# Modelling the Factors that Influence Mobile Phone Adoption

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## ABSTRACT
Technology adoption models specify a pathway of technology acceptance from external variables to beliefs, intentions, adoption and actual usage. Mobile phone adoption has been studied from a variety of perspectives, including sociology, computer-supported cooperative work and human-computer interaction. What is lacking is a model integrating all these factors influencing mobile phone adoption. This paper investigates technology adoption models as a strategy to match mobile phone design to user's technological needs and expectations. Based on the literature study we integrate three existing technology adoption models and then evaluate the proposed model with interviews and a survey. The contribution of this paper is a model for representing the factors that influence mobile phone adoption.

## Categories and Subject Descriptors
H.1.2 [**User/Machine Systems**]: Human factors, Human information processing, Software psychology; J.4 [Social and Behavioural Sciences] Economics, Psychology, Sociology.

## General Terms
Human Factors, Design, Experimentation.

## Keywords
Mobile phone adoption, technology adoption models.

## 1. INTRODUCTION
Mobile phone adoption and usage enjoyed dramatic and almost unprecedented success as far as the history of technology adoption goes [23]. However, there are signs that users are becoming frustrated by the unconstrained addition of features and services to mobile phones guided by the assumption that 'more is better' [40]. We argue that user frustration and resistance will grow since it is seated in the basic fact that human cognition is constrained, while technology development is not [13].

Mobile phone adoption has been researched from a variety of perspectives, for example, sociology [16, 33], computer supported cooperative work (CSCW) [7, 17], information systems [27, 45] and from human-computer interaction (HCI) [21, 25]. What is, however, lacking is a model integrating the factors that influence mobile phone adoption.

Technology adoption, in general, has been widely studied and several models of technology adoption has been proposed and tested [10, 46, 60]. This paper investigates technology adoption models as a strategy to match mobile phone design to user's technological needs and expectations. Based on a review of the mobile context and technology adoption models the first part of the paper proposes a model representing the factors that influence mobile phone adoption. The proposed model is evaluated by means of an experiment and structured interviews, and the latter part of the paper reflects on this experiment and its findings.

The remainder of section 1 expands on the purpose and motivation of this paper.

### 1.1 Purpose and Motivation
Mobile phone interaction lies at the intersection of the infrastructural, social and cultural factors that determine the user's experience of mobile phone interaction [21, 58]. Past research has focused on mobile phone adoption and usage from a variety of divergent perspectives. For example, in sociology the user has been researched as a social entity [16, 33], in information systems the focus has been on the user as an economic entity [34], while the field of HCI has focused on the usability issues of mobile devices [21, 24].

Technology adoption models can contribute towards anticipating future needs in a complex and ever-evolving scenario, but existing research on mobile phone adoption focuses mostly on a specific aspect of technology adoption. Examples include studies by Kleijnen et al. [27] on wireless finance, a study on mobile Internet [51] and a study on exploring cultural differences in mobile phone adoption [55]. Kwon and Chidambaram's model [28] distinguished between intrinsic and extrinsic motivation in mobile phone use, but although it provides a more general model it is limited by the fact that it does not include certain pertinent aspects, for example, mobile phone infrastructure, which has been found to be essential in mobile phone use [27, 58].

This paper aims to integrate the contributions of many of these studies and should therefore be of interest to a wide audience.

### 1.2 Investigative Stance
The epistemology is primarily positivistic. The theoretical framework reviews the mobile phone context as well as some


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existing models for technology adoption. Based on this literature review a new model is proposed which incorporates factors from existing models while focusing on the mobile context. This new model is tested quantitatively (using surveys) as well as qualitatively (using interviews). The qualitative study contributed insight in interpreting the statistical analysis and refining the model but the approach is essentially quantitative.

## 1.3 The Scope and Approach of this Paper

The scope of this paper is limited to addressing mobile phone adoption within the wider field of technology adoption. We studied and analysed literature on the mobile phone context and mobile phone adoption to form an understanding of the concepts, theories and models that influence mobile phone adoption. Based on this review we propose a mobile phone adoption model and then evaluate the model by means of a survey and interviews. The participants in the survey were all university students between the ages of 20 and 35, but the participants in the interviews were from different age groups and occupations.

## 1.4 Research Design

The research reported on in this paper focuses on two sub-questions:

- What are the factors that influence mobile phone adoption?
- How can these factors be represented?

The research design consisted of three phases. The first phase was explorative and consisted of a literature study of the context of the mobile phone user as well as the factors that influence mobile phone adoption. The findings from the literature study are our response to the first research sub-question. In the second phase these findings were integrated to propose the *mobile phone technology adoption model* (MOPTAM). This model is our response to the second research sub-question. The third phase is the qualitative and quantitative evaluation of MOPTAM. The model is also compared to existing technology adoption models in order to motivate the contribution of the study.

