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Techno-change: A New Study of the Causes of TechnoStress

By

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In the years 2013-2014
Abstract

Recent research by Pusey (2013), Ayyagari et al. (2011) and Tarafdar et al. (2007) found a significant increase in TechnoStress levels from 50% in 2009 to 88-96% in 2013. More research is therefore required to identify the causes behind this increase. Using Rosen and Weil’s research from 1995 as a foundation, this research presents a new concept, Techno-change to explain this increase. Extensive research has been carried out to explore the various aspects surrounding technological change, and the effects it has on stress levels. Further analysis of over 113 responses also revealed the need for a new TechnoStress measuring scale, which is presented towards the end of this research.

Key words: TechnoStress, Technological change, Stress, GATCS.
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1. Introduction

Rosen and Weil (1997) define TechnoStress as “any negative impact on attitudes, thoughts, behaviours, or body physiology that is caused either directly or indirectly by technology”. This definition explores the very nature of TechnoStress, it is broad and is not relevant to any one stressor, strain or approach.

TechnoStress levels have reached significantly high levels in recent years, and recent research has found an increase from 50% in 2009 to 88-96% in 2013 (Pusey, 2013; Ayyagari et al., 2011; Tarafdar et al., 2007). Research relating to this increase is very limited and is either based outdated causes or focuses on identifying levels of TechnoStress, compared to examining the causes behind the increase noted.

A new approach is therefore required to accurately explain the increased levels being recorded. To ensure this approach remains reliable and based on significant and trustworthy research, the concept of TechnoStress should be reduced to its basic form: research on stress, technology and possible causes. This however would not allow for a comprehensive research study, therefore the main concepts of stress, TechnoStress and a significant cause, based on modern research should be explored.

1.1. Project Rationale

TechnoStress is quickly becoming a significant problem, with most of the world unaware of its existence. This is largely due to the lack of research showing the causes of TechnoStress, without which solutions and understanding cannot be achieved. It is therefore essential that this research identifies a significant cause of the increase in TechnoStress levels seen in recent years.
1.2. Project Aims and Objectives

The aim of this research is to identify the potential causes of the increased levels of TechnoStress recorded in recent years. This will be achieved through examining existing literature and through collection and analysis of new data relating to the subject of TechnoStress and technological change.
2. Literature Review

2.1. Introduction

The approach taken throughout this literature review focuses on defining key concepts of stress and TechnoStress, followed by exploring the responses and effects technological change has on individuals.

2.2. Stress

2.2.1. The Challenges of Defining Stress

Strong debates exist within the field of stress when attempts are made to identify a conclusive definition of the term. Many researchers reach the conclusion that stress cannot simply be defined by a single concept, and instead requires input from a broad range of approaches (Cox and Griffiths, 1995). This research therefore explores stress through three key approaches: stress as a response, stress as a stimulus and stress as a transaction.

Stress as a Response

Stress as a response focuses on identifying and recording the outcomes and responses of stress, compared to exploring the broad nature of stress (Ayyagari, 2007). Hans Selye leads this approach with his definition of stress “the non-specific response of the body to any demand for change” (Selye, 1936). It was his belief that stress occurred in individuals subjected to demanding stimuli (which he referred to as a stressor), to which they would have to respond to through change or adaption in order to relieve the negative effects and return to a normal state (Selye, 1979; Rice, 2012). His research is noted as one of the most influential approaches within the field of stress, and begun after discovering changes to the physiological state of laboratory rates when exposed to various stimuli (Selye, 1936).
General Adaption Syndrome (GAS)

Selye created the General Adaption Syndrome (GAS) model to explain and measure the various stages of stress response (Selye, 1983). The use of resistance to measure an individual’s response was used, as Selye acknowledged that a normal level of resistance to everyday stressors is present in every individual, some stressors however require additional resources and higher levels of resistance, which if unaccounted for, create a need for adaption or change in the individual (Rice, 2012).

Source: Vogel (2006)

**Alarm Reaction** – This stage is separated by an immediate stage of shock, characterized by a decrease in body temperature and blood pressure, and a later stage of counter shock; during which the body’s Flight or Fight responses are activated (Cotton, 1990). These responses refer to the mobilization of internal resources (such as cortisol and adrenaline) to allow individuals to better cope with the demands of the stressor; through evading the immediate effects of the threat or dealing with the threat directly (Vogel, 2006).

**Resistance Stage** – After their immediate response, individuals will attempt to adapt to the demands of the stressor, in the hope of returning to a normal state of homeostasis; defined as “a steady state of being” (Cannon, 1929). During these adaptation attempts, resistance levels increase and the majority of the resources
mobilized during the Alarm Reaction Stage are either reversed or reduced to aid the adaptation process.

**Exhaustion Stage** – If an individual’s attempts at adapting are unsuccessful and exposure to the stressor becomes chronic, resources are likely to become overused and depleted. Resistance levels therefore reduce significantly, leading to increased risks of detrimental effects such as chronic depression, burnout, organ failure, and/or a lower resistance to infection or death (Vogel, 2006).

The GAS model allows researchers to identify and measure the responses of individuals experiencing stress, however it does not take into account the nature of the stressor or explain the differences seen in individuals dealing with the same stressor (Rice, 2012; Ogden, 2007). It is likely that these factors were a result of Selye’s research on laboratory rates, reducing his research to basic biological and physiological concepts rather than psychological concepts which would have shown these differences (Doctor Kristy, 2012).

**Stress as a Stimulus**

Stress as a stimulus views stress as an independent variable and places focus on measuring the demands and effects of a stressor, than measuring the responses of an individual.

The approach is based on physics and engineering concepts, after Robert Hooke found similarities between the effects a load (stressors) has on man-made structures and humans (Lazarus, 1993). Hooke explained that when a load or stress is placed upon a structure, deformation occurs, which he referred to as strain. Providing the strain is within the limits of a structures material resources (or a humans coping/resistance resources), the strain is reversed when the load or stress is removed; however if the strain requires additional resources, then lasting damage is caused.

Similarities therefore exist between the exhaustion stage of the GAS model and the strain concept explained by Hooke above, as if resources are overused or not available, chronic exposure to the stressor occurs and detrimental effects are seen.
According to Werner (1993) a stressor (or stress when referring to Hooke’s terminology), can be characterized as:

- **An event** – something noteworthy that happens.
- **A situation** – a combination of circumstance at any given moment.
- **A condition** – a state of being.
- **A cue** – the nature of something perceived.

These terms allow researchers to further analyse the effects of individual stressors, based on their characteristics. Holmes and Rahe (1967) furthered this by exploring the stress characteristics of various life events.

**Social Readjustment Rating Scale (SRRS)**

Holmes and Rahe created the SRRS to measure various life changes/life events which cause individuals stress (Holmes and Rahe, 1967). They defined stress in this context as the “change in the ongoing life pattern of an individual” (Holmes and Masuda, 1974).

Their scale included forty-three life events such as marriage, retirement, job loss and each was assigned a specific weighting (relating to the degree of strain caused). The higher an individual’s score, the more likely they were to be stressed (Holmes and Rahe, 1967).

Although the SRRS is useful for identifying the effects of various stressors (life events), it too does not take into account individual differences, as it assumes that each life event will be perceived as equally stressful by different individuals (Ogden, 2007). The scale also ignores the duration of the stressor (whether the stressor is acute (short-term) or chronic), which has been shown to increase the strain on individual (Moos and Swindle, 1990).

**Stress as a Transaction**

Acknowledging the flaws in the previous approaches, Richard Lazarus developed a new approach to measuring and identifying stress taking into account the type and duration of stress, individual differences and responses, and the various effects of stress (Lazarus, 1991; 1993).
Stress as a transaction is commonly used in modern practises to explain stress, as it attempts explore the entire nature of stress using concepts from both of the approaches above (Ayyagari, 2007). This is clear in Lazarus’s definition of stress, “stress is neither viewed as a result of the individual or the environment, but in the relationship between the two” (Lazarus, 1991; Cooper et al., 2001). Stress therefore cannot be defined as the stressor or the response, but as all of the various elements explored above as a process.

The Stress Process

The process begins once a stressor (seen above as a situation or event) has been acknowledged by an individual. The individual must then evaluate the significance of the stressor through two stages of appraisal:

- **Primary Appraisal** – The purpose of primary appraisal is to determine whether the stressor presented is perceived to be one of the following:
- **Harmful** – referring to situations where psychological damage has already occurred.
- **Threatening** – referring to the anticipation of harm that has yet to occur.
- **Challenging** – referring to demands which are likely to be overcome.
- **Beneficial** – referring to stressors which are likely to improve or benefit the individual.

By characterizing the stressor as harmful, threatening, challenging or beneficial an individual can then progress to the Secondary Appraisal process, or acknowledge that the stressor is unlikely to cause stress and they can return to their previous state of homeostasis (Cooper et al., 2001).

- **Secondary Appraisal** – The purpose of secondary appraisal is to evaluate whether the individual perceives that they have sufficient resources to cope with the demands of the stressor (Lazarus, 1993). If the individual perceives that they have sufficient resources, then they experience positive stress; otherwise they perceive that they do not have the sufficient resources and experience negative stress.

It is important to note that Lazarus specifically focused on an individual’s own perception of their situation and resources throughout this process, rather their actual behaviour or resources, as he acknowledged the importance of individual differences when discussing stress.

Criticism however states that Lazarus may focus too heavily on the importance of individual perceptions, leading to less obvious and useful conclusions for stress management (Brief and George, 1991).

**Defining Stress: Summarizing the Three Approaches to Stress**

As mentioned above, the most commonly accepted approach used when discussing stress is Lazarus’s transaction approach, due to his focus on understanding the broader nature of stress and his acknowledgement of individual differences. However his approach has been claimed to be less useful, and therefore for the purpose of this research a more useful definition is required (Brief and George, 1991).

Based on the importance placed on stressors in the Stimulus-based approach and the responses in the Response-based approach, the definition of stress which will be used throughout this research is:
The process of acknowledging, evaluating and coping with the various strains (consequences) of specific stressors (demands).

This definition encompasses all three of the definitions explored above, which may hinder its use for specific purposes given its use of lose terminology, however for the purpose of this research, it explains the nature of stress required for a fundamental understanding of TechnoStress.

2.2.2. The Various Types of Stress

Acute, Chronic and Episodic Stress

Acute stress refers to stressors which are overcome using minimal resources and effort, without leaving lasting effects on the individual (Guyton, 1981; Schuler, 1980). Acute stressors are likely to be short lived and are highly manageable (American Psychological Association, 2008).

