Evaluating "Usability" and "Anthropometric Dimensions" of ATMs in Kuwait for Ergonomic Design

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Abstract

This paper is about evaluation of usability characteristics and anthropometric dimensions of Automated Teller Machines (ATMs) in Kuwait. As for the usability characteristics, efficiency, learnability, readability, and satisfaction are considered. Additionally, as anthropometric dimensions of ATMs for ergonomic design, screen height, keyboard height, card slot height, and cash slot height are considered. In order to evaluate usability characteristics, a questionnaire with ten questions related to the mentioned characteristics are designed. The results of the questionnaire are analyzed by using Minitab Software using Spearman Coefficient Correlation. Spearman Coefficient Correlation was used to check if the questions from same categories are correlated or not. Additionally, comparisons between customer satisfaction and learnability, efficiency and readability characteristics are performed. Also, for the efficiency characteristics of ATMs, the total transaction time is measured by using a chronometer for each user. On the other hand, different anthropometric dimensions for three banks in Kuwait are measured. These measurements are indicated that ATM designers are not considering anthropometric dimensions for different users. Finally, some solutions related to usability issues and anthropometric dimensions for Kuwaiti banks and ATM designers are recommended.

Keywords
Usability characteristics, Anthropometric dimensions, Efficiency, Learnability, Readability, and User Satisfaction.

1. Introduction

Automated Teller Machine (ATM) gives users an opportunity to deal with financial transactions without contacting with the bank employee or teller. ATM helps customers to save their time during the attaining banking service such as fund transfer, cash withdrawal, bill payment, balance inquiry etc. ATMs have many advantages to users; not only saving time, but also, they are safe and easy to use. ATMs also provide to customers 24-hour access to banking services (Zhang et al., 2013). On the other hand, users can face many problems due to ATMs (Curran and King, 2008). While people try to use ATMs, they may do a lot of mistakes. ATM users in Kuwait are also having problems from different issues as limited language selections, long processing time, inappropriate ATM dimensions for different users. On the other hand, it is noticed that ATMs are not designed in different sizes which is considered as an issue for users. For example, reachability of ATMs components such as keyboard, card slot, cash slot, is creating serious problems for users.

There are many issues related to ATM usability characteristics and anthropometric dimensions (Quesenbery, 2001; Shende et al., 2014). One can evaluate usability characteristics of ATMs by analyzing efficiency, readability, learnability, and satisfaction. Efficiency characteristic is related with the ATM transaction time. Any ATM transaction process should be completed as fast as possible. In Kuwait, some users take long time than expected to do the transaction. Especially elderly users spend a lot of time for a simple transaction that is an example of efficiency issue. Second one is readability characteristic, where the font size, font and background color, and font style should be clear and easy to for ATM read. Likewise, the text size should be chosen to be clear and readable for all people in all ages.

Learnability characteristic is related with the ATM usage process that should be easy to learn without getting any help. Some users such as elderly users or first-time users take a long time to understand the ATMs operations that is an example of learnability issues. Also, the used language should be clear and simple in order to understand the process. Satisfaction characteristic refers to how happy and pleasant are users with the ATMs. Suitability of ATMs' for different users is correlated with user satisfaction. These characteristics are measured by using questionnaires (Ayimey et al., 2012; Mwatsika, 2016). On the other hand, there are different designs and different dimensions of ATMs in Kuwait. Since Kuwait is hosting many expats from different populations and nationalities, it is essential to consider the anthropometric dimensions for the design and installation of ATMs. There are four major ATM components, screen, keyboard, card slot, and cash slot, that should be taken into consideration to be appropriate for all users. All heights of these components should be reachable for all users with different sizes. For card slot and cash slot should be easy to insert or take both cash and card. Moreover, screen height should be comfortable and visible for all users. Additionally, keyboard should be at same level of elbow height in order to avoid awkward postures (Al-Saleh and Bendak, 2013; Rana et al., 2018).