## 1.5 Organisation of this Paper

This paper is organised as follows. Section 2 discusses the context of the mobile phone user and the limitations inherent to mobile phone usage. Section 3 addresses various adoption models as point of departure for modelling mobile phone adoption. Thereby sections 2 and 3 present the theoretical foundation for this study. Section 4 integrates selected technology adoption models (from the literature review) to propose a new model (MOPTAM) for representing the factors that influence mobile phone technology adoption. Section 5 describes the evaluation of MOPTAM and suggests refinements to the first version of MOPTAM. Section 6 reflects on the contribution of this paper by comparing MOPTAM to other technology acceptance models, and also some notes on researching technology adoption. Section 7 concludes.

# 2. MOBILE PHONE CONTEXT

In a traditional computing environment both the user and the computing equipment are stationary, the use of the equipment often takes place in the same, familiar location and the social context remains constant. Ruuska-Kalliokulju et al. [47] distinguish mobile devices from stationary office-based systems in the following ways:

- The physical, social, and cultural contexts of a device influence the way in which the device is operated via its user interface.
- The ability to use the device anywhere and anytime is one of the major factors that distinguish mobile personal devices from stationary office-based devices.
- Applications and services are the main thrust from the end-user perspective.
- Communication and personal computing devices get more task-specific, increasing the need for inter-device communication as the only way to simplify the task of the user in the most transparent way possible.

In the mobile context, the user and the equipment can be mobile and the surroundings may therefore change constantly. This opens up fundamental differences in the context of use between the traditional computing environments and information appliances such as mobile phones [20]. Four different aspects of mobile phone context have been noted [21, 25] in past research: physical context as discussed in section 2.1, social context as discussed in section 2.2, mental context as discussed in section 2.3 and the technological context as discussed in section 2.4.

## 2.1 Physical Context

The physical context denotes the physical constraints of the usage environment [21, 25]. We need to consider both the physical limitations of the device as well as the limitations of the surrounding physical context. Screen size, memory, storage space, input and output facilities are more limited in handheld devices such as mobile phones [6, 62], while sound output quality is often poor with restricted voice recognition on input [14]. While screen sizes will improve in resolution and colour support, they will remain small due to the need for portability [14].

Furthermore, the mobile scenario supports deployment in a wide range of physical environments to support users in diverse tasks [8, 22]. The physical context may vary in terms of location, illumination, background noise, temperature and weather, and even vary continuously. Users may be mobile during the task, which means that they may not be able to look at the screen continuously. They may have to operate the device with only one hand and possibly no hands, as with MP3 players or hands-free phone sets [62]. The working environment of the mobile user is often far from ideal and they are not guaranteed access to other sources for supporting the task (e.g. reference manuals) as the mobile device may be their only resource at that moment [14]. We will not address the physical context issues in this paper.

## 2.2 Social Context

Social context concerns the social interaction involved and enabled by using the mobile device [21, 25]. Mobile phones can be used anytime and almost anywhere, allowing people to converse according to choice rather than according to location[16]. When using a mobile phone a person is simultaneously in two spaces – the physical space they occupy and the virtual space of the conversation [41]. This introduces new issues of privacy and discretion as interaction can take place in public surroundings or other places where it may be inappropriate to communicate [37]. Mobile communication can utilize only a narrow bandwidth of the total human

communication spectrum [25], but these limitations are steadily being overcome by new innovations, e.g. adding visual images of the conversationalist and the development of sensory fabrics that make tactile feedback possible [48, 49].

## 2.3 Mental Context

The mental context relates to aspects of the user's understanding of the mobile handset usage model [25]. Mobile phones are acquired by a widespread population of users who will probably not have any formal training in operating them and consider them as devices to be used rather than computers to be maintained [14]. Furthermore, device vendors consolidate multiple functions into a single device. The mobile user has to handle interleaving of multiple activities and multiple public faces, previously unknown when only a landline or a stationary computer was used [44]. Cognitive demands are exacerbated due to physical constraints on size, bandwidth and processing power, which restricts the communication bandwidth and places extra demands on the user's attention [19].

## 2.4 Technological Context

The technological context refers to the mobile infrastructure including the networks available, services provided and features of the mobile device [21]. The development and implementation of cellular communication infrastructure varies across countries which means the technological context is determined by the network as well [38]. Network coverage and communication bandwidth can make communication or network service access inconveniently slow and unreliable, or completely impossible Infrastructural barriers to communications access are especially prevalent in developing countries [56]. Hardware, software, network services, and service agreements have been identified as factors affecting comfort with mobile phones [42]. Tobin and Bidoli [54] list the following as key factors in holding back adoption: high bandwidth cost, regulatory uncertainty, market uncertainty, and quality of service concerns.

