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User acceptance of mandated technology: An analysis of the role of moderating factors

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Abstract

This research assesses how the characteristics of age, gender and personality influence user acceptance of a software system in a mandated industrial setting. Guided by a conceptual framework based on the Unified Technology Acceptance and Use Theory (UTAUT) and research into the influence of personality, our study targeted an engineering team within a large medical device multinational organisation, who are officially required to use a specific software system. We collected empirical data from them to assess if age, gender and personality have a measurable impact on their use behaviour. The results of this study are discussed and recommendations for future research opportunities are presented.

Keywords: Technology acceptance ; case study analysis, mandated technology ; empirical analysis

1. Introduction

Technology systems are practically ubiquitous; they pervade almost all aspects of our professional and private lives. Morris et al [1] tell us that almost 50% of all new capital investment goes to information technology. However,

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it seems that such investments are not exploited to their full advantage. Research suggests that 50% of all IT initiatives are underused or not used at all. It seems that there is still much to be learned about how users interact with, and make use of, information technology. User acceptance of technology is therefore a very relevant research arena and an arena that is well established, building on work done in sociological, psychological as well as social behavioural schools of thought. While early models struggled to deliver reliable results, the emergence of models, such as the Technology Acceptance Model [3], provided reliable, economical if somewhat techno-centric approaches. More recent research has focused on improving the predictive ability of the user acceptance models by both combining and augmenting models with moderating and contextual elements such as use context, age, gender and personality traits. This augmentation introduces humanist factors to user acceptance of technology [3, 4]. This trend reflects a return to the sociological and psychological origins of user acceptance theory.

However, research has largely ignored what Saleem [4] calls "*dispositional factors*" and there is a lack of empirical evidence in this domain to guide our understanding. The relationships between these dispositional, contextual and moderating factors are complex but there is a growing body of evidence to suggest that these influences significantly increase the predictive power of user acceptance models. Recent research has focused on how personality, age and gender interact [5, 6, 7, 8]. This body of research suggests that interactions between age, gender and personality traits are themselves contextual in that the patterns of behaviour and the strength of the factors on user acceptance vary. An interesting trend in the research suggests that while gender differences exist in "older" subjects the differences lessen for subjects in their twenties and thirties.

Research in technology acceptance is characterised by several other limitations. Firstly, the majority of studies are typically conducted in university or consumer related settings, while research in industrial organisational settings is very limited [7, 9, 10]. Secondly, research tends to focus on situations where adoption of the systems is voluntary not mandatory. Conversely in most organisational settings adoption is, to a large degree, mandatory. Thirdly, previous research suggests that the role played by age and gender in user acceptance models is changing for younger study subjects, potentially suggesting increasingly homogenised behaviour. However, the literature does not address how the acceptance models should be updated to account for this emergent change. Fourthly, chronological age has been used as a measure in the vast majority of studies yet Hong et al [11] suggest convincingly that cognitive age is a more accurate measure of the impact of age on user acceptance. Finally, it is widely accepted in the literature that the impact of personality is inadequately researched [6, 7, 8, 10, 12]. Any previous research has centred on the Five Factor Model of personality traits, known as "the big five". However, organisations tend to use well established personality measurement systems focused on preferred styles and team interaction such as DiSC models (which profile primary personality types of dominance, influence, steadiness or conscientiousness) as well as behavioural based inventories such as Belbin's team role analysis. It is not known if these methods provide any useful insight into the user acceptance of technology in an organisational setting.

There is a clear need to research the impact of age, gender and personality in an industrial setting where the information technology setting is mandatory. In light of this, this research aims to test the theory that behaviour associated with user acceptance of technology homogenises for males and females in favour of personality traits in an industrial setting where the use of the technology is officially required or mandated. The study uses the Unified Technology Acceptance and Use Theory (UTAUT) [9] as a framework and proposes to investigate whether the moderating factors of gender and age have significance. It is hypnotised that gender and age factors will become insignificant and that personality factors increase in significance. The research questions can be summarised as follows:

- What is the relationship between age, gender, personality and use behaviour? Can moderating effects such as age and gender be removed from the models in favour of personality traits?
- Is there a difference between chronological age and cognitive age?
- Do DiSC analysis provide any insight into the user acceptance of technology over and above that provided by the five-factor model of personality?