The scope of this paper is to focus on evaluating usability characteristics and the anthropometric dimensions of ATMs in Kuwait. For the next section short background information about usability and anthropometrics for ATMs are explained. After this section, the methodology and the questionnaires for the study are given. After the analysis and results section, conclusion and recommendations are summarized.

2. Background on ATMs Usability Characteristics and Anthropometric Dimensions

Usability analysis is the way to test how efficiently and effectively different users use a specific product or system (Lehto & Landry, 2012). Moreover, usability is defined as the objective of designing a product or a system that gives users the opportunity to achieve their goal in effective, efficient and satisfied way (ISO 9241-11: 2018). The most accepted definition of usability by ISO 9241-11 is "the 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". "*Efficiency*" is defined as the time spent by users to accomplish their goals in using the system, "*effectiveness*" is defined as how good users interacting with the system, and "*satisfaction*" is defined as how happy and pleasant are users with the system (ISO 9241-11, 2018). Additionally, ISO/IEC 25010 describes more characteristics of usability such as *learnability*, *readability*, efficiency, effectiveness, satisfaction, etc. (ISO/IEC 25010, 2011). "*Learnability*" is defined as easy to use and learn the system. "*Readability*" is defined as the ability of reading the text used for the system (Miguel, Mauricio, & Rodríguez, 2014). Elderly users spend a lot of time for a simple transaction that is an example of efficiency issue. Efficiency means the total time users spent and the required effort to use ATM system. Designers fail to choose the proper background color that contrast with font color that is a readability issue. Some users such as elderly users or first-time users take a long time to understand the ATMs operations that is an example of learnability issues. Moreover, customer satisfaction is included as usability test method; which means how satisfy is the customer with ATM performance. One can evaluate usability characteristics of ATMs by analyzing efficiency, readability, learnability, and satisfaction. Canapi et al. (2015) defined efficiency as how long one transaction takes to be completed by the user such as cash withdrawal, checking balance or changing PIN number. They defined learnability as how fast can users understand the ATM process is known as learnability. How words are displayed on the screen based on font size, font and background colour and font style are readability characteristic. Finally, satisfaction depends on efficiency, learnability and readability. It's the defined as how satisfied and agreed is the customer on the service. Furthermore, not all ATM designers know what usability characteristics is, so they are designing ATMs based on their customers, banks, needs not bank customer needs. This will affect customer satisfaction, which what banks are seeking for (Ayimey et al., 2012; Mwatsika, 2016).

The field of applied anthropometry relates basic dimensions of human body to very helpful design criteria used by designers interested in creating things that fit the size or other aspects of human body. "*Accessibility requirements*", "*postural criteria*" and "*visibility criteria*" are three important criteria for ATM design. *Accessibility requirements* refer to how easy it is to reach something. This criterion is important to guide decision on where to locate controls and displays for ATMs. *Postural criteria* refer to the way particular combinations of design elements and human bodily dimensions interactively affect objectives such as the need to reduce bending, twisting, or awkward sustained postures. *Visibility criteria* are for the most part concerned with blockages of vision as a function of expected eye positions and the location of obstacles (Lehto & Landry, 2012). The upper extremities of human body such as elbow, shoulder, wrist, neck, back and hand involve important role in using ATMs. Therefore, knowing the upper extremity dimensions is extremely important for ATM designers so they can design ATMs these are appropriate for all users. In this case,