The mobile context poses unique challenges and opportunities in terms of mobility, portability and personalisation [63], and yet there is an overlap between the factors influencing mobile phone adoption and technology adoption in general [28]. Therefore we will now consider models for technology adoption as background to proposing a model for mobile phone adoption.

# 3. TECHNOLOGY ADOPTION MODELS

Technology adoption has been studied from different fields. In this section we review four technology adoption models as background, before proposing a technology adoption model for mobile phones in section 4. Rogers proposed the innovation diffusion model from the field of sociology as discussed in section 3.1. Section 3.2 discusses the Technology Adoption Model (TAM) [10], which has been the basis for many studies in the past. Section 3.3 discusses the Unified Technology Adoption Model (UTAUT) [60], while section 3.4 discusses the application of technology adoption models to mobile technology.

## 3.1 Rogers' Diffusion Model

The sociologist Rogers developed the innovation diffusion model to explain how an innovation diffuses through a society [25, 46]. The innovation diffusion model has been used extensively to explain the acceptance or rejection of IT innovations in an organisation or society [55].

According to Rogers [46]: 'An innovation is an idea, a practice, or object that is perceived as new by an individual or another unit of adoption' [46:36], while 'Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system' [46:35]. Rogers' adoption/innovation model divides adopters of innovations into five categories. Each adopter group in the model represents a unique psychographic profile based on the idea that some individuals are more open to adoption than others are. The categories can be described as follows [25, 46]:

- The innovators are the 'techies', the experimenters who have technology as a central interest in their lives and pursue new technology as soon as it appears, no matter what its function is. Innovators make up approximately 2.5% of the population.
- The early adopters are the 'visionaries' who blend an interest in technology with a concern for significant professional problems and tasks. Early adopters make up approximately 13.5% of the adopter population.
- The early majority are the 'pragmatists'. Although fairly comfortable with technology in general, their focus is on concrete professional problems rather than on the tools (technological or otherwise) that might be used to address them. They make up approximately 34%, which is the first half of the mainstream.
- The late majority are the conservatives or 'sceptics'. They share the attitude of the early majority, though being less comfortable with technology. The late majority make up approximately 34%, which is the latter half of the mainstream.
- The laggards are the most likely never to adopt at all. Laggards make up the last approximately 16% of the potential adopter population.

A successful innovation will be adopted in this order, beginning with the innovators, followed by the early adopters, the early and late majority, and perchance the laggards. A new technology is best focused on innovative adopters since they do not insist that the technology should have a track record, as they value a product on the basis of the latest technology built into it [31]. Given the rapid spread of mobile phone adoption, the innovation of mobile phones is already being adopted by the late majority and the laggards. This means that the target mobile phone customer demands value and will become even more critical in considering all relevant factors before adopting. Rogers [46] did not apply his model to information technology, but that has been done since by Kiljander [25]. Other models that deal with technology diffusions are the Bass diffusion model [3], the product life cycle by Levitt and the Positioning model by Trout and Reis [1].

## 3.2 Technology Acceptance Model

Technology Acceptance Model (TAM) proposes that beliefs about usefulness and ease of use are essential elements in determining user attitude towards adopting a new technology [10, 27, 34].

The theoretical foundation for TAM is based on Fishbein and Ajzen's theory of reasoned action (TRA) model [15]. TRA is widely studied in social psychology where it is used to explain

why people behave as they do in situations of 'reasoned action' by identifying causal relations between beliefs, attitudes, intentions and behaviour [28, 43]**.** TAM is a special case of TRA for modelling technology adoption in organisations [43]. TAM, as illustrated in Figure 1, includes six concepts [11, 34]:

- External variables (EV), such as demographic variables, influence perceived usefulness (PU) and perceived ease of use (PEU).
- Perceived usefulness (PU) is defined as 'the extent to which a person believes that using the system will enhance his or her job performance' [59].
- Perceived ease of use (PEU) is 'the extent to which a person believes that using the system will be free of effort' [60] .
- Attitudes towards use (A) is defined as 'the user's desirability of his or her using the system' [34]. Perceived usefulness (PU) and perceived ease of use (PEU) are the sole determinants of attitude towards the technology system.
- Behavioural intention (BI) is predicted by attitude towards use (A) combined with perceived usefulness (PU
- Actual use is predicted by behavioural intention (BI).