2. Prior work

Dillon [13] defines user acceptance of information technology as "the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support". Researches in user acceptance of information technology seek to understand the factors that influence the adoption of technologies. Understanding what influences

individuals and groups of individuals to adopt technologies is vital as it can differentiate between success and failure of an organization, particularly in the current climate which is characterised by high levels of innovation, change and choice. Table 1 provides a representative chronological map of the main theories and developments in the research of user acceptance of technology from the 1960's to the current date.

Table 1. Chronological map of user acceptance of technology research

Era	Development
1960's	Innovation Diffusion Theory (adapted in 80's, 90's) Analysis User Teamwork Theory of Attitudes Theory of Propositional Control
1970's	Theory of Human Behaviour Expectancy Model Technology and Organisational Validity Cost Benefit Paradigm Theory of Reasoned Action (TRA)
1980's	Usability and Importance Effectiveness and Ease of use Social Cognitive Theory Technology Acceptance Theory (TAM) Intent Behaviour Relationship Human Computer Interaction Value & Accessibility Chanel (Disposition Model)
1990's	Theory of Planned Behaviour (TPB) Analysis of Model Factors and Determinants of Factors Model of PC Utilisation (MPCU) Task Technology Fit (TTF) Technology Readiness Index (TRI) Motivation Model (MM) Model Combination (C-TAM – TPB etc.)
2000's to today	Further analysis of Model Factors and Determinants with increasing focus on personality, age and gender Technology Acceptance Model Evolution (TAM 2) Meta-Analysis of Acceptance Models Model Combination Increases (TAM & TTF, TAM & FFM (five factor personality model), TAM & TRI etc) Unified Theory of Acceptance and Use of Technology (UTAUT) Analyses of Use and Situational Contexts

Early research in the 60's and 70's built on behavioural research such as innovation diffusion theory and the theory of human behaviour. In the 80's behavioural research continued, and the decade is characterised by an increasing focus on understanding key components of user. The decade culminated with the publication of the Technology Acceptance Model. Most developed theories of user acceptance for systems which incorporate technology have their genesis in this seminal work. It is useful to think of the development of TAM as a watershed in the development of user acceptance theory. The 1990's was the decade of user acceptance models, synthesising the previous two decades of research. Cross fertilisation of different models began in earnest in the 1990's as did investigations into model factor determinants and antecedents. This trend strengthened in the 2000's as researchers worked to improve the predictive strength of models and gain a richer understanding of model moderators, determinants and antecedents.

Venkatesh et al [10] empirically analysed eight prevailing unified technology acceptance and use theory models. They compared each model and integrated the consistently relevant factors into a unified model. The unified model was then empirically tested. The study found that the eight models accounted for between 15% and 53% of the variation in user intentions to use a technology whereas the unified model accounted for 70% of the variation in user intention to use. The unified model is essentially an enhanced variant of TAM with three determinants of behavioural intention;

1. Performance expectancy (analogous to perceived usefulness)
2. Effort expectancy (analogous to perceived ease of use)
3. Social influence (analogous to subjective norm)

There are two determinants of use behaviours namely (1) behavioural intention and (2) facilitating conditions. Of particular interest in the research are the moderating factors of gender, age, experience and voluntariness of use. The study analyses the complex contextual interactions where gender, age experience and voluntariness of use impact the strength of relationships and outcomes. For example, the study showed that effort expectancy is a more powerful determinant of behavioural intention for older women with minimal experience of the system in question.