many different ATM users will be satisfied with these new designed ATM by considering anthropometric dimensions, since they won't face problems while using ATM. But, ATM manufacturers for Kuwait are not considering the anthropometric dimensions for their products and designs. In fact, this case is not only for Kuwait but also for Saudi Arabia, Pakistan and Philippine (Al-Saleh and Bendak, 2013; Canapi et al., 2015;Rana et al., 2018). Corresponding studies showed that there is no standard for ATMs in these countries. All of these studies used a standard for ATMs was developed in Australia; it gives ATM dimensions based on anthropometric measurements of the Australian population (Australian Bankers' Association, 2001). The following Figure 1 illustrates these dimensions.
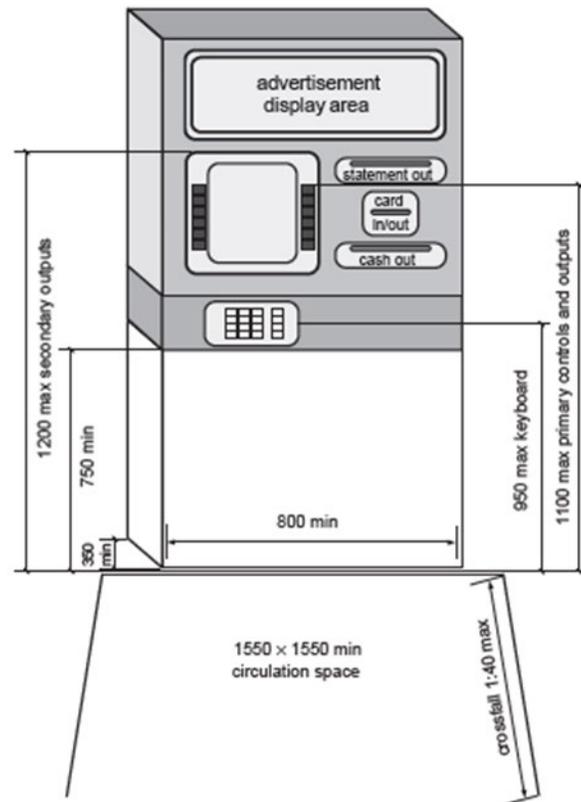

Figure 1. ATMs dimensions by the Australian Standards (Australian Bankers' Association, 2001).

According to Al-Saleh and Bendak (2013), there is no ATM standards exist in Saudi Arabia, so banks install ATMs without considering anthropometric dimensions such as card slot height is different from bank to another causing problems for different users. For example, some ATM users can't reach to the card slot window, so they need to either extend or flex their elbow which results an awkward posture. Based on their study, they have identified the following four basic anthropometric dimensions affecting the ATM users: screen height, keyboard height, card slot height, and cash slot height.

- *Screen Height:* For this dimension, accessibility requirements, postural criteria and visibility criteria have to be considered. The screen should be easily visible for all users and easy to see. It should be not too high or too low to avoid awkward position of the neck. Very high screen levels will cause the arms and the head to be raised unnecessarily and may turn lead to fatigue in the neck area, arms and the shoulders. Likewise, if the screen level is too low, the trunk and the neck will be inclined forward causing postural stress on the spine area. Screen height must be close or below to the eye height. One can state that, reasonable screen height should not expose shoulders, arms, or the back area to additional postural stress. The center of the screen should be 900-1150 mm above the floor (Lehto and Landry, 2013).
- *Keyboard Height:* For this dimension, accessibility requirements and postural criteria have to be considered. Since using an ATM keyboard requires high attention, this task can be considered as high precision work (Lehto and

Landry, 2013). It is recommended such precision work to be done 0–100 mm above elbow height by Grandjean (1988). Wrong height of keyboard may cause fraction and affect shoulder, neck and wrist.

- *Card Slot Height:* For this dimension, accessibility requirements, postural criteria and visibility criteria have to be considered. It is very important to insert the card easily to the card slots in a good height and position and be visible for user clearly. The height of card slot should be 100 mm above the average elbow height of adult user population to prevent awkward position.
- *Cash Slot Height:* For this dimension, accessibility requirements, postural criteria and visibility criteria have to be considered. The cash slots should be in an easily reachable place and visible to users. The height of cash slot should be 0 - 100 mm above the average elbow height of adult user population to prevent awkward position.

3. Methodology

To evaluate usability characteristics and the anthropometric dimensions of ATMs in Kuwait, data collection and analysis must be performed. In order to evaluate usability characteristics of ATMs which are learnability, readability, efficiency, and satisfaction, a questionnaire given in Table 1 with ten questions related to the mentioned characteristics are designed. In addition, for anthropometric dimensions that affect the interaction between users and ATM, card slot height, screen height, keyboard height, and cash collect height are measured for the banks in Kuwait.