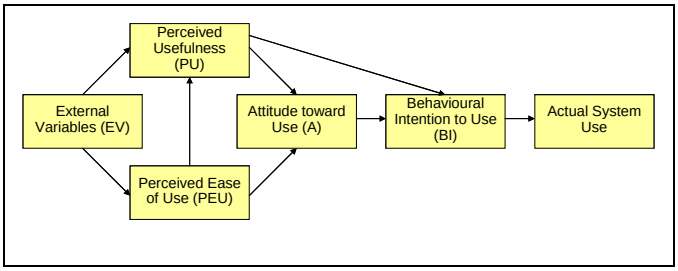


**Figure 1 : Technology Adoption Model (TAM) [11]**

While TAM is mainly applied to explaining the adoption of technology within organizations, the constructs of the model are meant to be fairly general and universal to different types of computer systems and user populations [34]. Over the years several researchers have used TAM to explain the attitudes and behaviours of information system users, but TAM has also been criticised for its shortcomings. For example, the attitude towards adopting a technology is believed to be the result of personal and social influences, and the fact that TAM does not account for social influence is a limitation [34]. Several categories of modifications have been proposed to TAM to counteract some shortcomings, including the following:

- Incorporation of factors suggested by other theories for improving TAM's predictive power. For example, including social influence as proposed by TRA and supported by studies involving social influence [34] and the inclusion of prior factors, such as prior usage and experience [26].
- The incorporation of contextual factors such as age, gender and technological development. Urbaczewski et al. [55] propose the addition of culture as a variable that might determine the success or failure of an innovation.
- Differentiation of the *actual system use component* to measure number of calls, length of calls and the type of use (personal or work-related) [28].

Meso et al. [35] found that in addition to the traditional TAM factors of usefulness and ease of use, easier access and greater reliability of the technology contribute significantly towards greater confidence and hence greater use of mobile information and communication technology. TAM is based on the assumption of the 'free' availability of basic infrastructure and organisational context for the adoption of new technology [34]. If this is not the case, as with mobile phone usage, facilitating conditions, such as infrastructure, become important in technology adoption. The findings of Uzoke et al. [56] support the fact that infrastructural and management factors exert considerable influence over the organizational decision to adopt e-commerce. The inclusion of facilitating conditions as determining factor is also proposed by Venkatesh et al. [60],as described in section 3.3.

## 3.3 Unified Theory of Acceptance and Use of Technology Model

Venkatesh et al. [60] developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model to explain user intentions to use an information system and subsequent usage behaviour. UTAUT was developed through a review and consolidation of the constructs of the following models: theory of reasoned action [15], technology acceptance model [10], motivational model [12], theory of planned behaviour [2], a combined theory of planned behaviour/technology acceptance model [50], model of PC utilization [53], innovation diffusion theory [36] and social cognitive theory [9]. UTAUT, as depicted in Figure 2, proposes performance expectancy, effort expectancy, social influence and facilitating conditions as the four key constructs that determine usage intention and behaviour. Gender, age, experience, and voluntariness (i.e. the degree to which use of the innovation is perceived as being of free will) are mediating factors in the impact of the key constructs on usage intention and behaviour. An important contribution of UTAUT is to distinguish between mediating factors and determining factors.

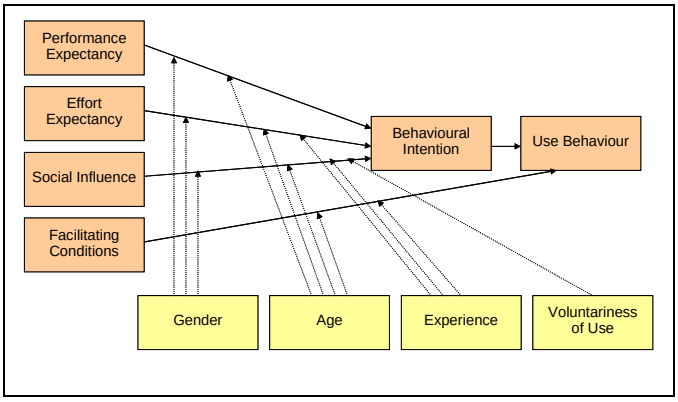


**Figure 2: Diagrammatic representation of UTAUT [60].**

## 3.4 Models Applied to Mobile Technology

Looking specifically at technology adoption and mobile phones, several studies were found that applied technology adoption models to mobile phones or mobile phone features, for example:

- Lee et al. [29] studied user acceptance of the mobile Internet and found that social influence and self-efficacy variables significantly affect perceived usefulness and perceived ease of

use, respectively, while perceived ease of use and perceived usefulness influence actual usage frequency.