Chronic stress refers to stressors which cannot be overcome easily, and are consistently present regardless of coping efforts (Schuler, 1980). The GAS model explains chronic stress as when an individual has failed to adapt or cope to existing stressors (Selye, 1983). This is further supported by the similarities between the exhaustion stage and the consequences of chronic stress including: “damaged arteries, plaque formation and heart problems” (Brownley et al., 2000).

The final type of stress, episodic stress refers to when the same stressors seen in acute stress, appear more frequently leading to episodic stress (American Psychological Association, 2008). This type of stress usually causes less severe chronic consequences such as constant feelings of being overwhelmed and distressed (Hwang, 2013).

Distress and Eustress

Both Selye and Lazarus identified the concept of both positive and negative stress within their research (Selye, 1936; Lazarus, 1991; 1993). Positive stress is commonly referred to as eustress, and negative stress is referred to as distress.
Distress relates to the negative feelings and responses associated with stressors, for example feelings of anger or anxiety. Compared to eustress which relates to the positive feelings and responses, such as feeling motivated or stimulated.

When using Lazarus’s transactional approach, stressors influencing distress are also usually perceived as harmful or threatening, while stressors influencing eustress are usually perceived as challenging or beneficial (Lazarus, 1991; 1993). For example, while getting a job promotion is perceived as beneficial, it is also a very stressful experience causing acute stress and strain for individuals (Moorhead and Griffen, 1989).

### 2.2.3. The Various Types of Strain

To further explain the consequences of stress (strain) on individuals, research usually explores strain through four main approaches: physical, cognitive, emotional and behavioural.

**Physical Strain**

Physical strain relates closely to the physical health problems seen in individuals suffering from stress. These include (Luthans, 2002):

<table>
<thead>
<tr>
<th>Bodily System</th>
<th>Examples of Health Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immune system problems</td>
<td>• Impaired ability to fight off infections and illness.</td>
</tr>
<tr>
<td>Cardiovascular system problems</td>
<td>• Irregular blood pressure.</td>
</tr>
<tr>
<td></td>
<td>• Heart disease.</td>
</tr>
<tr>
<td>Musculoskeletal system problems</td>
<td>• Muscle tension.</td>
</tr>
<tr>
<td></td>
<td>• Headaches.</td>
</tr>
<tr>
<td>Gastrointestinal system problems</td>
<td>• Diarrhoea</td>
</tr>
<tr>
<td></td>
<td>• Constipation</td>
</tr>
</tbody>
</table>
It is not uncommon for long-term physical problems such as diabetes, infertility and heart disease to occur due to chronic exposure to stressors (Carlson, 2004). Using Selye’s GAS model, most of the long-term physical strains are introduced during the exhaustion stage, when individuals can no longer cope with the demands of the stressors (Selye, 1936). However as the GAS model suggests, strains caused by acute or episodic stress are likely to be short-lived and reversed once the stressor has been removed, for example headaches and diarrhoea.

**Cognitive Strain**

Cognitive strain relates to the impact stressors have on an individual’s thoughts. Many of the cognitive strains listed below are also symptoms of depression, a relationship may therefore exist between stress and depression (Polak et al., 2012).

Examples of cognitive strains include (Bressert, 2006):

- Constant worry/anxiety
- Confusion
- General negative attitudes or thoughts
- Impaired memory
- Reduced attention
- Indecisiveness

Relationships have been found to exist between the cognitive strain an individual experiences and their vulnerability to TechnoStress, for example negative attitudes towards computers is commonly acknowledged as one of the main symptoms of TechnoStress (Kupersmith, 1992; Becker, 2012; Rosen and Weil, 1992; 1998).

**Emotional Strain**

Relationships have also been found between emotional strains, depression and TechnoStress (NHS, 2012; Bouchez, 2014; Ceaparu et al., 2004). However they are harder to diagnose and treat as they are more likely to be based on individual perceptions (Martin, 2006).
Emotional strains include (Dormann and Zapf, 2002; Moorhead and Griffin, 1989; Luthans, 2002):

- Feelings of helplessness (individuals no longer feel in control of their situation or behaviour, and they begin to believe that their situation cannot be changed).
- Frequent mood changes
- Feelings of being overwhelmed
- Feeling frustrated
- Feeling overexcited

**Behavioural Strain**

Behavioural changes are more likely to be acknowledged due to their high significance in an individual’s life. Rahe and Holmes (1967) refer to various behavioural changes in their SRRS, when discussing life events.

Behavioural strains include:

- Under-eating or over-eating
- Increased smoking, drinking and/or drug abuse
  - Experiencing outbursts of aggressive behaviour
- Avoiding situations and other individuals
- Sleeping too much or too little

Relating to TechnoStress, behavioural strain also includes reduced productivity and poor task performance (Tarafdar et al., 2010). It is highly likely that behavioural strains also serve as stressors, as sleeping too little or too much is likely to cause poor task performance, and increased smoking/drinking/drug abuse is likely to cause physical strains such as heart disease (Alhola and Polo-Kantola, 2007; NHS, 2011).

### 2.2.4. Conclusions of Stress

According to Rosen and Weil (1997), TechnoStress refers to the “negative impact on attitudes, thoughts, behaviours, or body physiology that is caused either directly or indirectly by technology”. This definition clearly relates to the strains described above, and relationships can be found between the three approaches to stress explored at the beginning of this section and the TechnoStress research explored below.
2.3. TechnoStress

2.3.1. The Challenges of Defining TechnoStress

Like attempts made to define stress, defining TechnoStress is challenging. Definitions are mostly unclear and there is very little in-depth, academic research into the topic (Tarafader et al., 2011; Beckers et al., 2001). Some definitions and key researchers do however provide explanations for the term.

What is TechnoStress?

Craig Brod’s definition is arguable the most commonly used definition when defining TechnoStress; he claimed that TechnoStress is “a modern disease caused by an inability to cope with new computer technologies in a healthy manner” (B). This definition relates closely to the adaptability concept discussed in the GAS model, if an individual fails to adapt to the demands of the stressor (in the case, new computer technologies) then exhaustion occurs, followed by detrimental effects. Critics have however made the point that the term inability suggests that adaptation is not possible under stressful situations, and given that the appraisal process described by Lazarus (1991; 1993) occurs while an individual is suffering from the demands of stress, this definition appears flawed. Other claims have also be made suggesting that the definition appears too clinical and medical-specific, through use of the term disease (Davis-Millis, 1998).

Rosen and Weil’s (1997) definition used above, “any negative impact on attitudes, thoughts, behaviours, or body physiology that is caused either directly or indirectly by technology”, however relates closely to the concepts discussed above and does not restrict the term by specific stressors, strains or specific measures. The only concept missing from this definition is the importance of eustress, though given eustress also produces negative impacts, it could be loosely related if required. It is for these reasons that Rosen and Weil’s definition will be used for the purpose of this research.
What is Technology?

Traditionally technology referred to “the study of art and crafts”, referring specifically to the skills and knowledge required by workers of all industries: sailors, musicians and craftsmen (Reydon, unknown; Perry, 2008).

The term then took on another meaning after the Industrial Revolution, referring towards the more conventional meaning of “purposeful inventions and the strategic deployment of such inventions” (Rip and Kemp, 1997).

Against common perception that technology refers to specific devices or hardware, modern definitions actually refer to technology as the “knowledge of any technique for achieving specific goals” (Richer, 1982); or “the application of scientific knowledge for practical purposes (Oxford Dictionaries, 2014).

Each of these definitions acknowledges the importance of purpose when defining technology, whether it is defined through technique and skill for creating a livelihood or through application to specific sciences. This concept is commonly discussed by marketing experts and designers when developing new technologies/devices, however when examining the real-world application of such technologies and devices, such as mobile phones, purpose seems to be replaced by desire (Ferren, unknown). A recent study by WDSGlobal (2008) found that only “20% of a phone’s services and features are used regularly”. One explanation is that feature-rich products are more likely to sell and please customers looking for ‘value for money’ (Hondoh, 2014). Other explanations explain that customers are also looking for more advanced and innovative devices, and therefore by introducing a range of new features (despite their lack of purpose and value), manufactures are able to promote their new innovative device at lower manufacturing costs (Fraser, 2012).

2.3.2. What Causes TechnoStress?

TechnoStress Creators

Tarafdar et al. (2007) used the term TechnoStress Creators to describe their proposed causes of TechnoStress (described in Table 1 below). Support for their causes is overwhelming, with the majority of researchers using their TechnoStress Creators as a foundation for their own research.
Table 1 – Evaluation of TechnoStress Creators

<table>
<thead>
<tr>
<th>Description of TechnoStress Creator</th>
<th>Evidence to Support TechnoStress Creator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Techno-overload</strong> – as technology and devices advance, individual productivity is also expected to increase. TechnoStress occurs due to an individual’s lack of resources and high expectations.</td>
<td>Multitasking has become an accepted practise within most modern practises, especially within the workplace. Most devices are capable of multitasking demands due to their increased processing speeds. Individuals therefore begin to expect the same multitasking efforts from themselves and TechnoStress occurs when failure to meet these efforts occurs (Pribbenow, 1999).</td>
</tr>
</tbody>
</table>

| **Techno-invasion** – as devices become more connected to various aspects of an individual’s life, interruptions become more frequent causing disruption in both home and work environments. These disruptions are shown to cause TechnoStress. | Most devices are constantly connected to various networks and environments, this may promote efficiency and productivity, however interruptions are more likely to occur at inappropriate times (such as work calls during breaks, and notifications for updates during meetings) creating strain for their users. According to recent research, smartphone users are vulnerable to interruptions every four minutes (Carrier et al., 2011). These disruptions are therefore causing additional strains for their users, such as lack of sleep and lack of concentration (Park, 2007; Ritchel, 2010). |

| **Techno-complexity** – as devices become more advanced, individuals begin to believe that they do not have the adequate skills or knowledge to use them effectively. They | With evidence showing that only 20% of mobile phone features are used frequently, individuals may feel overwhelmed by the increased complexity of the additional |
then spend their time and effort attempting to learn how to use them, while feeling overwhelmed and stressed. features and therefore do not use them (WDSGlobal, 2008). Other evidence shows that training materials and software support documents are no longer useful due to their use of computer jargon (technical terms) and reduced quality (Robin, 1998).

| Techno-insecurity – similar to Techno-complexity, individuals feel that they do not have the adequate skills to use the devices effectively within the workplace, and TechnoStress occurs when individuals believe that other, more able individuals may replace them within the workplace. | Role conflict has become an issue since the introduction of technology to various workplaces, for example libraries. Librarians have been found to suffer high levels of TechnoStress due to their insecurity when attempting to learn new computer systems and understand additional responsibilities (Enis, 2005). |
| Techno-uncertainty – constant changes and rapid updates for devices are causing TechnoStress, as individuals feel overwhelmed by the increased pace of change. | Research by B2B Marketing (2013) found that 96% of individuals surveyed believed that the pace of change in technology and marketing will continue to increase, and 63% felt it is difficult to keep up with these changes. |

Support is also provided by Ennis (2005) who identified the following six causes of TechnoStress in Librarians:

- Rate of change
- Lack of standardization
- Lack of training on the equipment
- Reliability issues with the technology being used
- Increased workload
- Changing roles and responsibilities
Rate of change and lack of training equipment appeared as the most significant causes of TechnoStress, relating closely to the findings of Tarafder et al.’s Techno-complexity and Techno-uncertainty.