The discussion in this study raised very intriguing questions regarding the changing dynamic of gender and age moderating effects on behavioural intention. Venkatesh et al [10], arguing for further research, suggest that it is possible that the maturation of the younger generation of workers brought up in an increasingly digital age, may lead to a change in the nature of gender and age moderating effects. While there is undoubted merit in each of the varied incarnations of user acceptance models they all lack a key input – the impact of personality. Only models incorporating motivation element hint at the influence of personality on user acceptance. It is widely accepted in the literature that the impact of personality is inadequately researched [6, 7, 8, 10]. Devaraj et al [7] suggest that one reason for this lack of investment is that reliable measures of personality that have a basis in the theory and can provide aid to researchers have only recently been developed. Hu and Pu [14] suggest that "*research has shown that personality is an enduring and primary factor that determines human behaviours*". Adopting this as a principle, one could suggest that personality, rather than having an external influence on behaviours as the theroy of planned action suggests, could have a more direct role in behaviour.

3. Method

This research follows largely to a functionalism paradigm in that it conforms to an objectivist ontological position and adopts a regulatory perspective in that it seeks to explain how the research subjects behave rather than to overturn the existing state of affairs. The nature of this research is explanatory in that it assesses the causal relationships between variables. A deductive critical realism research philosophy suggests that a quantitative research design is most appropriate for this study. Therefore, a structured survey was used to capture data. This is lauded to be a coherent and efficient approach to use based on the need for statistical comparison of the strength of influence on model variables on intended behaviour. The research design is cross-sectional rather than longitudinal in that the intent of the study is to establish behavioural relationships at one point in time in a specific setting rather than to study their development over time. The software system being studied is a Performance Development Coaching Tool. System use is officially required or mandatory for all full-time employees and therefore fitted the research criteria of this study. The system is used by individuals to;

- Define and share goals and objectives for the year ahead.
- Assess progress to these goals
- Define individual development plans
- Present information for review at performance and development reviews with their supervisor
- Provide feedback from supervisor to employees relating to their development and performance.

3.2 The Sample

The target population for this research is the Manufacturing and Quality engineering team within a large multinational medical technology organisation in Ireland. This includes 290 people excluding management and is made up of 67 women and 223 men. Mandated use of technology (use of technology is obligatory) is commonplace within this organisation therefore the population is suitable for study. A simple random probability sampling technique was employed. However, as gender is a key attribute of the study a minimum acceptable sample size was needed. Therefore, a stratified random sampling technique with a standard 95% confidence level and a 5% margin of error was used.

- N = the total population (290)
- n = the minimum required sample size
- p% = the % proportion of females in the target population (27%)

- q% = the % proportion of males in the target population (63%)
- z = 1.96 for a 95% level of confidence
- e% = the margin of error required which is chosen at 5%

n = p% x q% x (z/e%) = 270
n adjusted = n / (1+(n/N) = 140
This represents a 48% required response rate. An unbiased incentive in the form of a restaurant voucher was designed into the research questionnaire to ensure a high response rate.

3.3 Questions

The study variables were determined after completion of the conceptual framework and research questions were defined that relate to each study variable. The questions were adapted from and compared to those found in personality and user acceptance surveys within the literature to ensure that they were sufficiently easy to understand and had little scope for misinterpretation. This was done to assure reasonable internal or measurement validity and reliability. This structured approach also helped to ensure that the questionnaire covered the study variables required by the conceptual framework and aligned well with the research goals. The survey was then piloted by ten individuals. Three individuals were interviewed after the survey for their feedback and the remaining pilot respondents completed written feedback forms returned by e-mail to simulate the actual survey environment. Feedback from the pilot was incorporated into the questionnaire. The updated survey was piloted again with two individuals – the additional questions added a small amount of additional time and the new questions were judged to be clear. Finally, the pilot was shared with the directors of the target population in order to get final agreement to circulate the questionnaire. The variables associated with the model are presented in Table 2.

Table 2. Study variables.