- Pedersen [43] studied the adoption behaviour of early adopters of mobile commerce services. According to his findings, the TAM model should be extended to include both subjective norm and behavioural control norm, in order to improve model fit and add explanatory power. Behavioural control includes two components: resources, e.g. time, and financial resources, and self-efficacy. The latter refers to the users' confidence in their own ability to enact behaviours or use a service. Behavioural control relates to both intention to use and actual use.
- Teo and Pok [52] studied the adoption of WAP-enabled mobile phones amongst Internet users and found that attitudinal and social factors, like perceptions of relative advantage (usefulness), risk and image, play a significant role in influencing intentions to adopt a WAP-enabled mobile phone.
- Kleijnen et al. [27] investigated consumer acceptance of wireless finance and found that the variables of perceived cost, system quality and social influence correlated significantly with attitude towards use. The variables of age, computer skills, mobile technology readiness and social influence proved to have moderating effects in the mobile phone usage context.
- Roberts [45] studied factors in corporate adoption of mobile phones and found security, reliability, digital standards and web connectivity to be the most important technology adoption factors, with customer service the most important non-technology factor.
- Kwon and Chidambaram [28] found that perceived ease of use significantly affected users' extrinsic and intrinsic motivation, while apprehensiveness about cellular technology had a negative effect on intrinsic motivation. Whereas the other studies listed above mostly focused only on the influence of single variables, their study integrated a number of variables. Kwon and Chidambaram proposes a model for mobile phone adoption and use which includes the following components: demographic factors, socio-economic factors, ease of use, apprehensiveness, extrinsic motivation (perceived usefulness), intrinsic motivation (enjoyment, fun) social pressure and extent of use. The limitation of this model is that it does not represent infrastructural factors.

Two of the findings from these studies regarding mobile phone adoption have special significance for our research:

- The finding that social factors influence mobile phone adoption [43, 52] means that we need to control for social and cultural (peer group) influence.
- The importance of infrastructural factors in mobile phone adoption [27] means that infrastructural factors must be taken into account during the design of this research, e.g. selection of participants with access to similar infrastructure, etc.

# 4. PROPOSED MOPTAM

Drawing upon the mobile context as discussed in section 2 and the studies on technology adoption models as discussed in section 3, Table 1 gives a summary of the variables we found to be most relevant to mobile phone adoption. The leftmost column lists the factors, the next three columns shows which model included it, and the last column gives evidence of studies to support the importance in the mobile phone context.

**Table 1: Variable influencing mobile phone adoption**

| Models / Factor | TAM | UTAUT | Kwon and Chidambaram | Mobile context |
|---|---|---|---|---|
| Social influence | No | Yes | Yes | [16, 29] |
| Perceived ease of use | Yes | Yes | Yes | [11, 28, 60] |
| Perceived usefulness | Yes | No | Yes | [11, 28, 60] |
| Facilitating conditions (infrastructure) | No | Yes | No | [27, 45] |
| Attitude | Yes | No | No | [16] |
| Behavioural intention | Yes | Yes | Yes | [11, 28, 60] |
| Actual system use | Yes | Yes | Yes | [11, 28, 60] |
| Demographic | External variables | No | Yes | [27, 43] |
| Socio-economic | External variables | No | Yes | [5, 18] |
| Personal | No | No | No | [21, 63] |

Based on the literature overview in sections 2 and 3, the factors most relevant to mobile phone technology adoption are summarised in Table 1. The Mobile Phone Technology Adoption Model (MOPTAM) is then proposed as depicted in Figure 3. The model is described by discussing the determining factors in section 4.1 and the mediating factors in section 4.2. Variables not mentioned in these sections, including omitted or grouped variables, will be discussed in section 6.

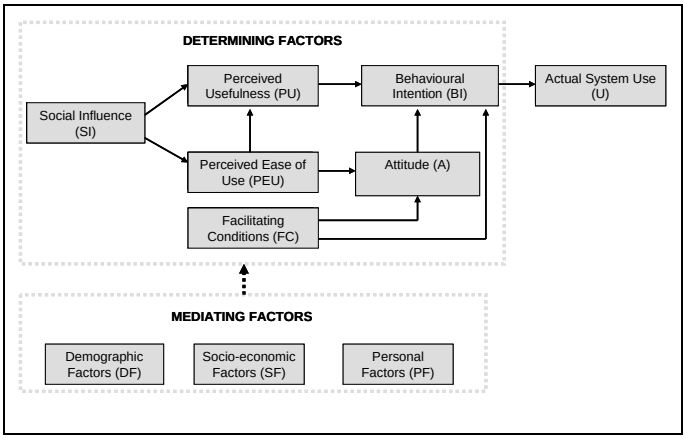


**Figure 3: Proposed MOPTAM**

## 4.1 Determining Factors

As illustrated in Figure 3 the following six determining factors have been identified:

- Social influence (SI) (referred to as subjective norm (SN) in the TRA) encompasses the social pressure exerted on the individual by the opinions of other individuals or groups. In MOPTAM, social influence also includes the cultural influences as recommended by Urbaczewski [55]. SI influences perceived usefulness (PU) and perceived ease of use (PEU).