The majority of these causes are related to a change in either responsibilities, environments or technology (including devices), however very little is mentioned about the specific change processes, such as purchasing a new device or upgrading an old system and how they affect an individual’s TechnoStress level.

2.3.3. **Consequences of TechnoStress**

Relationships can be found between the consequences seen in individuals suffering from stress, and those suffering from TechnoStress; therefore this section will be discuss the physical, cognitive, emotional and behavioural strains to highlight any similarities.

**Physical Strain**

Individuals respond to stressful situations involving technology, using the same Fight or Flight responses used in any other stressful situation. Adrenaline and noradrenaline levels have been shown to increase, along with an individual’s heart rate, blood pressure, muscle tension and skin conductance (Furedy et al., 1993; Riedl et al., 2013). However due to the nature of technological use, Flight responses are mostly unused, as technology is rapidly becoming unavoidable and more invasive (Tarafder et al., 2007).

Repetitive strain injury (RSI) is mentioned throughout many modern practises and guidelines for explaining the consequences of incorrect computer use within the workplace. When using computers on a regular basis, RSI occurs due to the repetitive action of typing on a keyboard (NHS, 2013). Neck pain, back pain and numbness have also been recorded consequences of extended computer use within the workplace (Chauhan, 2003).

Health related problems such as cardiac, stomach/intestinal and heart-related issues (including high blood pressure) have also been directly to TechnoStress, furthering this relationship between stress consequences and TechnoStress consequences (Pribbenow, 1999; Brillhart, 2004). Luthans (2002) suggests that these consequences are likely to be caused by the strain placed on individual’s immune system, hindering its effectiveness and leading to illness.
Cognitive Strain

Technophobia, referred to as computer phobia by Rosen et al. (1987), refers to the high levels of anxiety felt by individuals when using a computer. It has since been incorporated into the current definition of TechnoStress, however it is important to note the original differences. Rosen and Weil (1994) described computer phobia as relating to the negative attitudes, anxiety and fear felt when using a computer; compared to TechnoStress which relates to all aspects of stress felt when using a computer.

The amount of information and technology available to individuals not only causes Techno-uncertainty and Techno-complexity, but also causes reduced attention and indecisiveness. Hallowell (2005) developed the term ADT (attention deficit trait) to refer to individuals who have become so overwhelmed by information, technology and responsibilities that their attention and decisiveness is significantly reduced.

Emotional Strain

Due the uncertainty and unreliability surrounding technology, frustration levels are likely to increase as a result of TechnoStress. Lazer et al. (2006) defines technological frustration as “when a computer acts in an unexpected way that annoys the user and keeps them from reaching their task goals”. This is supported by Ceaparu et al. (2004) who state that 47-53% of the average time spent on a computer, usually involves the user recovering from frustration.

Feelings of being overwhelmed are also more likely to occur in those suffering from TechnoStress, as Ceaparu et al. (2004) found that one in three computer users felt overwhelmed, and felt trapped by their technology. When feeling overwhelmed individuals have also been shown to appraise situations differently (based on Lazarus’s appraisal approach to stress), for example rather than viewing an additional task as challenging, when feeling overwhelmed they then view the task as a threat (Lee and Schnall, 2014).

Furthermore, studies show that TechnoStress can significantly affect an individual’s sense of control over their work and personal lives. Lee et al (2013) proposes two types of control:

- **Internal** - referring to the cause of an event or behaviour depending on an individual’s own decisions and efforts.
- **External** - referring to the cause of an event or behaviour depending on another being, belief or force (for example, the concept of luck or fate).

Individuals who suffer from TechnoStress tend to view technology as an external force, which cannot be controlled. These individuals are referred to as determinists (Surrey, 1997; Chandler, 1995). Individuals who view technology as a force which can be controlled are referred to as Instrumentalists, though they are less likely to suffer from TechnoStress as their degree of control and perception is higher (Surrey, 1997).

**Behavioural Strain**

Tarafder et al. (2007) found four behavioural consequences of TechnoStress:

- Reduced productivity
- Increased employee turnover and absenteeism
- Poor task performance

It is likely that individuals suffering from TechnoStress, suffer from the other physical, cognitive and emotional strains discussed above and therefore take time off work to cope. Statistics support this showing an increase of 40% of employees suffering from stress-related illnesses since 2005.

Job burnout refers to “a syndrome of emotional exhaustion, depersonalization, and reduced accomplishment” and is found in individuals suffering from TechnoStress (Maslach, 1982). As individuals feel overwhelmed and feel that they do not have the skills necessary to complete tasks, they become exhausted (supporting the GAS model’s final stage), which leads to poor performance and productivity. Conclusions of TechnoStress

### 2.3.4. Conclusions of TechnoStress

Recent statistics show that TechnoStress levels are estimated to be around 88%-96%, a considerable increase to Rosen and Weil’s research identifying 44% TechnoStress level in 1995 (Rosen and Weil, 1995; Pusey, 2013).
The increase seen in TechnoStress levels could be explained through the TechnoStress Creators discussed above, however as change processes have been mentioned throughout the previous research discussed, but not thoroughly explored, the rest of this research is dedicated to exploring the effects technological change processes have on recent TechnoStress levels.

2.4. Techno-change

2.4.1. Defining Techno-change

Techno-change refers to the direct and indirect stress caused by the process of technological change (upgrading or purchasing new technological devices). When an opportunity for technological change presents itself to an individual they have one of two choices: to either adopt the change or resist the change; both responses lead to varying degrees of direct and indirect stress.

2.4.2. What is Technological Change?

Schumpeter’s Three-staged Theory of Technological Change

The technological change process is explained by Schumpeter (1939) in three stages:

- **Invention** – the development of a new technological device or process.
- **Innovation** – the improvement process of a particular device or process. The Law of Accelerating Returns suggests that these changes are made to better the speed, cost-effectiveness and/or power of the technology.
- **Diffusion** – the implementation and general adoption of the device into a specific industry or society.

As an example, mobile phones were first invented to “bring safety and freedom to people” and then became subjected to changes improving their speed, cost-effectiveness and power. They are now commonly accepted by society, with over 7.3 billion mobile phones used worldwide (Tiexreira, 2010).

This theory is supported by Robertson (1971) who further explains the difference between invention and innovation. According to Robertson, there are two types of technological change:
• Discontinuous (disruptive) innovations – relating to the invention stage above, these are changes relating to the introduction (disruption) of new technologies.
• Dynamically continuous innovations (DCIs) – relating to the innovation stage above, these are changes relating to development and improvement of existing technologies.

By exploring the differences between the various stages of technological change, and defining discontinuous and dynamically continuous innovations a more comprehensive understanding is obtained for understanding the direct relationship between technological change and TechnoStress.

2.4.3. The Pace of Change

Techno-uncertainty explores how the increased pace of change seen in everyday technological devices and systems produces stress for individuals attempting to use them effectively (Tarafder et al., 2007). Individuals begin to feel overwhelmed by the amount of changes occurring to their devices and systems and become stressed as a result. Therefore by exploring the reasons behind the increased pace of change, reasons behind these relationships may be found.

Moore’s Law

Moore’s Law developed in the 1970s explains the increased pace of change by referring to transistors on a circuit board. Moore (1965) suggests that every 24 months twice as many transistors will be integrated onto a circuit, producing twice the speed and quadruple the power at a reduced cost (Moore, 1965; Kurzweil, 2001).

This therefore suggests that the pace of change will continue to increase as the innovation and DCI stages of technological change occur.

Law of Accelerating Returns

The Law of Accelerating Returns supports Moore’s Law using a less engineering-orientated approach. The approach taken by the Law of Accelerating Returns suggest that paradigm shifts (fundamental changes in the approach taken to developing and producing technology) increase in frequency due to the increased efficiency and power of the technology used throughout society.
Al Shami (2008) shows various paradigm shifts since the 1300s in the following diagram:

<table>
<thead>
<tr>
<th>Historical Age</th>
<th>Timeframe</th>
<th>Duration of Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Ages</td>
<td>1300 – 1720</td>
<td>330 Years</td>
</tr>
<tr>
<td>Industrial Revolution</td>
<td>1720 – 1870</td>
<td>150 Years</td>
</tr>
<tr>
<td>Age of Modernism</td>
<td>1870 – 1950</td>
<td>80 Years</td>
</tr>
<tr>
<td>Era of Mass Communication</td>
<td>1950 – 1990</td>
<td>40 Years</td>
</tr>
<tr>
<td>Personalize Automation</td>
<td>1990 – 1994</td>
<td>4 Years</td>
</tr>
<tr>
<td>Age of Information</td>
<td>1994 – 1996</td>
<td>2 Years</td>
</tr>
<tr>
<td>Instant Interaction</td>
<td>2000 – ...</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

Source: Al Shami (2008)

Technological change therefore cannot be seen as a linear projection, as the two explanations above suggest 20 years of the current rate of change could be equal to the entire 20th century’s rate of change when taking into account the increase in technology and knowledge (Kurzweil and Meyer, 2003).

It is clear that the pace of change is increasing at a phenomenal rate. This causes individuals to become overwhelmed by the increasing amount of change surrounding them. Individuals then begin to feel that they do not have the adequate resources to deal with the changes, and that their technical skills are inadequate (Moreland, 1993). This results in more time and effort being put into upgrading their skills, only to be faced with further change and even greater feelings of being overwhelmed (Pascarella, 1997).

### 2.4.4. Individual Differences

Examining the differences in how individuals think and respond to technological change is essential when attempting to understand the relationships seen between TechnoStress and technological change.

