3.2.6 Watches Vitals



Figures 22. Measured vitals incidence.

The main vitals or measurements recorded by the analysed watches are steps, sleep quality, heart rate monitoring and one offers Vo2max for training purposes, although it is not specified how accurate it is or how it is obtained.

3.3 BPM Market Analysis

There have been found only 6 BPMs with medical grade clearance and connectivity available as consumer products. In addition, BPMs do not vary in functionality, all make use of a mercury or mechanical manometer to measure the pressure. Therefore, an analysis as in the previous products will not be conducted.

The only relevant difference between Nokia BPM and the other BPMs is the possibility to have on-screen feedback and memory storage, so the synchronization with the mobile device can be doon afterwards. This reduces the steps while taking a measurement.

Figure 23. Nokia BPM[12] (top-left). Philips BPM DL8760/15[13] (top-right). Omron Evolv[14] (centre-left). iHealth Track[15] (centre-right). Beurer BM85[16] (bottom-left). Qardio BPM[17] (bottom-right).

It is worth mentioning the iHealth Track device due to the price and convenience. It costs $34.99[40], has memory to store records, synchronizes new records and the stored ones with the phone, provides on-screen feedback and records the heart rate.

3.4 ECG Market Analysis

There has been found only one ECG/EKG with medical clearance available as a consumer product in major online retailers, the KM device included in the Box. The other one is the Kardia Smartband (KS) for Apple Watch which has the same features, but it is integrated in a band for the Apple Watch. Figure XX shows its construction.

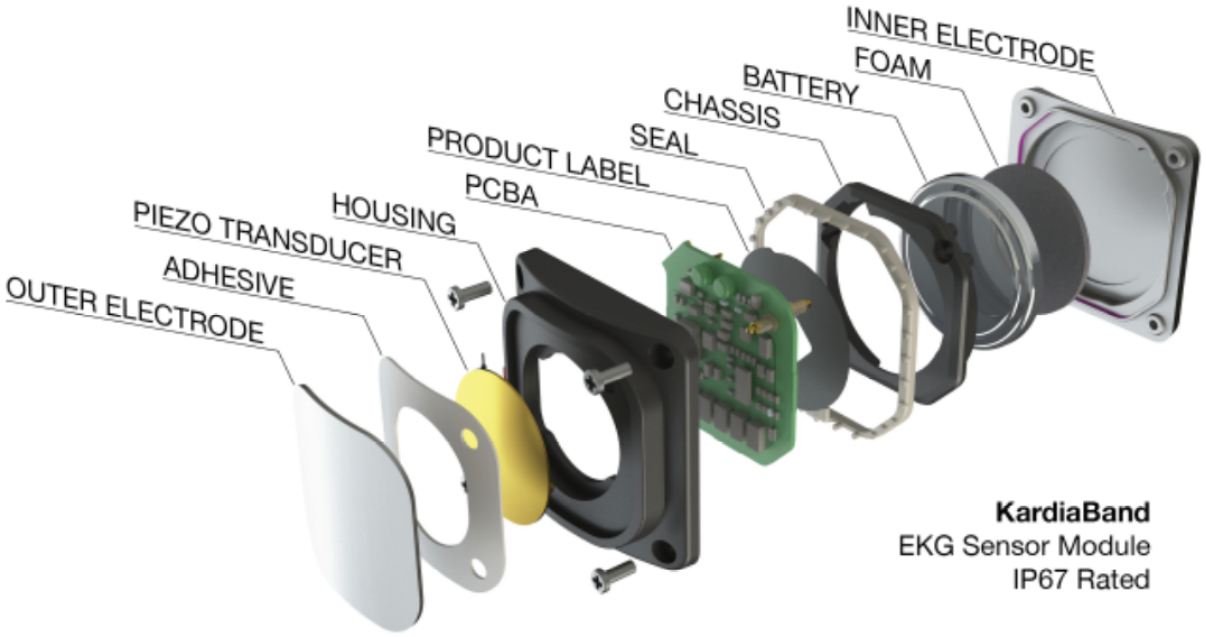


Figure 24. KS construction [18]

Two products worth mentioning are the new Apple Watch Series 4, which features ECG analysis, similar to the KM. It is a complete product that includes continuous heart rhythm monitoring (to help prevent strokes[18]), fall detection, activity tracker and ECG analysis. Moreover, all that information is used for proactive feedback, such as ECG analysis suggestion when the heart rhythm varies abnormally.