- Facilitating conditions (FC) refer to the mobile phone infrastructure. This includes variables such as system service, system quality, cost of the handset and cost of the service as determined by the business model of the service provider [60]. Facilitating conditions influences attitude (A) and behavioural intention (BI).
- Perceived usefulness (PU) is the extent to which a user believes that he or she will benefit from using the mobile phone [10, 60]. Perceived usefulness influences behavioural intention (BI).
- Perceived ease of use (PEU) is the extent to which a user believes that using the mobile phone will be free of effort [10, 60]. Perceived ease of use influences perceived usefulness (PU) and attitude (A).
- Attitude (A) is defined as the individual's positive or negative feelings about enacting a target behaviour [56]. Attitude influences behavioural intention (BI).
- Behavioural intention (BI) is the intention to enact the behaviour of using the phone [10, 60]. Behavioural intention influences actual system use (U).

## 4.2 Mediating Factors

As illustrated in Figure 3, three mediating factors have been identified as influencing mobile phone usage:

- Personal factors (PF) refer to personal preference and user's beliefs about the benefit of technology including relative advantage, compatibility, complexity, trialability, observability, image and trust [4]. In our study the personal factor influence was based only on the response to technological orientation (as described by Roger's categories [46]).
- Demographic factors (DF) are variables like age, gender, education and technological advancement (i.e. the person's knowledge of technology and ability to use technology) [27, 43].
- Socio-economic factors (SF) are described by variables like job status, occupation and income [5, 18].

The external variables component from TAM is not included as such, because this has been differentiated into social influence, demographic, socio-economic and personal factors.

# 5. Evaluation of MOPTAM

According to Olivier [39] a model should be evaluated against the criteria of simplicity, comprehensiveness, generality, exactness and clarity. MOPTAM was evaluated on two levels. A qualitative evaluation was done in one-to-one interviews to 'measure' the model against proposed the criteria. This was followed by a quantitative evaluation aimed at verifying the importance of the components of the model and the relationships between the components of the model, i.e. between the different determining and mediating factors. The results of the qualitative evaluation are briefly discussed in section 5.1 and the results of the quantitative evaluation in section 5.2.

## 5.1 Results of Qualitative Evaluation

The 6 participants for the interviews were selected with a gender balance, two each from the age groups 20-29, 30-39, and 40-49. The model was discussed and evaluated according to the criteria of simplicity, comprehensiveness, generality, exactness and clarity as noted by Olivier [39]. According to the results from the evaluation interviews the model was found to be simple. To test completeness participants were requested to list the factors that influence their mobile phone use, before showing them the model. No one listed a factor that was not accounted for by the model. In some cases they used different terms but when presented with the model they could place the factors under one of the existing categories, and therefore the model is considered to be comprehensive. There were some suggestions about improving clarity by colour coding the determining factors and the mediating factors appropriately. The model was found to be general in the sense that all age groups are influenced by the factors noted, but the strength of the influence varied between age groups. For example, everyone found the price of the service important, but for people under the age of 30 it was more important than for the older age groups. The exactness of the model was not evaluated.

## 5.2 Results of Quantitative Evaluation

To evaluate MOPTAM qualitatively a questionnaire driven survey was conducted aimed only at the age group 20-30. The participants in the validation survey were 59 undergraduate university students from a South African university, 39 (66%) of whom were male, 16 (27%) female, while 4 (7%) did not indicate their *gender*. Considering *age*, 95% of the participants were between 18 and 30 years of age. The remaining 5% were under the age of 35, with a mean age of 23. All questionnaires are available in Van Biljon [57]. Participation was optional and anonymous.

The statistical evaluation focused on verifying the importance of the components and the relationships between the components. Section 5.2.1 discusses the findings on demographic and personal factors whilst section 5.2.2 discusses facilitating conditions.

### *5.2.1 Demographic and personal factors*

The participants in this study were selected to be similar in age, education and technological development by selecting computers science and information systems students.

- The demographic variables were captured to check that this was true, but the only demographic variable used in the analysis is technological advancement (Tech_A).
- The personal variables are represented by technological orientation (Tech_O), where participants (based on their responses) were classified according to Rogers' categories.

**Table 2: Demographic and personal factors (Pearson correlation (two tailed))**

| Factor | Tech_A | PEU | Tech_O | Use | A |
|---|---|---|---|---|---|
| Tech_A | 1 | | | | |
| PEU | .480** | 1 | | | |
| Tech_O | .389** | .661** | 1 | | |
| Use | .274* | .216 | .105 | 1 | |
| A | -.010 | .009 | .053 | .067 | 1 |

A multi-variant correlation (Pearson) was done between factors representing *determining* components (perceived ease of use (PEU), perceived usefulness (PU), attitude (A) and actual usage (intensity and breadth) (U). The *mediating* variables identified are technological advancement (Tech_A) from demographic factors

and technological orientation (Tech_O) from personal factors. Socio-economic influence was not tested as the students were selected to be in the same socio-economic group.

Table 2 depicts the results (the significant values at 0.05 level are indicated by a * and those at 0.01 level by a **).