### The Different Philosophical Views of Technology

Throughout history interesting debates have been held over the philosophical meaning of technology and its purpose in modern society. Table 2, adapted from a lecture by Feenberg (2005), explores some of the key concepts held in these debates.
Table 2 – Physiological Concepts of Technology

<table>
<thead>
<tr>
<th>Neutral – this refers to views that technology has no preference over its possible uses.</th>
<th>Determinism</th>
<th>Instrumentalism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determinists believe that technology cannot be controlled, and that it has the power to control society by forcing the requirements of efficiency and constant progress (Surrey, 1997; Chandler, 1995).</td>
<td>Instrumentalists believe that technology is just a tool, and that humans have control over its purpose and use (Surrey, 1997; Levinson, 1996)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autonomous – this refers to views that technology will advance at a pace and direction outside of human control.</th>
<th>Humanly Controlled – this refers to views that technology will advance at a pace and direction decided by humans.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantivism views technology as a way of life (like a religion). The famous philosopher Hiedegger believed that if this view is accepted, everything in life will be transformed into raw materials for specific technical processes; including human beings.</td>
<td>Critical theorists acknowledge that technology has specific values and purposes in life, and that current use of technology is problematic. However they believe that humans can still solve these problems, using democratic processes where consumers have the ability to shape the design and development of technology, not just experts and manufacturers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Neutral/Value-laden – this refers to views that technology has a specific purpose (value) in life.</th>
<th>Critical Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical theorists acknowledge that technology has specific values and purposes in life, and that current use of technology is problematic. However they believe that humans can still solve these problems, using democratic processes where consumers have the ability to shape the design and development of technology, not just experts and manufacturers.</td>
<td></td>
</tr>
</tbody>
</table>
Depending on an individual’s beliefs their decision to adopt or resist technology is likely to significantly affect (Rotter, 1966; Lee et al., 2013). For example, an instrumentalist is more likely to adopt a new technology as they feel in control of its use and purpose (Surrey, 1997).

Relationships can also be made between Schumpeter’s three-staged model of technological change and the above approaches, as the effectiveness of a technologies diffusion process is likely to depend on the views of certain social and cultural views at the time. Non-neutral/value-laden societies are only likely to accept the technology if it is understood to have a specific purpose and fits their current way of life (Feenberg, 2005).

**Innovators, Early Adopters, Early Majority, Late Majority and Laggards**

Studies have also attempted to characterize individuals based on their behaviour when using technology. Rosen and Weil (2000) suggest three types of individual:

- **Eager Adopters** – characterised by the same behaviours as Techno-centered individuals. They embrace technology and are fully motivated to adapt to new technology, and enjoy solving any problems they encounter.

- **Hesitant ‘Prove Its’** – do not embrace technology until a benefit is seen and evaluated. Technology is seen as a tool and not an enjoyable experience.

- **Resisters** – characterised by the same behaviours as Techno-anxious individuals. Resisters avoid technology where possible, and become intimidated, embarrassed and certain they will break something. They become extremely anxious around technology.

Further to Rosen and Weil’s characteristics, Rogers (1995) proposes the following five types of individual:

- **Innovators** – Individuals who are eager to try the latest technology, and see the benefits of the new technology in a variety of situations and contexts.

- **Early Adopters** – Using the information provided by the Innovators, Early Adopters will adopt the new technology if it takes their interest, and is evaluated by Innovators to be beneficial. They have been coined “visionary users” by Geoghegan (1994).

- **Early Majority** – Although not technically focused, the Early Majority will adopt the technology they see as beneficial in aiding their progress (whatever that may be).
• **Late Majority** and **Laggards** – The Late Majority and Laggards are the least likely to adopt new technology. They prefer traditional methods and would rather avoid the technology altogether. The Late Majority will however eventually adopt the technology but tend to use it only when necessary.

![Diagram of technology adoption curve]

Source: Surry (1997)

By defining the characteristics of these various types of individual, researchers can predict an individual’s response to technological change and act accordingly. It is also useful to use these characteristics as a measurement, to determine the severity of an individual’s response to a specific change. For example innovators are more likely to adopt any changes presented to them, compared to laggards and resisters who can be expected to resist all radical changes.

## 2.4.5. Responses to Technological Change

There are two possible responses to technological change; adoption of the change or resistance of the change. These two responses have been explored by many researchers in the past, however very few identify relationships between TechnoStress, stress and adoption/resistance.

**Theory of Reasoned Action (TRA)**

The Theory of Reasoned Action attempts to explain an individual’s choice to adopt by evaluating their beliefs, attitudes and subjective norms claimed to be influencing their decisions (Fishbein and Ajzen, 1975).
Beliefs and attitudes are formed from predispositions towards use of a certain device (Melvin, 1979). Relationships have been found between an individual’s evaluation of the benefits and value of a device and their recorded attitudes, showing support for this theory (Chutter, 2009).

Subjective norms relate to an individual’s desire to comply with the beliefs and values of family, friends, colleagues and other external influences in their life (Chutter, 2009). Interesting research has been carried out to see the influence of family, friends and colleagues on adoption rates of specific technologies. Nielsen Global Online (2009) found that 92% of consumers trust recommendations from people they know when deciding whether to upgrade or purchase new devices. Other research by Goldstar Events (2007) found that 86.9% of consumers trust their friend’s recommendations over online critics, showing a strong relationship between adoption rates and influence from friends.

Interesting relationships have also been found between the use of social media sites to gain approval from friends, family and colleagues and adoption rates (Reed, 2011). The following graph shows the negative and positive reviews read on various social media sites. Considering the purpose of social networking sites is to connect friends, family members and colleagues, these high rates of negative and positive reviews support the findings above showing the influence external figures have on adoption rates (Reed, 2011).
Combined with beliefs and attitudes, subjective norms then lead to the behavioural intent of an individual to adopt a specific device and eventually the actual adoption of the device.

**Technology Acceptance Model (TAM)**

The Technology Acceptance Model relates specifically to the adoption of devices, compared to the TRA which explains an individual’s decision to behave in a certain manner.
Adapted from Davis (1989)

External variables include an individual’s:

- position in the workplace
- systems experience and computer experience
- user training received
- degree of participation in the design

In addition to the system’s own characteristics, these factors affect the individual’s attitude and beliefs towards the new device/technology and therefore have a strong influence on their likelihood to accept or reject it (Hubona and Geitz, 1997; Venkatesh and Davis, 1996; Chutter, 2009).

Research support this showing that those in management-level positions tend to express a higher level of resistance to change, due to fear of losing their status or job position as a result of the change. Other research suggests that employees suffer from higher resistance levels due to the manager’s response to the change (Flower, 1962).

Lack of training and infrequent-use of a computer also appear to contribute towards an individual’s likelihood to resist new change (Molinie, 2002). Clark (1989) found that poorly delivered training actually lowered performance grades and increased stress levels of participating individuals, compared to performance grades prior to the training.
Relationships have also been found between computer experience and task performance (Agbatogun and Banjo, 2010). However this could be due to the training received, leading to less uncertainty about the new technology, compared to excessive experience (Gurcan-namlu and Ceyhan, 2003).

Perceived usefulness refers to an individual’s perception that the new system/technology will be beneficial to their work performance. While perceived ease of use, refers to an individual’s perception that the new system/technology will require little effort to use (Chutter, 2009). The degree to which these perceptions are true directly affects an individual’s attitude towards the new technology/system. If the individual’s attitudes are favourable towards the new technology/system then behavioural changes occur to lead to actual use of the new technology/system.

**Coping Strategies**

Using the TAM, Cui, Bao and Chan (2009) developed a new model to explain the process of adoption and resistance in individuals when raced with technological change.

Their model uses the term coping strategies to refer to two specific responses: confrontation and avoidance.

- Confrontation refers to positive methods of gaining knowledge and experience with a new device prior to adopting it (they call this extended decision making EDM).
- Avoidance refers to refusing to acknowledge the new device at all or delaying its implementation.
Support is found from Mish (2003), Dent (1995) and O’Neill (2001) who believe resistance is an individual’s unwillingness to embrace change due to their desire to remain “unaffected and undamaged”. This desire relates to the state of homeostasis individuals are predisposed to desire, explored within the resistance stage of the GAS stress model (Cannon, 1929). By avoiding the change completely, individuals do not perceive any threat to their homeostasis state.

Like TAM, importance is also placed on an individual attitudes and beliefs towards a device’s usefulness, ease of use and fun. The use of fun as an influencing factor refers to the perceived entertainment value of the device, for example using a phone to play music or games (Bruner and Kumar, 2005; Pagani, 2004).

Cui, Bao and Chan’s results showed strong support for this model, showing strong relationships between an individual’s choice to adopt or resist technology and their coping strategy used. They also support the findings of Davis (1989) and Fishbein and Ajzen (1975) showing a relationship between an individual’s beliefs and attitudes about a device, and their choice to adopt it.

**Diffusion of Innovation Theory**

Rogers developed the Diffusion of Innovation Theory to explore the uncertainty and stress individuals experience when an innovation (for the purpose of this research, a new technology) is introduced into their lives (Rogers, 1995; 2003). Close links can therefore be found between the Technocreator Techno-Uncertainty and this theory (Tarafdar et al., 2007).

The theory aims to provide coping mechanisms to overcome this uncertainty and help promote adoption of a new technology/system.
The theory is explained in the figure above as a process consisting of five main stages (Sahin, 2006):

- **Knowledge Stage** – An individual learns about the existence of the new technology and is motivated to find out more about it. This is a typical characteristic of Early Adopters (Rosen and Weil, 2000).

An individual may seek:

- **Awareness knowledge** – more information about the existence of the technology.
- **How-to-knowledge** – information relating to the correct use of the technology, and,
- **Principles-knowledge** – specific information relating to how and why the technology works and was introduced.
• **Persuasion Stage** – Positive and negative feelings are expressed about the new technology. These feelings are affected by: a) the degree of uncertainty felt by the individual and, b) social reinforcement factors (the views and opinions of others).

• **Decision Stage** – An individual decides whether to adopt the technology or to reject/resist the technology based on the information gathered from the previous two stages. Rejection/Resistance develops in two forms: active (where an individual has considered the technology, but has rejected/resisted it regardless) and passive (where an individual has put no thought into the decision, and simply rejects/resists the technology anyway).

• **Implementation Stage** – The new technology is trialled in a suitable environment by the individual. Due to uncertainty factors, this stage usually requires additional support by external professionals.

• **Confirmation Stage** – An individual seeks support from social groups and communities. At this stage, despite adopting and trialling the technology, the individual may decide to discontinue the technology adoption due to negative support influences, finding a better replacement or being dissatisfied with its performance in the trials. Alternatively, the individual may continue the adoption and successful adopt the new technology.

Each of these stages contributes a degree of knowledge and understanding about the new technology to help relieve the uncertainty felt by the individual. By feeling more certain about the technology, adoption is more likely as the individuals perceived level of control will have also increased (Rotter, 1996).

Similarities can also be made between this theory and the models discussed above. Social norms are taken into account and an individual gathers knowledge to build on their attitudes and beliefs about the technology, to decide whether to adopt the technology in the adoption stage.