Table 1. Questionnaire for ATM usability characteristics.

A.	**Learnability:**
1.	The system is easy to understand from the first time you used.
2.	Language used is simple and easy to understand.
3.	Instruction on how to use the system is visible and easy to learn.
B.	**Efficiency:**
4.	Shortcuts are provided for most frequent items and commands
5.	Speed of transaction is acceptable
C.	**Readability:**
6.	Text colour is clear and readable
7.	Font size and style are legible
8.	Contrast between background colour and text colour is high
D.	**Satisfaction:**
9.	ATMs are suitable for different users
10.	ATM interfaces are pleasant for users

4. Results and Analysis

The data is collected from 202 respondents by using the questionnaire given in Table 1. To answer the questionnaire, respondents chosen one the following answers: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. The number of given answers and percentages of being agree, disagree or neither to each questionnaire items are given in the following Table 2. First three questions (Q1, Q2, and Q3) are related to learnability characteristics. Q1 is about the easy understandability of ATMs. Based on results of Q1, 79.7% of respondents agreed that the system is easy to understand from first time to use and 5% of them disagreed. Q2 is about the language used in ATMs. Based on the results of Q2, 90.6% of respondents agreed on language used is simple and understandable and 5.9% of them disagreed. Q3 is about the instructions of ATMs. So, based on the results of Q3, 76.7% of respondents agreed on instructions are visible and easy to learn and 17.8% of them answered as neither agree nor disagree. The next two questions (Q4 and Q5) are related to efficiency characteristics. Q4 is about shortcuts of ATMs. For Q4, results show that 59.4% of respondents agreed that shortcuts were provided for most frequent items and commands and 32.7% neither agreed nor disagreed. Q5 is about transaction speed of ATMs. For Q5, results showed that 75.7% of respondents agreed that speed of transaction is acceptable for them and about 10.9% of them totally disagreed. The following three questions (Q6, Q7, and Q8) are related to readability characteristics. Based on results of Q6, 82.2% of respondents agreed that text color is clear and readable and 7.9% of them disagreed. For Q7; most of respondents, 87.6% of them agreed on font size and style are legible and 5.4% of them disagreed. Also, for Q8, 78.2% of respondents agreed that contrast between background color and text color is high and 5.9% of them disagreed. The

last two questions (Q9 and Q10) are related to satisfaction characteristics. Q9 is about the suitability of ATMs. Based on the results of Q9, 65.8% of respondents disagreed on ATMs are suitable for different users and only 33.2% agreed on this question. Q10 is about the interfaces of ATMs. For Q 10, 67.3% of respondents are pleasant with different ATM interfaces and 25.2% of them neither agreed nor disagreed.

Table 2. Number of given answers and percentages of being agree, disagree or neither to each questionnaire items.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Strongly Agree	71	97	57	39	46	63	69	51	28	40
Agree	90	86	98	81	107	103	108	107	39	96
Neither agree nor disagree	31	7	36	66	27	20	14	32	2	51
Disagree	10	7	11	16	18	16	11	9	95	11
Strongly Disagree	0	5	0	0	4	0	0	3	38	4
Agree or above	79.7%	90.6%	76.7%	59.4%	75.7%	82.2%	87.6%	78.2%	33.2%	67.3%
Neither agree nor disagree	15.3%	3.5%	17.8%	32.7%	13.4%	9.9%	6.9%	15.8%	1.0%	25.2%
Disagree or below	5.0%	5.9%	5.4%	7.9%	10.9%	7.9%	5.4%	5.9%	65.8%	7.4%

After the analysis of the questionnaire results by using Minitab software, Spearman correlation coefficient is used to check if two questions from same categories are correlated or not for different usability characteristics by identifying sample size, N, α whether 0.01 or 0.05, and degrees of freedom, df = N-1 respondents. Note that, for the questionnaire that is given in Table 1, there are 10 questions divided into four categories such as learnability, efficiency, readability, and satisfaction characteristics. From spearman table, when df=201 and α= 0.05, r= 0.138, the outputs of spearman correlation using Minitab software are illustrated in the following Table 3.