- Significant positive correlations were found between technological advancement (Tech_A) on the one hand and perceived ease of use (PEU), technological orientations (Tech_O) and actual usage (U), on the other. This implies that people who are technologically advanced were found to be technologically orientated, find perceived ease of use important other than than people who are not technologically advanced. Technological advancement is a demographic variable and therefore this result confirms that demographic variables can influence perceived ease of use (PEU).
- Significant positive correlations were found between perceived ease of use (PEU) and technological orientation Tech_O. Technological orientation is a personal factor and therefore this indicates that personal factors can influence perceived ease of use (PEU). The positive correlation of perceived ease of use with both technological advancement and technological orientation respectively can possibly be ascribed to the fact that technologically advanced people have a certain expectation of ease of use due to their experience with technology.
- *No significant correlation was found between attitude towards use and any of the other determinants.* This corresponds with the qualitative observation that most people between the ages of 10 and 70 use mobile phones. Dissatisfaction with the perceived ease of use, or the usefulness, does not deter people from using the phone. This finding supports the validity of omitting the attitude (A) component, which is a component of TAM, from MOPTAM. This omission of attitude as a separate component is also confirmed by being omitted from UTAUT.

The factor perceived usefulness (PU) was omitted from Table 2 as no significant correlations were found between PU and any other component. Despite the lack of evidence about the influence, this factor was retained for further investigation (as described in section 5.2.2).

### *5.2.2 Facilitating Conditions*

Table 3 depicts the correlations between facilitating conditions (infrastructural variables) and the determinants of perceived ease of use and perceived usefulness:

- Over and above technological orientation and technological advancement, as discussed above, perceived ease of use (PEU) is related to system cost and, to a lesser extent, system service. This confirms the influence of personal factors (PF) like technological orientation (Tech_O), demographic factors (DF) like technological advancement (Tech_A), and facilitating conditions (FC) on perceived ease of use (PEU).
- Perceived usefulness (PU) is correlated with system cost and system quality. This confirms the influence of facilitating factors (FC) on perceived usefulness (PU).
- Technological orientation (Tech_O) is correlated with technological advancement (Tech_A) and system service. This suggests that people with a high score on the personal attribute of technological orientation (typically innovators according to Rogers Innovation Diffusion Model) are inclined to be technologically advanced and find system service important.
- Technological advancement (Tech_A) is correlated with system service, system cost and system quality. This suggests that people with a high score on technological advancement (Tech_A) find system service, system cost and system quality important. This confirms that demographic factors (DF) influence facilitating conditions (FC), as represented by these infrastructural variables.
- System service is correlated with system cost. This suggests that people who find system service important also care about system cost. Both are facilitating conditions (FC).
- System cost is correlated with phone cost and system quality. This suggests that people who find system cost important also care about phone cost and system service. This suggests that the influence of infrastructural variables could be related.

A tally of the significant correlations (vertically and horizontal added for each factor) produces the following totals: System cost: 6, Technological advancement: 5, System service: 4, Perceived ease of use: 4, Technological orientation: 3, System quality: 3, Perceived usefulness: 2, Phone cost: 1. This result underlines the importance of infrastructure (facilitating factors) in mobile phone adoption as supported by Kleijnen [27]. Given the selection of students (who are responsible for their own phone bills) as participants, the importance of system cost is understandable. The cost of the phone is seen as least important, since a mobile phone is often acquired as part of a contract where the phone is not paid for separately. In summary it can be said that the following has been confirmed:

- Demographic (DF) and personal factors (PF) can influence perceived ease of use (PEU).
- Demographic (DF) and personal factors (PF) can influence facilitating conditions (FC).
- Facilitating conditions (FC) can influence perceived ease of use (PEU) as well as perceived usefulness (PU) (this was not depicted in UTAUT).
- Facilitating conditions (FC) can influence actual use (the high priority facilitating factors have is depicted in Table 3).

These findings support the inclusion of personal factors (PF) in MOPTAM, as well as the recognition of the influence of infrastructure (facilitating conditions (FC). Based on the findings of the evaluation the proposed MOPTAM is revised to omit attitude (A) as a component. The links indicating the influence of facilitating conditions (FC) on perceived ease of use (PEU), perceived usefulness (PU) and actual use are added. Appropriate colour coding is introduced to distinguish better between the components. The revised model is depicted in Figure 4.