Based on this concept of gathering knowledge about the technology, Rogers also suggested that individuals need to see the following characteristics in the technology for successful adoption (Sahin, 2006; Rogers, 1995).
• **Relative Advantage** – the technology must be perceived as an advancement (providing benefits for the individual) compared to past solutions/technologies used.

• **Compatibility** – the technology must be consistent with existing “values, past experiences and needs of potential adopters” (Rogers, 1995).

• **Complexity** – the technology must be perceived as easy to use.

• **Trialability** – the ability to trial the technology must be available.

• **Observability** – the results and reviews of others having used the technology must be readily available to the individual.

These characteristics must be met in order for the individual to feel certain and in control of the adoption. Failure to meet these characteristics increases the chance of resistance of the technology (Sahin, 2006). Again similarities exist between the TAM and TRA models explored above, individuals seek to see the usefulness and ease of use of new technology, and an individual’s attitudes and beliefs are founded on “values, past experiences and needs of the individual”. These similarities support the importance of these elements for successful adoption of a new device.

### 2.4.6. Integrative Model of Organizational Change, Stress and Resistance

The Integrative Model of Organizational Change, Stress and Resistance developed by Tavakoli (2010) appears to be the only model which emphasises the relationship between stress and change responses explicitly. Many of the terms and concepts used within the model have already been discussed above, and support for the model is strong considering its main approach has not been discussed elsewhere.
According to the Integrative Model of Organizational Change, Stress and Resistance, change triggers two responses: negative perceptions or fear, and positive actions (similar to resistance and adoption responses).

- **Negative perceptions/fear** – include various fears and losses which have been discussed in various forms as contributors to both resistance and TechnoStress in the above models and concepts.
  
  - **Fear of Loss** – Change recipients will resist change if they feel that they will lose something as a result of the change. For example, they may fear losing their job and social status, revenue or power (Dent and Goldberg, 1999).
Fear of Threat – According to Lazarus (1993) if a change recipient appraises the change as threatening (the anticipation of harm that has not yet taken place but may be imminent) then resistance and stress are likely to occur (Cooper et al., 2001). Change recipients feel that their homeostasis will be threatened by the change, resulting in anxiety and uncertainty (Ford, Ford and McNamara, 2002; Lapointe and Rivard, 2005).

Fear of Ambiguity – Change must be explained and thoroughly understood by change recipients to be adopted, otherwise resistance is likely because they do not understand the need for change and therefore remain in their current state of homeostasis.

Job Insecurity and Work Overload – As most of the research relating to change focuses on employees and the workplace, resistance is likely to occur when an individual fears that their job is at risk or that they won’t cope with the perceived additional workload resulting from the change (Emmott, 2013). In addition to causing TechnoStress and a resistance response, decreased satisfaction and a decreased commitment to the workplace is also likely (Yu, 2009).

Fear of Lack of Control – Introverts feel a need to control all aspects of their lives, and change threatens this control. In the workplace, control over an individual’s workload may be threatened by the change and therefore job performance, satisfaction and commitment may also be threatened leading to anxiety and resistance (Hansen, 2001; Yu, 2009).

Fear of Unpredictability – The term uncertainty is commonly used in research to describe the unpredictability of change. Uncertainty leads change recipients to resistance because they fear they may suffer as a result of the change and prefer to remain in a state of homeostasis where they are not at risk of losing the above (Carnall, 1990).

These fears have therefore been shown to promote distress in individuals, which then becomes a stressor promoting resistance to the technological change encountered. Interesting connections have also been made by Tavakovi (2010) showing that resistance is both a strain of distress, and a stressor causing distress.
• **Positive actions** – Positive actions are said to promote coping abilities and lead to cognitive change. The positive actions explored aim to trigger coping abilities (as explained by Cui, Bao and Chan, 2009) to lead to adoption. Tavako does however also acknowledge the importance of other approaches such as the process of knowledge gathering explained in the Diffusion of Innovation Theory and Lazaru’s concept of appraisals, which he defines as coping strategies (Rogers, 2003; Sahin, 2006; Lazarus, 1993).

  o **Participation** – If a change recipient is involved throughout the change process, they are more likely to adopt the change as ambiguity, fears and threats are acknowledged and overcome during the change process rather than experienced during the introduction to the change leading to immediate withdrawal and resistance, as explained in the RTCI model (Griffin, 1993; Venkatesh and Davis, 1996; Chutter, 2009).

  o **Benefit Finding** – Rogers (2005) explains that a relative advantage (a benefit) must be seen in proposed changes before they are successfully adopted; these benefits may include improve performance, efficacy and/or satisfaction (Lunceford, 2009; Kim and Kakanhalli, 2009; Davidson, 2002). However the TAM also acknowledges the importance of ease of use and usefulness in order for adoption to take place (Davis, 1989).

  o **Organizational Justice** – If a change recipient values their workplace, position and manager through the various power aspects described by (French and Raven, 1959), then adoption is more likely to occur.

  o **Communication, Support and Training** – The TRA explains the affect social norms have on adoption of change, for example the use of user reviews to appraise behavioural intentions. Research by Clark (1989) acknowledges the importance of training to improve performance and adoption rates (Chutter, 2009).
These coping abilities and new cognitive perceptions, lead to eustress. As explained within the stress section of this research, eustress relates to the positive feelings and responses, such as feeling motivated or stimulated. This model further suggests that eustress will lead to health, cooperation, challenge, growth, flow, joy and productivity; however as with distress, these elements also contribute towards the individuals over level of eustress too (for example, productivity promotes job burnout and work overload; shown in other research to act as stressor for distress).

The relationships established between the various aspects of this model provide the foundations for the rest of this research as they show that technological change and an individual’s response to change lead to stress. However it is important to note that this model was created with the intention of explaining organizational change, and although discussed showing its relations to technological change, differences should be expected.

2.5. Conclusions

After defining and evaluating the key concepts of both stress and TechnoStress, Techno-change appears to be a valid additional TechnoStress Creator influencing an individual’s TechnoStress level. Research shows that whether an individual adopts or resists the technological change (through updating or purchasing a new device), stress levels have been shown to increase. Therefore it is highly likely that TechnoStress levels will also be shown to increase as a result of an individual’s beliefs and responses to technological change.

2.5.1. Key Issues

- To identify the reasons behind the recent increase in TechnoStress levels (Rosen and Weil, 1995; Pusey, 2013).

- To identify whether Techno-change is a valid TechnoStress creator.
2.5.2. **Refined Research Questions**

- To identify whether the pace of technological change has increased in recent years.
- To identify what influences an individual’s technological change response and beliefs.
- To identify the relationships between technological change responses, beliefs and TechnoStress levels.
3. Research Methodology

3.1. Introduction

To ensure that the research being carried out produces reliable and significant results to the research questions identified above, this section will identify and justify the intended research methods that will be used.

3.2. Research Strategy

As this research is based on Rosen and Weil’s previous research of TechnoStress, their scales and research methods will be taken into account when conducting this research. For example, Rosen and Weil developed three scales (each asking twenty questions) to measure different aspects of TechnoStress, these included (Rosen and Weil, 1995):

- General Attitude Towards Computer Scale (GATCS) – this measures an individual’s general attitude towards computers.
- Computer Thoughts survey (CTS) – this measures an individual’s thoughts and feelings towards technology.
- Computer Anxiety Rating Scale (CARS) – this measures an individual’s anxiety towards computers.

Each of these scales consists of twenty questions answered using a Likert scale from strongly agree to strongly disagree. After researching the various scales individually, it is clear that GATCS stands out as more significant than the other two scales at predicting TechnoStress levels, therefore this alone will be used to accurately assess an individual’s TechnoStress level (Pusey, 2013).

By assessing an individual’s TechnoStress level during this research, strongly comparisons and relationships can be identified between Techno-change beliefs and responses and TechnoStress levels.
As Rosen and Weil used a quantitative survey to produce their scales and findings, the same method will also be used in this research. This survey will be based on the same Likert scale (strongly agree to strongly disagree) to show consistency. Support for this method of gathering data is provided by Tewksbury (2009) who refers to quantitative research methods as more scientific in approach, “looking at contexts, environmental immersions and a depth of understanding”. As this research aims to identify and understand individual’s beliefs and responses to technological change, this method seems effective at gaining useful data. This is also supported by Johnson and Onwuegbuzie (2004), stating that quantitative research allows for assessment of cause-and-effect relationships.

Unlike Rosen and Weil, a more modern approach to gather data would be to conduct an online survey. An overwhelming amount of support is provided for the use of online surveys, including its potential to reach individuals all over the world at speed, low administration costs and high flexibility and customization levels.

### 3.3. Data Generation Methods

As already mentioned, an online survey will be used to gather data for this research. The survey will consist of three sections:

- Demographic questions (gender, age, computer experience and employment status)
- Rosen and Weil’s GATCS questions
- Techno-change specific questions (these will be devised from the literature review)

By collecting data through these three sections, relationships between an individual’s TechnoStress level and their beliefs and responses to technological change should be clearly identified. By asking for demographic information further analysis can be carried out to help identify the reasons behind their identified beliefs and responses.

Both the GATCS questions and the Techno-change specific questions will use the same Likert scale as used by Rosen and Weil to allow for consistent analysis of individual TechnoStress levels.

A list of all the questions and possible answers is provided in Appendix 1.
3.4. Data Analysis

Due to the quantitative approach used, the analysis process of the data collected should be efficient and reveal significant relationships between the various questions asked. The analysis process will first consist of analysing the sample using the demographics collected to identify the potential significance of the research.

As part of the GATCS scale created by Rosen and Weil, an algorithm was created to identify an individual’s TechnoStress (Technophobia) score; this can be used to identify whether an individual has no TechnoStress, Low TechnoStress or Moderate/High TechnoStress.

<table>
<thead>
<tr>
<th>GATCS (Form C):</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Technophobia</td>
</tr>
<tr>
<td>Low Technophobia</td>
</tr>
<tr>
<td>Moderate/High Technophobia</td>
</tr>
</tbody>
</table>

Source: Rosen (1997)

After identifying individuals by demographics and TechnoStress level, analysis can begin attempting to identify their responses and beliefs to technological change using their answers to the Techno-change specific questions.

Using SAS, an analysis software capable of handling large amounts of data, relationships can then be identified between the three sections and shown in visual graphs and scatter plots. This kind of analysis will allow the significance of the relationships to be shown in a clear and meaningful manner.

3.5. Sampling

The survey will be available to anybody with internet access and knowledge of its location. To ensure that a significant sample is collected, the survey location will be shared on social networking sites and provided to friends and family in the Leicestershire and Derbyshire area.
Ideally this will provide a sample size of around one hundred and fifty individuals of all ages, genders, cultures and backgrounds.