References

[1] Li, D., Mei, H., Shen, Y., Su, S., Zhang, W., Wang, J., . . . Chen, W. (2018, 06). ECharts: A declarative framework for rapid construction of web-based visualization. Visual Informatics, 2(2), 136-146. doi:10.1016/j.visinf.2018.04.011

[2] Tanita RD-545IM Ironman Multi Frequency Segmental Body Composition Monitor. (n.d.). Retrieved from http://www.amazon.com/Tanita-RD-545IM-Frequency-Segmental-Composition/dp/B0772VCD2Z

[3] Tanita RD-901 plus IRONMAN® Android and iPhone Bluetooth Radio Wireless Body Composition Scale. (n.d.). Retrieved from https://www.amazon.com/Tanita-IRONMAN®-Bluetooth-Wireless-Composition/dp/B01MTXSH1Q/

[4] Welch Allyn Home Scale with Simple Smartphone Connectivity - RPM-SCALE100. (n.d.). Retrieved from https://www.amazon.com/Welch-Allyn-Home-Smartphone-Connectivity/dp/B072JSQGCL/

[5] Yunmai Color Smart Scale, Body Composition Analyzer Smart Digital Bathroom Weight Scale Health Monitor Compatible with iOS and Android APP. (n.d.). Retrieved from https://www.amazon.com/Yunmai-Bluetooth-Smart-Scale-Monitor/dp/B01B8LEELA/

[6] Fitbit Aria 2 Wi-Fi Smart Scale. (n.d.). Retrieved from https://www.amazon.com/Fitbit-Aria-Wi-Fi-Smart-Scale/dp/B0752M6T6K/

[7] IHealth Core Wireless Body Fat Scale Smart BMI Scale Digital Bathroom Wi-Fi Weight Scale, Body Composition Analyzer with Fitness app 400 lbs, Large Tempered Glass Surface, lbs/kg/st Units. (n.d.). Retrieved from https://www.amazon.com/iHealth-Wireless-Composition-Scale-Android/dp/B00Y2N86JI/

[8] PHICOMM S7 Smart Body Fat Weight Scale with Fitness App & Body Composition Monitor, 22 Indicators (Pearl White). (n.d.). Retrieved from https://www.amazon.com/PHICOMM-Fitness-Composition-Monitor-Indicators/dp/B076MPFG7J

[9] Fossil Q Men's Gen 3 Explorist Stainless Steel and Silicone Smartwatch, Color: Black (Model: FTW4005). (n.d.). Retrieved from https://www.amazon.com/Fossil-Explorist-Stainless-Silicone-Smartwatch/dp/B075ZL5K7J/

[10] Amazfit Bip Smartwatch by Huami with All-Day Heart Rate and Activity Tracking, Sleep Monitoring, GPS, Ultra-Long Battery Life, Bluetooth, US Service and Warranty - A1608 Black. (n.d.). Retrieved from https://www.amazon.com/Amazfit-Smartwatch-Monitoring-Ultra-Long-Bluetooth/dp/B07CRSK5DM

[11] Fitbit Versa Smart Watch, One Size (S & L Bands Included). (n.d.). Retrieved from https://www.amazon.com/Fitbit-Versa-Smart-Aluminium-Included/dp/B07B4915CX

[12] Withings - Blood Pressure Monitor. (n.d.). Retrieved from https://www.amazon.com/Withings-70002601-Blood-Pressure-Monitor/dp/B00C7NKVD4/

[13] Buy the Philips Upper arm blood pressure monitor DL8760/15 Upper arm blood pressure monitor. (n.d.). Retrieved from https://www.philips.co.uk/c-p/DL8760_15/upper-arm-blood-pressure-monitor

[14] EVOLV. (n.d.). Retrieved from https://www.omron-healthcare.com/en/evolv

[15] Health Track Wireless Blood Pressure Monitor Bluetooth Blood Pressure Cuff, Digital Upper Arm Cuff, BP Meter with Multi-Color Backlight Large Display, Kit Comes with Batteries (BP Monitor New). (n.d.). Retrieved from https://www.amazon.com/dp/B01C5QS1T8

[16] GmbH, B. (n.d.). BM 85 - Upper arm blood pressure monitor. Retrieved from https://www.beurer.com/web/gb/products/medical/blood-presure/upper-arm-blood-pressure-monitors/bm-85.php

[17] QardioArm Blood Pressure Monitor: FSA-Eligible, Medically Accurate, Wireless & Compact Digital Upper Arm Cuff. App enabled for iOS, Android, Kindle. Works with Apple and Samsung Health. (n.d.). Retrieved from https://www.amazon.com/QardioArm-Wireless-Blood-Pressure-Monitor/dp/B00JM6EBHG

[18] How it works - Alivecor. (n.d.). Retrieved from https://www.alivecor.com/how-it-works/