## 6. DISCUSSION

MOPTAM was synthesized from TAM, UTAUT and the model by Kwon and Chidambaram, and refined by integrating findings of other studies on mobile phone adoption (as summarized in Table 1). The contribution of proposing a new model lies in the fact that it is different from the models listed above in the following ways:

**Table 3: MOPTAM and infrastructural variables**

| | | | | Personal Factor | Demographic Factor | Facilitating Conditions | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PEU | PU | Tech_O | Tech_A | System Service | System Cost | Phone Cost | System Quality |
| | PEU | 1 | | | | | | | |
| | PU | .241 | 1 | | | | | | |
| Personal Factor | Tech_O | .661** | .220 | 1 | | | | | |
| Demographic Factor | Tech_A | .480** | .245 | .389** | 1 | | | | |
| Facilitating Conditions | System Service | .356** | .159 | .358** | .294* | 1 | | | |
| | System Cost | .286** | .334** | .154 | .352** | .430** | 1 | | |
| | Phone Cost | .016 | .248 | -.124 | .113 | .162 | .456** | 1 | |
| | System Quality | .189 | .256* | .177 | .366** | .225 | .393** | .108 | 1 |

- MOPTAM differs from TAM in the refinement of the external variables (as mentioned in section 4.1), the inclusion of social influence and the adaptation to the mobile context, which includes the addition of facilitating conditions.
- MOPTAM differs from the model by Kwon and Chidambaram by including facilitating conditions as a factor influencing mobile phone use.
- MOPTAM is similar in structure to UTAUT but differs in the selection of mediating factors, the influence of external variables, and the fact that UTAUT is a general technology adoption model while MOPTAM focuses on mobile phones.
- MOPTAM differs from Rogers' model in that it acknowledges the influence of external variables. Rogers' model assumes that users behave in a rational way by weighing positive and negative factors and does not acknowledge the influence of broader social processes [32].

The innovation diffusion model influenced the addition of personal factors to mediating factors. Using Rogers's categories in the survey, it was established that people with similar socio-economic and demographic factors differ in Roger's categories of technological orientations. This was confirmed in the interviews. Personal factors are therefore included as a mediating factor due to the evidence that the personal attribute of technological orientation influenced mobile phone usage. According to Legris [30] research in technology adoption has been limited by the choice of participants, the type of applications and the fact that self-reported, rather than actual use, has been measured in many cases. In response to these limitations it can be said that:

- Age and technological advancement influences mobile phone usage [28], and therefore participants in surveys have to be as homogeneous as possible in age and technological advancement in order to compare other influences. The choice of students as participants was further justified by the study of King and Jun who confirmed the value of students as surrogates for professionals in TAM studies [26]. However, it has to be acknowledged that the selection of participants limit the applicability of the model to the age and socio-economic group of students between the ages of 20 and 30. Further research is needed to validate the findings and the applicability of MOPTAM to other age and socio-economic groups. Furthermore, the sample size of 59 could be argued to be small for a statistical study.
- The type of application is not an issue as this study focuses on mobile phones.
- The use of self-reporting can arguably lead to measuring the variance in self-reported use, rather than actual system use, and this should be noted as a limitation. However, the personal nature of mobile phones makes it very difficult to measure actual system use in any other way than self-reporting. Furthermore Yi et al. [61] found a strong causal link between behavioural intention to use and actual use, which means that students intentions (as measured) should strongly influence actual use.

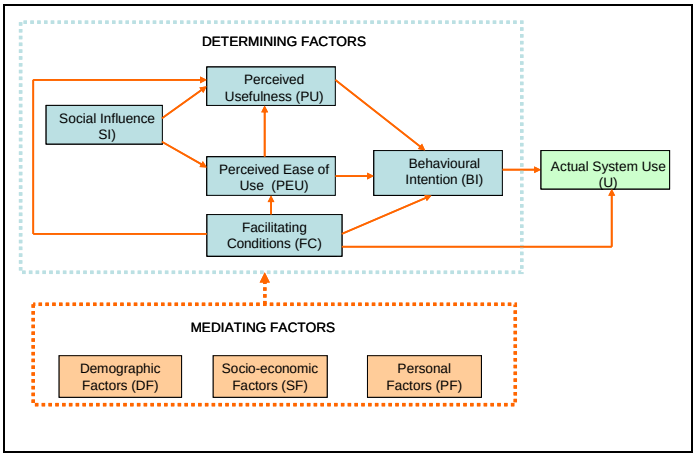


**Figure 4: Final MOPTAM**

## 7. CONCLUSION

The main contribution of this paper is the proposed model to represent the factors that influence mobile phone adoption. The model combines the influence of mediating factors (personal, demographic and socio-economic) and determining factors (social influence, perceived ease of use, perceived usefulness, and facilitating conditions) on behavioural intention. Given the personal nature of mobile phones and the individual's vulnerability to infrastructural factors, the effect of infrastructural and personal factors on mobile phone usage has been highlighted as the most significant differences between MOPTAM and general technology adoption models. Further research is needed to test MOPTAM with other demographic and socio-economic groups. This paper also makes a contribution on uniting research from sociology, information systems and HCI. However, the

models discussed and incorporated in MOPTAM are mostly deterministic and there is a need for taking a more complex approach towards mobile phone adoption and usage by including qualitative factors such as different world views and technological frames of reference.

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