The use of an online survey, distributed using social media may however provide additional results due to snowball effect of online distribution and trends. This refers to when an individual selected to complete the survey, distributes the survey to others upon completion, the effect continues to involve more actors as the duration of the survey increases (Lewis-Beck, Bryman and Liao, 2004).

### 3.6. Ethics

The ethical guidelines and expectations which will be used throughout this research can be found at:

http://www.derby.ac.uk/research/uod/ethics/.

### 3.7. Limitations

As the survey is only available through the internet, anybody who is not computer literate may find accessing and completing the survey difficult.

The reliance upon social media and gathering data from friends and family, also creates a risk that the data collected will be based on individuals of the same opinions, values and beliefs, hindering the significance and variability of the sample (Robinson and Tajfel, 1996).

### 3.8. Conclusions

Based on these expectations, the potential for this research to explain an unexplored aspect of TechnoStress is high. The use of Rosen and Weil’s original research methods and GATCS scale makes this research relevant and increases the chance of relationships being found between Techno-change and TechnoStress levels.
4. Findings and Analysis

4.1. Introduction

Using the analysis strategies and methods discussed above, this section presents the findings of this research, along with analysis descriptions of interesting trends and relationships found in the data. Interesting conclusions were drawn from the data, and towards the end of this section a new TechnoStress measuring scale is proposed. Further identification and exploration of the data is provided in the next section.

4.2. Analysis

4.2.1. TechnoStress Levels

Graph 1 – TechnoStress Levels
Using the answers provided to the GATCS questions and Rosen and Weil’s algorithm discussed above, TechnoStress levels have been produced in the graph above. Unfortunately these results do not support other recent findings, showing only 70% of all participants are suffering from TechnoStress compared to Pusey’s findings of between 88-96% in 2013. However despite being unexpectedly low, an increase is seen compared to Rosen and Weil’s findings of 44% in 1995, and therefore these results can still be considered significant.

**TechnoStress Levels by Demographics**

- **Gender**

<table>
<thead>
<tr>
<th>Gender</th>
<th>TechnoStress Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (76 participants)</td>
<td><img src="image" alt="Graph 2 - TechnoStress Levels by Gender" /></td>
</tr>
<tr>
<td>Male (36 participants)</td>
<td><img src="image" alt="Graph 2 - TechnoStress Levels by Gender" /></td>
</tr>
</tbody>
</table>

With the exception of moderate-high levels, gender differences are unseen when further analysing the TechnoStress levels of participants. A difference of 14% however is noticeable between moderate-high levels of TechnoStress, perhaps suggesting that Females are less likely to suffer from the high intensity of TechnoStress.
• Age

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-25</td>
<td>39</td>
</tr>
<tr>
<td>26-40</td>
<td>26</td>
</tr>
<tr>
<td>41-55</td>
<td>33</td>
</tr>
<tr>
<td>56-70</td>
<td>16</td>
</tr>
</tbody>
</table>

**Pie Charts**

- **10-25 (39 participants)**
- **26-40 (26 participants)**
- **41-55 (33 participants)**
- **56-70 (16 participants)**
Remarkably results show an inverse relationship between a participant’s TechnoStress level and their age. This is unexpected and does not support the literature review research, showing higher levels of resistance to new technological devices in older individuals (Molinie, 2002). However less results were gathered from the higher age categories, therefore these results cannot be generalized in terms of relationships to those categories with fewer participants.
• Employment Status

<table>
<thead>
<tr>
<th>Employment Status</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time Employment</td>
<td>51</td>
</tr>
<tr>
<td>Part-time Employment</td>
<td>23</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6</td>
</tr>
<tr>
<td>Self-Employment</td>
<td>2</td>
</tr>
</tbody>
</table>

**General Attitudes Towards Computers Scale**

*Frequency of Stress Level*

---

<table>
<thead>
<tr>
<th>Stress Level</th>
<th>Full-time Employment</th>
<th>Part-time Employment</th>
<th>Unemployment</th>
<th>Self-Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>29</td>
<td>12</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Moderate-High</td>
<td>14</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No Technophobia</td>
<td>7</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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Given the representative figures of each category, it is hard again to draw significant and reliable conclusions. However initial interpretations do propose that no relationships are found between whether an individual is in full-time employment or is unemployed. Relationships may however exist between part-time employment and self-employment and reduced TechnoStress; this could be due to reduce work hours or having through the increased control associated with these work positions (Nordenmark, Vinberg and Strandh, 2012).
• Previous Computer Experience

Beginner (10 participants)

Intermediate (81 participants)

Expert (24 participants)

Graph 5 – TechnoStress Levels by Age
Unexpectedly these results show that those who consider themselves less competent at using computers actually suffer lower TechnoStress. Those who consider themselves more competent again show low levels of TechnoStress, with very few showing signs of moderate-high scores. This is surprising as assumptions are made that those who feel less competent using technology would become more stressed when required to use it, these results however do not support this assumption, and working on statistics alone actually provide information against the assumption.

4.2.2. Techno-change Specific Results and Analysis

The following graphs show the results and analysis of the Techno-change research questions asked to participants. Further analysis by demographics is provided for those questions where interesting results were found.

- Rate of Change and Uncertainty
The results to these initial questions show that all participants believe that technological change rates have increased in recent years, supporting the literature review research above. However the effect this increase has on the participants appears to be unclear, as a clear division is seen between those who agree that the increased rate is overwhelming, and those who disagree.
Attempts to further understand the results show very little. A slight relationship is seen between females and uncertainty, compared to a slight relationship between males and certainty; however these relationships are not strong enough to explain anything significant about uncertainty and the increased rate of change.
• Stress Levels

Graph 8 – Techno-change Q3 and Q4 Results
The main concept of Techno-change appears to be supported by these results, with the majority of participants stating they are stressed when upgrading and purchasing a new device. A significantly large proportion are more stressed when upgrading a technology, compared to purchasing a new device. Further research specifically relating to upgrading technology is therefore likely to show high TechnoStress levels.

- Lack of Necessary Skills

As with Graph 6, this graph shows a clear division between those who feel they have the skills to cope with new technology, and those who do not. However when further analysis is applied, gender specific responses reveal that the majority of male participants perceive that they have the skills required to cope with new technology; compared to mixed responses from the female participants.

Differences can also be seen between the various age categories and their answers. Participants in the age categories 10-25 and 26-40 show high levels of disagreement with the research question; showing that a lack of necessary skills may not affect their TechnoStress levels and likelihood to resist new technologies. This could be due to their higher engagement with new technologies, compared to the older generations.
Graph 10 – Techno-change Q5 Demographic Analysis
• Avoidance Coping Strategies

Although these questions do not relate explicitly, they both relate to avoidance coping strategies as explained by Cui, Bao and Chan (2009).
The results however do not support their findings, showing the majority of participants chose not to avoid change situations. The majority do however only purchasing or upgrade their devices when it is essential that they do so, showing that despite choosing to not avoid change, they only actively seek change when it necessary. This also shows that resistance levels are low amongst the participants.

As expected when comparing previous computer experience and avoidance, the less competent participants show higher levels of avoidance compared to lower levels amongst more competent participants. This shows that once participants feel comfortable with using and understanding technology, they are less likely to avoid it; adoption rates are therefore also likely to be higher amongst more competent users.
• Degree of Control

Graph 13 – Techno-change Q8 and Q9 Results
These questions were purposefully used to confirm the reliability of participant’s answers, as they ask for opposite answers to the same question. Fortunately the results show that this was taken into account by the participants, and a significant majority believe that technology and its development can be controlled. This also identifies the majority of participants to be instrumentalists (Surrey, 1997; Feenberg, 2005).

- **Motivation to Adopt**

Motivation levels are high amongst participant, with over 50% showing high levels of motivation and a large number remaining neutral in opinion. This supports the points made in Graph 11 that resistance levels are low, as relationships have been found between motivation levels and higher adoption rates (Rogers, 1995; 2003).

Given the support of both this graph and the results from graph 11, it can be assumed the majority of the participants are also likely to be defined as Early Adopters or Early Majority by Rogers (1995) and Rosen and Weil (2000). Support from further analysis will however be required to support this assumption.
Relationship between Cognitive Significance and Rejection Response

“Techno-Change Questions”
“I Put Thought into My Decision to Reject Certain Technologies/Change”

Graph 15 – Techno-change Q11 and Q12 Results
As with questions 8 and 9 (Graph 13), these questions were designed to validate the reliability of participants answers, requiring opposite answers to be given. Again this was confirmed through the participant’s answers.

Due to the high levels of thought put into rejection, according to Roger’s Diffusion of Innovations model the majority of participants are engaging in active decisions, increasing their likelihood of continuous resistance (Rogers, 1995; 2003).

- **Significance of Attributes Affecting Adoption**
As expected all four of the attributes mentioned were seen as important factors of adoption by the majority of the participants. This supports Roger’s Diffusion of Innovations model and Tavakoli’s Integrative Model of Organizational change, Stress and Resistance, who both stress the importance of these attributes for successful adoption (Rogers, 1995; 2003; Tavakoli, 2010).

The most valuable attribute based on these responses appears to be ease of use and perceived benefit which coincide with the TAM elements. This therefore supports the previous results, indicating that adoption levels are likely to be high amongst the participants.

A significant number of participants also remained neutral to the statements, perhaps showing that other attributes which were not mentioned are more important to them.
Interesting relationships can also be drawn from further analysis of these attributes, showing that ease of use was of high importance to those with less experience with using a computer, compared to those who consider themselves experts who begin to show signs of devaluing ease of use as an important attribute.
The Importance of Experiencing the Technology Prior to Adoption

Experiencing the device prior to adoption was explored as an essential attribute of successful adoption by Rogers in his model of Diffusion of Innovations (Rogers, 1995; 2003). These results support his model; however as with the results in Graph 16, a significant number of participants remained neutral, perhaps suggesting that the importance of experiencing the device is subject to various situations.
• Influences Affecting Adoption

**“Techno-Change Questions”**
“*My Friends Opinions Influence My Decision to Adopt or Resist Certain Technologies*”

**“Techno-Change Questions”**
“*My Colleagues Opinions Influence My Decision to Adopt or Resist Certain Technologies*”
The TRA discusses the importance of subjective norms influencing an individual’s decision to adopt or reject change. These results show that friends, colleagues and online reviews all strongly influence the participant’s decisions. Online reviews appear to have the most influence over decisions, supported by the literature review research by Reed (2011).
Interesting conclusions can be drawn from analysing the influences against previous computer experience. Participants who identified themselves as beginners tended to value friend’s opinions over colleagues and online reviews, while those who identified themselves as intermediates or experts rated online reviews, over friends and colleagues. To an extent these results could be anticipated, as those less competent with technology are more likely to trust friends over online reviews which they would have trouble accessing in the first place. Experts however are more likely to trust online reviews, acknowledging their value when written by experts/reliable authors.
The Importance of Training and Learning Processes

Graph 21 – Techno-change Q20 and Q21 Results
Interesting relationships can be seen between these two questions relating to the importance and enjoyment of training and learning. After identifying the majority of the participants as Early Adopters or Early Majority, assumptions are met showing that the majority of participants gain enjoyment from learning about new technologies. However results are less clear and predictable when analysing the participant’s evaluation of training. It is possible that answers were based on negative previous experiences of training which have been shown to have dramatic effects on an individual’s overall performance when using a computer (Clark, 1989).