Table 3. Spearman Correlation Coefficient for different questions.

Between:	r_{s1} Values: (from Minitab)	r_s value when N=200 when α= 0.05	Significant or not:
Q1 and Q2	0.827		0.827 > 0.138 = significant.
Q1 and Q3	0.915		0.915 > 0.138 = significant.
Q2 and Q3	0.777		0.777 > 0.138 = significant.
Q4 and Q5	0.858	0.138	0.858 > 0.138 = significant.
Q6 and Q7	0.931		0.931 > 0.138 = significant.
Q6 and Q8	0.908		0.908> 0.138 = significant.
Q7 and Q8	0.845		0.845 > 0.138 = significant.
Q9 and Q10	0.851		0.851 > 0.138 = significant.

As result; for learnability characteristic, the correlation between question 1 and 2 is significant because understanding the system is correlated to the language used. For example, if ATM is using simple language and easy to understand the user will easily understand the system; otherwise, user will face difficulty in completing simple transaction. Moreover, questions 1 and 3 are correlated to each other because understanding the system depend on the provided instructions shown on the screen. Also, the used languages and clear instructions, questions 2 and 3, are correlated to each other. For instant, the user will easily understand the instruction if designers provide simple and understandable language. On the other hand, we have two questions related to efficiency characteristics. Since there are more many operations user can use, frequent transactions should be provided in shortcuts to increase the speed of usage. Therefore, one can state that questions 4 and 5 are correlated to each other. In readability characteristics questions, if the color of the text is clear, in optimal size, and legible style that makes the user doing the process in an easy way without wasting time. Also, when the background color is various from the text color that will help the users read the text easier than if they are similar. For example, if the background is white and the text is black it shows a clearly for users. Finally, customers satisfaction, suitability of ATM for different users is correlated with pleasant of users while using the machine. For example, different users as elderly need suitable machines with pleasant interfaces so he/she can easily interact with the machine.

Spearman correlation coefficient is also used to check the relationship between ATM customer satisfaction, such as question 9 and other characteristics as readability, learnability and efficiency by using df=201 and α= 0.05, r= 0.138.

the outputs of spearman correlation using Minitab software for question 9 are illustrated in the following Table 4. As a result, all ATM usability characteristics are correlated to customer satisfaction, Q9.

Table 4. Spearman Correlation Coefficient for Q9.

Between:	r_{s1} Values: (from Minitab)	r_s value when N=200 when α= 0.05	Significant or not:
Q1 and Q9	0.933		0.933 > 0.138 = significant.
Q2 and Q9	0.796		0.796 > 0.138 = significant.
Q3 and Q9	0.912		0.912 > 0.138 = significant.
Q4 and Q9	0.845		0.845 > 0.138 = significant.
Q5 and Q9	0.888	0.138	0.888 > 0.138 = significant.
Q6 and Q9	0.942		0.942 > 0.138 = significant.
Q7 and Q9	0.942		0.942 > 0.138 = significant.
Q8 and Q9	0.895		0.895 > 0.138 = significant.
Q9 and Q10	0.878		0.878 > 0.138 = significant.

To identify the efficiency characteristics of ATMs, the total transaction time, the needed time to complete one transaction such as cash withdrawal or balance check by the ATM user, is measured by using a chronometer from 52 respondents (30 females and 22 males). The age and transaction time details for the respondents are shown in Table 5. It is observed that the mean transaction time for females is 32.71 seconds while it is for males 34.44 seconds. The maximum and minimum transaction times are for females are 79.08 and 15.96 seconds and for males are 70.97 and 16.73 seconds, respectively.

Table 5. Results for efficiency measurements.