Variable Type	Variable Title	Variable Measure
Determinants	Performance Expectancy	Likert Scale
	Effort Expectancy	Likert Scale
	Social Influence	Likert Scale
	Facilitating Conditions	Kept constant during the study
Moderators	Gender	Male / Female
	Age	Chronological Age Cognitive Age
	Experience	Likert Scale
	Voluntariness of Use	Mandated Technology Example therefore eliminate from the model
	Personality	Added to the base Model, Measured by FFM, Disc, MBTI, Belbin
Outcomes	Behavioural Intention	Likert Scale
	Use Behaviour	Likert Scale

4. Synthesis of the findings

This research set out to establish if age and gender have a measurable impact on use behaviour associated with a mandated software system in an industrial setting. The work proposed that age and gender are not significant factors that influence user acceptance behaviour and that personality would have a more significant impact on behaviour in the mandated setting. However, it has been established that this hypothesis is wrong. The data suggests that age has a measurable impact on all the core elements of the user acceptance model;

- Social Influence was stronger for individuals in their mid-40's and 50's compared to those under 35, proportionately in terms of percentage of individuals in each group by a factor of three to one.
- Under 35's expected the software to be easier to use compared to individuals in their mid-40's and 50's by a factor of two.
- Under 35's had significantly lower performance expectancy compared to older individuals and
- Older individuals had measurably higher behavioural intention to use the software system.

Findings reveal that cognitive age is a measurable characteristic with the majority of respondents (52%) reporting that they have a lower cognitive age than their chronological age. The study also suggested that younger respondents were more likely to have a higher cognitive age while older respondents felt they were younger at heart.

Gender influence on user acceptance behaviour appears to be not as significant as age but still evident in the research findings. A greater proportion of males expected the software to be easier to use, a greater proportion of males had little or no intention of using the software and males exhibited more extreme responses to social influence with greater proportions experiencing both high and low social influence compared to women. Indeed, differences in gender attitudes, expectations and behaviours occurred at the edges of the distributions, the central group showing more homogeneous results.

It was interesting to note that gender did not show measurably different levels of performance expectation. Both sexes reported low performance expectation in relation to the Performance Development Coaching Tool that was the software system used in this research. This highlights the importance of the context of the study and in analysing the study results.

The study population themselves were all from an engineering background, on average very comfortable and experienced with software systems, mostly male (67% male to 23% female) and had an average age of around 40 (the majority grouped between 30 and 45). Indeed, from a personality profile perspective the study population showed itself to be largely homogeneous in terms of personality traits and team role preferences. Other study populations with more varied demographics and backgrounds may well behave differently.

The research also proposed that there would be a relationship between personality or team role preferences and behavioural intent to use the software. However, the data suggested that there were no measurable differences in behavioural intent to use the software system for individuals with different DISC primary personality preferences (i.e. dominance, influence, steadiness and conscientiousness). Analysis of the primary Belbin preferred team role category suggested that individuals with thinking orientations had measurably more intent to use the software system. Further analysis revealed that the majority of this group had a specialist orientation and they had higher results for social influence than the average result. The “Big Five” personality traits of openness, agreeableness, conscientiousness, neuroticism and extroversion were assessed against behavioural intent with some mixed results. However, we cannot say with confidence that differences exist in levels of behavioural intent associated with differing levels of extraversion. The data may suggest that individuals with higher levels of neuroticism had lower behavioural intent to use the software.

The potentially exciting results suggesting that individuals with lower levels of openness, agreeableness and conscientiousness must be tempered with the limitations of the study data where groups with these characteristics represented low proportions (less than 8%) of the study population. In conclusion the research suggests that personality does not matter as much as age, gender, effort expectancy and certainly social influence when it comes to understanding user acceptance of mandated software systems in an industrial setting.

5. Conclusion

The power of social influence in a mandated use setting was evident in the research results. It would be interesting to further research the mechanisms associated with how managers exert social influence in mandated settings and how this impacts individuals within the organisation. The personality data in this study was assessed against behavioural intent; it would be interesting to assess this data against the key elements of social influence, effort expectancy and performance expectancy in order to compare to the research of Devaraj et al [7]. As noted earlier, the study population was a technically orientated group; it would be interesting to assess if the findings of this research changed for groups with differing profiles, for example with a HR background or those working in a non-technical field. Elements of this study were limited by sample size; greater confidence in the results could be gained by repeating the study in other similar organisations and with similar study populations to understand if the findings are consistent or differed in different organisations for similar groups. Potentially larger sample sizes could provide data that was more readily disposed to more rigorous statistical analysis. An internet-based approach could be used to survey thousands of individuals.

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