### 4.2.3. Cross Analysis of Techno-change Questions

More interesting relationships can however be seen when comparing all of the questions against each other. This type of cross analysis has revealed unseen relationships which were previously disconnected.

![Graph 22 – Techno-change Question Comparison Matrix](image)

(see Appendix Two for a more detailed copy of this graph)
4.2.4. TechnoStress and Techno-change

Comparison

Using scatter graphs and regression lines, the following graph explores the relationship between TechnoStress scores and each Techno-change question.
Unfortunately after analysing the results of both the GATC total TechnoStress score and each individual Techno-change question, very little can be concluded in terms of comparison. As each sub-graph shows, correlation significance (shown by the red regression line) is very poor. Despite some sub-graph appearing to show slight positive and negative correlations, these are not significant enough to justify generalizing any conclusions from.

It is however questionable that the comparison has revealed no significant results, given the vast amount of literature explored above, and the data gathered and analysed in this research. An alternative approach to this comparison may therefore reveal more useful and significant results.

**Developing a New TechnoStress Scale**

After exploring other approaches to comparing the results gathered and TechnoStress scores, it became obvious that many of the scales used to compare and analyse TechnoStress scores are outdated and no longer accurately measuring modern stress towards technology. Therefore using the data gathered and analysed above, alongside Rosen and Weil’s existing research, a new scale will be proposed to accurately measure Techno-change against TechnoStress.

The new scale was created using the twenty-two questions asked during this research, and the same approach and algorism (for determining the level of TechnoStress) developed and used by Rosen and Weil (1995) was used to generate the following graphs and conclusions.
Although the concluding result is disappointing, with a significantly high proportion of participants showing no signs of total TechnoStress when using the new scale, it does at least allow future researchers to deduct this exact comparison from their own research. The use of the term exact comparison is used specifically, as despite overall TechnoStress levels being low, the data gathered from individual questions and analysed above does indicate interesting relationships between various aspects of Techno-change and TechnoStress.
Graph 25 and 26 show the differences and correlation between the GATC TechnoStress score and the new Techno-change score. It is very clear that no correlation is found between the two, and that differences are significant.

4.3. Conclusions

The significance given to Techno-change as a stressor throughout the literature review section set high expectations for the rest of this research, however after analysing the data received, it is apparent that perhaps Techno-change in this particular form is not a significant cause of TechnoStress. However this is a generalized view of this research, the actual data collected, the relationships identified between the various aspects of Techno-change and the proposal of a new TechnoStress measuring scale provide interesting points of discussion for the following section.
5. Discussion

5.1. Introduction

As mentioned above, this purpose of this discussion is to answer the three research questions identified at the beginning of this research document, and to justify and explore the new Techno-change scale elements in interesting and informative ways.

To ensure that this section remains critical and informative, the research questions have been used as sub-section titles, along with a section explaining the initial GATC results.

5.2. GATC Results

TechnoStress Level

Disappointing results were analysed in graphs 1 to 5 relating to the GATC results gathered, with very little support being provided to the recent research carried out by Pusey and other researchers (Pusey, 2013; Tarafdar et al., 2007; Ayyagari et al., 2011). Pusey identified TechnoStress levels of 88-96% in 2013 and this was expected to continue rising; however the results gathered from this research shows only 70% of the participants suffer from TechnoStress, with the majority suffering from only low forms of TechnoStress.

One explanation for the differences identified could be the difference in sample size and sample diversity. The age ranges used for this research were all accounted for by the large sample size, ranging from age 10 to 85. The analysis in graph 3 revealed an interesting relationship between low TechnoStress scores and increasing participant age. This was unexpected, as the literature review suggested that older individuals suffer from increased levels of uncertainty and decreased performance scores during computer training (Molinie, 2002).

Another explanation could be that by using only an online survey to collect results, those who are more likely to suffer from TechnoStress may have avoided completing the survey or attempted to complete the survey and became frustrated (Lazer et al., 2006).
Over 25 responses received were incomplete, suggesting that difficulties occurred when filling out the survey. As no problems were reported, it would not be unreasonable to assume that these responses were either abandoned due to boredom (unlikely given the simple questions and Likert scale answering) or due to difficulties using the online survey software (characterized as a strain of TechnoStress).

5.3. Has the Pace of Technological Change Increased in Recent Years?

Rate of Change and Uncertainty

Substantial amounts of research throughout the literature review suggests that technological change will continue to occur and increase as time goes on. Moore’s Law and the Law of Accelerating Returns explain that the rate of change will continue to increase rapidly until eventually reaching the Singularity (Kurzweil, 2001; Moore, 1965). The Singularity is a time when technological change happens at such a rapid pace that it “represents a rupture in the fabric of human history” (Kurzweil, 2001).

The results gathered from this research support this, with all participants perceiving an increase in the rate of technological change in recent years (see graph 6). With such significant results and supporting research, it is clear that technological change will only continue to increase in pace and become an overwhelming issue. However this research indicates that at the moment the stressful effects of technological change appear to be manageable (see graph 6). Participants may believe that the pace of change is increasing, but a clear division is seen between those who felt overwhelmed as a result of the increased pace and those who did not. A significant correlation of 0.7 is also seen between those who identified feelings of being overwhelmed and their lack of skills to cope with change (see appendix 2). This explains the division further, as those who perceive that they do not have the skills required to cope with new technologies, begin to feel overwhelmed when the pace of change increases, as they expect more advanced technologies to arrive soon leading to an increased need for superior skills and knowledge.
A weaker but highly significant correlation of 0.4 can also be seen between feelings of being overwhelmed and perceiving lack of control. Research shows that a perceived lack of control, not only causes uncertainty but also contributes towards anxiety and resistance (Hansen, 2001; Jick and Peiperl, 2003; Yu, 2009). By perceiving a lack of control, participants also identify themselves as determinists who believe that the pace of change cannot be directed or controlled (Feenberg, 2005). Sharing a deterministic view of technological change affects the likelihood of adoption of new technologies as well, because as shown in the TRA and TAM, beliefs and attitudes contribute significantly to overall adoption success (Fishbein and Ajzen, 1975; Davis, 1989).

5.4. What Influences an Individual’s Technological Change Response and Beliefs?

Lack of Necessary Skills

Although not explicitly mentioned within the literature review, perceiving a lack of skills to cope with new technologies is discussed through ease of use and complexity within the majority of models discussing adoption of new technologies. For example, the TAM states that a device must be perceived as easy to use before adoption is even considered (Davis, 1989). Rogers (1995; 2003) also addresses the issue of complexity in the Diffusion of Innovations model, supporting Davis by declaring ease of use as essential criteria for adoption.

The results of this research show a division again between those who believe that they do not have the skills required to cope, and those who believe that they do have the skills required. However as the analysis shows, the younger participants tended to believe in their skills and knowledge more. This relates strongly to their high engagement levels with technology and training from a young age, compared to those from past generations who struggle in training and were not bought up using devices on a daily basis (Clark, 1989).
Strong relationships are also seen between perceived lack of skills and increased uncertainty, stress levels (when upgrading technologies) and avoidance (see appendix 2). These all indicate a high likelihood of resistance according to Cui, Bao and Chan (2009) and Tavakoli (2010).

**Avoidance Coping Strategies**

The analysis (Graphs 11 and 12) revealed that avoidance as a coping strategy was not popular amongst the participants, however the majority of participants would only adopt new technologies when absolutely necessary. This disproves Cui, Bao and Chan’s model, as neither avoidance (avoiding situations of change and any knowledge of change) or confrontation (the process of gaining knowledge and experience prior to adoption) strategies are used. Prediction of adoption or rejection based on this model are therefore likely to be flawed and inaccurate.

Cross question analysis does however show a strong negative correlation between avoidance of technological change and enjoyment from learning about new technologies (see appendix 2). This supports expectations as those who engage in avoidance strategies, do not want to learn about new technologies or care of their existence. Using this analysis and Roger’s Diffusion of Innovations model which identifies gaining knowledge as one of five stages towards confirmed and successful adoption, conclusions can be drawn that resistance is likely due to a lack of knowledge and understanding.

**Degree of Control**

As explained above, control over technology and decisions made relating to upgrading/purchasing technology, is a highly significant factor when attempting to predict adoption or resistance behaviours. The results of the analysis (graph 13) show that despite the relationship acknowledged between participants who are uncertain/overwhelmed and their reduced perception of control above, in general, the majority of participants can be identified as instrumentalists, viewing technology as controllable (Feenberg, 2013). As the perceived degree of control is high, adoption of new technology is also likely to be high, as the beliefs and attitudes of instrumentalists are more positive and accepting of technology. This is supported by both the TAM and TRA, both showing the significance of beliefs and attitudes towards technology when adopting new technologies.
What is interesting however is how the perceived degree of control not only influences strongly on adoption and resistance decisions, but also on an individual’s motivation to learn about new technologies and the enjoyment they receive from doing so. A correlation can be seen between questions 8 and 10/21 showing this (see appendix 2). This further supports the concept that instrumentalists and those perceiving a high degree of control over their technology and decisions, are likely to adopt new technologies. It is likely that an individual’s perception of control is increased as a direct result of their knowledge acquired from learning about new technologies. As with the concept of perceived skills for coping above, it is highly likely that the younger participants have been exposed to more teaching based around use of devices and therefore their skills and perception of control is increased alongside their knowledge of the device/technology. Higher adoption rates can therefore be expected from those who perceive higher degrees of control and skill.

**Motivation to Adopt**

Further supporting the arguments made above, the analysis reveals high levels of motivation to adopt new technologies. Based on Rogers (1995) and Rosen and Weil’s (2000) characteristics, this would define the majority of the participants as Early Adopters or Early Majority. Relations are being to emerge between the various questions which are not statistically obvious through the matrix in Appendix 2. For example, the lack of support for the avoidance coping strategy seen in graphs 11 and 12, can be explained by the high motivation to adopt new technologies.