	Mean	St. Dev	Min.	Max.
Age	33.69	12.37	17.00	60.00
Transaction time (sec)	33.86	13.79	15.96	79.08

Transaction times for different age groups and for different transactions are shown at Table 6. One can state that elderly people spent more time in using ATM by comparing to younger people.

Table 6. Transaction times for different age groups and different transactions.

Transaction time	Mean	St. Dev	Min.	Max.
Ages between 17-27	25.9	5.89	19.61	40.79
Ages between 28-38	32.41	10.51	15.96	52.12
Ages between 39-49	40.13	12.66	23.33	70.97
Ages between 50-60	46.95	22.11	16.73	79.08
For cash collect	35.99	14.55	15.96	79.08
For balance check	25.92	5.995	16.73	34.45

For data collection, anthropometric dimensions of ATMs for three different banks were collected and shown in Table 7. Figures 2, 3 and 4, show different ATMs in Kuwait with different dimensions and designs.

Table 7. Anthropometric dimensions of different ATMs in Kuwait.

Dimension	First Bank (cm)	Second Bank (cm)	Third Bank (cm)
ATM dimension: height x width	144 x 44	154 x 70	166 x 78
Screen size	23 x 30	25 x 30	23 x 30
Keyboard size	9 x 12	10 x 17	9.5 x 13
Card Slot size	r = 4 (circle)	7 x 9	r = 4 (circle)
Cash Deposit size	3 x 19	3 x 12	3 x 24
Screen Height - From ½ screen to floor	124	115	106

Keyboard Height - From keyboard to floor	102	90	100
Card Slot Height - From ½ card slot to floor	106	110	106
Cash Slot Height - From ½ cash slot to floor	92	93	118

Figure 2. First Bank ATM

Figure 3. Second Bank ATM

Figure 4. Third Bank ATM

These measurements are important for ATM design and installation. As one can see that ATM dimensions and measurements change from one bank to another. Due to different populations and nationalities in Kuwait, there are different anthropometric measurements should be taken into consideration. For this reason, it is essential to know the needed anthropometric dimensions are important to create standards and designs. In addition, to increase customer satisfaction, it's very important to reduce awkward positions of elbow, shoulder, wrist and neck.

5. Conclusions and Recommendation

ATMs have been an important part of our daily life since we are using it for many banking operations such as cash withdraw or balance check. At this paper, evaluation of usability characteristics and the anthropometric dimensions of ATMs in Kuwait are performed. Usability characteristics of ATM are represented as efficiency, readability, learnability and customer satisfaction. In order to evaluate usability characteristics, a questionnaire with ten questions related to the mentioned characteristics are designed. The results of the questionnaire are analyzed by using Minitab Software using Spearman Coefficient Correlation. Spearman Coefficient Correlation was used to check if the questions from same categories are correlated or not. As a result, 66% of respondent disagreed on "ATMs are suitable for different users", which means that people are not satisfied with ATMs design. As for other questions, respondents are happy about ATMs. Also, the efficiency of different ATM users is measured. We have found that elderlies are facing more issues while using ATM. Moreover, comparisons between different categories such as gender, ages and transaction type are analyzed. It is observed that female ATM users spent more time for a transaction and more cautious while using ATM. Based on results one can state that ATM designers are not considering neither the usability characteristics nor anthropometric dimensions of ATM in Kuwait.

After the analysis of the questionnaire results, there is one major problem about the satisfaction of ATM users, more specifically, about the suitability of ATMs for different users. Kuwaiti banks should focus on the ATM user satisfaction by changing some of their ATM interface designs to reduce or remove unnecessary steps during the process to speed up the transaction process. They can provide more shortcuts for frequently used transactions. They can focus cognitive elements of design by providing such as clear and understandable descriptions and messages. Finally, for anthropometric dimensions, ATM designers should consider the population measurements, not only for Kuwaiti but also for majority of the population. For some features such as font sizes, written or audible messages, and language ATM designers should use adjustability feature to serve to wide range of users from different age and

population groups. Due to many different nationalities in Kuwait, ATM designers must provide ATMs with different languages other than Arabic and English.

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