**Cognitive Significance**

Based on the analysis of questions 11 and 12 (graph 15), the Diffusion of Innovation model suggests that resistance is likely to be continuous due to their active engagement with their decision to reject the change. This does not however support the conclusions drawn from the above discussion showing high levels of motivation to adopt. This may be explained by Lazarus’s theory of Stress (Lazarus, 1993). Lazarus suggests that cognitive appraisal of a situation or object is a continuous process, and therefore due to the rapid pace of change and development identified above, active decisions are likely to occur again once a situation or object (in this case, a device or technology) has significantly changed. The nature and pace of technological change would therefore lead to rapid reappraisal opportunities; and given the
high motivation of participants to adopt new technologies, it is likely that adoption will occur in due time.

**Perceived Benefits, Ease of Use, Entertainment Value and Price**

Questions 13, 17, 19 and 22 were designed specifically with this discussion in mind, to discover the significance of influencing attributes (identified from the literature review research) when deciding to adopt or resist technological change.

Many of the models explored within the literature review list attributes which are proposed as required criteria for successful adoption, failure to meet the listed criteria therefore increases the likelihood of the change being rejected. Roger’s Diffusion of Innovation model suggests five attributes: relative advantage (perceived benefits), computability, complexity, trialability and observability. Due to the formation of the questions, the majority of Roger’s attributes have been explored in different questions (below), however relative advantage refers to the requirement of perceived benefits/advantages over existing solutions/technologies (Rogers, 1995; Sahin, 2006). This is also supported the TAM, which states the importance of usefulness when deciding on adopting a change (Davis, 1989). According to the analysis (graph 16), almost 85% of the participants valued this attribute as influencing their decision to adopt a change, this is therefore a widely accepted as a significant influence on adoption decisions.

The TAM also discusses the significance of the ease of use of a device when considering adoption, supported by the complexity of the device discussed by Rogers. These attributes refer to how easy the device is to operate, which based on the analysis of the importance of perceived skills discussed above, is of high importance. Again the analysis reveals that over 85% of the participants value the ease of use of a device as important; 30% of those participants even showed strong levels of agreement. Given the importance of user-centered design principles in the design and development process of modern devices, it is not surprising that these conclusions have been drawn.

Entertainment value is discussed as an important attribute in the coping model proposed by Cui, Bao and Chan (2009). They also support the above attributes, identifying the following three main influences: usefulness, ease of use and fun (entertainment).
Unlike the other two attributes discussed above, the analysis showed that only 60% of the participants value entertainment as an influencing power over their adoption decisions. The noticeable increase of neutral responses noted in the analysis, also suggests that entertainment may only be seen as valuable in some situations/environments. Jayson (2009) identifies the different uses of the internet when used by individuals of different generations, showing higher uses of the internet for entertainment purposes by the younger generations. While Palazzi, Marfia and Roccetti (2014) identify how different features and software have led to multi-dimensional devices capable of performing a wide variety of tasks and fulfilling multiple purposes.

Lastly, the influence of price is analysed in graph 16 showing similar results to the value of entertainment as an influence above, with just over 65% of participants identifying it as an important factor when considering adoption decisions. Unlike the previous attributes price was not identified as an influence of adoption decisions within the literature review, this was therefore included to identify any potential relationships. No relationships were found during the analysis, however given the majority of participants identifying it as an important influence, more research in the future may lead to more valuable and interesting results.

**Experiencing/Observing the Technology**

The analysis of question 14 (graph 18) showed that 50% of the participants acknowledge the importance of experiencing and observing the change object (device) prior to adoption. As mentioned above, this was included due to its inclusion within Roger’s Diffusion of Innovation model (Roger, 1995). The influence of this as a significant influence is however questionable given the number of neutral and negative responses shown in the analysis, however further research would confirm this.

**Friends, Colleagues and Online Reviews**

Unlike the above influences, significant support can be found from the analysis of graphs 19 and 20. Participants identified online reviews as significantly influencing their decisions to adopt or resist technologies, followed by friends and colleagues both showing high levels of support. These results are supported by the TRA, through the use of subjective norms affecting an individual intent and behaviour (which can also be applied to making decisions, such as whether to adopt a technological change).
Further research from the literature review suggested that consumers were more likely to trust friends recommendations over online critics, however this is not shown in the results gathered in this research as online reviews were identified as the most influential (Goldstar Events, 2007). However as explained in the analysis, friends were trusted and seen as more influential for those participants who identified themselves as beginners when using a computer. This is likely to be due to the relationship between uncertainty and lack of computer experience, leading beginners to distrust online sources (Anderson, 2013).

5.5. What Relationships Exist Between Technological Change Responses, Beliefs and TechnoStress Levels?

Unfortunately even with the creation of a new Techno-change scale to accurately measure TechnoStress scores against the Techno-change relevant questions, relationships between the two appear weak. Graphs 25 and 25 clearly show no correlation between Techno-change response scores and TechnoStress levels.

This could be due to problems with the new scale created, however as the scale was created from the twenty-two questions asked to participants, which were all based on accurate and proven literature review research, that is unlikely. It is more likely that the sample used in this research does not represent the general population. Arguments have already been raised regarding the use of an online survey, omitting those likely to suffer from TechnoStress and those following resistant behaviours (Cui, Bao and Chan, 2009).
It is worth noting however that 40% of the participants are still shown to suffer from TechnoStress when using the Techno-change scale; therefore it may just be certain parts of the scale which are leading to the reduced final figure.
6. Conclusions and Recommendations

6.1. Conclusions

Despite resulting in unexpected results, this research does highlight some key relationships when discussing TechnoStress levels and the nature of technological change. By splitting the initial literature review research into Stress, TechnoStress and Techno-change, each section can now be reapplied to various elements of the Techno-change scale to create the foundations for further research.

In terms of the research questions asked, the following conclusions can be drawn:

- To identify whether the pace of technological change has increased in recent years.

Results show that perceptions of technological change are that it is increasingly rapidly, and a clear relationship can be seen between perceived pace of change and feelings of being overwhelmed. This supports the expected results, and the literature review research.

- To identify what influences an individual’s technological change response and beliefs.

After identifying various models and approaches in the literature review, it is clear that some influences are deemed more significant than others. According to this research: degree of control, relative advantage, ease of use, friend’s opinions and online customer reviews are all shown to significantly affect an individual’s decision to adopt or resist technological change.

- To identify the relationships between technological change responses, beliefs and TechnoStress levels.

As mentioned above, only 40% of the participants appeared to suffer from TechnoStress when using the new measuring scale. This is disappointing given the amount of research and time spent developing the concept of Techno-change; however due to the vast amount of research carried out into each element of the scale future research can be carried out using specific elements of the scale, shown in the analysis to produce strong results. For example, more emphasis on influences mentioned above.
Overall the conclusions that can be drawn from this research show that relationships do exist between various elements of the Techno-change scale and TechnoStress, but that this particular research wasn’t able to show their potential. These relationships are identified throughout the analysis and discussion sections above; and in the graph seen in appendix 2.

### 6.2. Recommendations and Future Research

As this research focused on attempting to find relationships between various causes (primarily Techno-change) and TechnoStress, the recommendations listed below are for the attention of future researchers or for those who feel that Techno-change may affect them in some way and want to know more about what they should do next with this research.

- This research has identified the need for further research to be carried out finding relationships between adoption, resistance and general stress. Additional research will then be needed to relate these findings specifically to TechnoStress.

- The Techno-change scale produced in this research should be adapted for future use, as it is unclear whether the scale is accurate without further testing.

- Further research should also be carried out relating specifically to the use of coping strategies (such as avoidance) and resistance, as these appeared to relevant to a lot of the Techno-change scale elements.
7. Personal Reflection

Reflecting on the process of writing this dissertation, it is clear that I have had a difficult time finding the inner strength required to reach this point. I have always had a clear mind when making decisions regarding my education, my mind was always set on getting as far as possible in education before deciding on a career. However since starting my university course, my views and values have changed significantly.

Initial progress was slow and the work accomplished is now lost amongst the many word documents (all copies of the same Dissertation-version###.docx) found on my external hard drive. I have an extremely frustrating problem where progressing onto additional tasks if I believe my completed work is not a high standard, is impossible. This leads to re-writing the same section many times (the literature review above was re-written completely five times). Although I can accept this as my way of ensuring that I am doing the very best I can, when in an academic environment it frustrates tutors and means my work is never checked until after the deadline; this seriously hinders its potential. Luckily I have strong relationships with my tutors and friends, and I was therefore able to get advice and guidance from them without causing too many problems.

Progress was also hindered due to the extensive research I carried out during the initial few months, when deciding on an innovative and significant topic to use. I had so many ideas forming in my head that it was impossible to fully evaluate each idea for its potential. I therefore had to settle on an idea which I believed to be of value, based on intuition and a little initial research. This meant that finding reliable sources of information was hard (compared to others who identified topics with vast amounts of previous research and found value through relating them to new concepts or theories).

I also didn’t manage to get my survey sent out into the public domain until a few weeks before the final deadline due to constant changes being made to my literature review and questions. This significantly affected the time I had available to gather and analyse the results.

In the future I will look to create a structured plan from the start of a project, and ensure that milestones were put in place to track my progress. I feel that by doing this I would be able to acknowledge when I am spending too much time on a single aspect of the entire process, and correct my actions before they cause any significant knock on effects.
8. Bibliography


Gender Differences Based on Skin Conductance, Hindawi Publishing Corporation: US.


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9. Appendices

1. Appendix One – Survey Questions

1. The rate of technological change has increased in recent years.

2. I feel overwhelmed by the increased rate of change.

3. I often feel stressed when upgrading my existing technology.

4. I often feel stressed when purchasing a new technology.

5. I often feel that I do not have the skills to cope with new technology.

6. I avoid situations which require upgrading my existing technology or purchasing new technology.

7. I only purchase/upgrade to new technologies when it is essential that I do so.

8. Technology is just a tool, I am in control of how and when I use it.
9. Technology cannot be controlled.

10. I feel motivated to find out more about new technology.

11. I put thought into my decision to reject certain technologies/change.

12. I put no thought into my decision to reject certain technologies/change.

13. I must perceived benefits to using a new technology before purchasing/upgrading to it.

14. I must experience (trial) new technologies before purchasing/upgrading to them.

15. My friend’s opinions influence my decision to adopt or resist certain technologies.

16. My colleague’s opinions influence my decision to adopt or resist certain technologies.
17. Ease of use is important to me when purchasing or upgrading to new technology.

18. Reviews from other users are important to me when purchasing or upgrading new technology.

19. Entertainment value is important to me when purchasing or upgrading to new technology.

20. Training is important after purchasing/upgrading to new technologies.

21. I enjoy learning how to use a new technology.

22. I wait for technology to be a certain price before deciding to purchase it.
2. Appendix Two – Matrix Comparison