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Peter O'Boyle
Department of Communications, Marine, and Natural Resources, peter.oboyle@dcmnr.gov.ie

Thomas Acton
National University of Ireland, thomas.acton@nuigalway.ie

Michael Campion
National University of Ireland, Michael.Campion@nuigalway.ie

Kieran Conboy
National University of Ireland, kieran.conboy@nuigalway.ie

Murray Scott
National University of Ireland, murray.scott@nuigalway.ie

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Peter O'Boyle

Department of Communications, Marine, and Natural Resources,
Adelaide Rd, Dublin 2, Ireland
peter.oboyle@dcmnr.gov.ie

Thomas Acton

Michael Campion

Kieran Conboy

Murray Scott

National University of Ireland, Galway, Ireland.
[firstname].[lastname]@nuigalway.ie

Abstract

Usability is an important component of information systems acceptance. Independent consultants in the assessment of organisational intranets often perform heuristic appraisal, a common method of usability evaluation. However, there are alternative usability models that offer valuable analysis in the evaluation process. Using a government organisation's intranet as a case study, this paper assesses the value of an independent heuristic-based intranet audit by providing a comparable approach to assessment realisable internally in the organisation using questionnaires. Using a single case study, we empirically apply the Technology Acceptance Model (TAM), together with some heuristic aspects, to provide an alternative tool for intranet usability and acceptance. We provide insight into the usability impact of intranet design changes, and compare the findings of an external usability audit with the approach outlined. An overall toolset for intranet evaluation is proposed as an initial step for further exploration and potential use.

Keywords: intranet, evaluation, acceptance, TAM, eCollaboration, eInfrastructures

1   Introduction

The main driver behind the growth of organisational intranets is the ability to meet business goals through improved productivity and efficiency of employees (Lederer, Maupin, Sena and Zhuang, 2000). Intranets can offer significant benefits through internal communication, collaborative/cooperative work, knowledge management and

process redesign (Baker, 2000). In intranet development, usability is a critical element determining not only user acceptance of the system but also in gaining the potential benefits of intranet technology. This paper empirically compares a heuristic evaluation model conducted by independent consultants with an alternative approach combining the Technology Acceptance Model (TAM) and some heuristic aspects as indicators of intranet usability. The latter approach is fully realisable within organisations through the use of internally implemented and distributed questionnaires. This case study illustrates the relative effectiveness of the internal approach: we argue that best practice in intranet evaluation can be achieved from the use of these indicators. This paper provides an initial case to support this.

2 Organisational Intranets

Intranets are a small-scale version of the Internet, but only accessible from within an organisation, and protected from unauthorised users by a firewall (Denton, 2003; Horton, Buck, Waterson and Clegg, 2001; Lloyd, 1998). An intranet can also be considered as an information technology application to a defined community of users within an organisation (Dasgupta, 2001). Typically, intranets use the same technologies and software as the Internet. As such, intranets are typically accessed using the same web browser applications used for accessing the Internet (Baker, 2000).

2.1 Benefits of Intranets

In an environment where knowledge has become an extremely important resource, intranets have been identified as having significant benefits for an organisation (Horton et al., 2001). Lloyd (1998) identifies many particular benefits experienced by organisations from the development of intranets, including improved competitiveness gained through operational efficiency and improved productivity through increased access to timely and up-to-date information; cost savings related to reduction of papers use, warehousing documents and distribution, time savings on searching for and locating information, improved productivity due to faster communication of information, and easier understanding of information due to instinctive intranet interfaces (Lloyd, 1998). However, the benefits of intranets can only be achieved if intranet users are viewed as customers of the organisation and by designing the intranet with usability best practice in mind (Ganzalez, 1997). Indeed usability is a central aspect of an intranet's success (Perrott, 2001).

2.2 From Usability to Acceptance

Mayhew (1999) considers usability as a quantifiable characteristic of an information system and an important aspect of its overall quality, a view echoed by others (De Angeli, Matera, Costabile, Garzotto and Paolini, 2003; Fu, Salvendy and Turley, 2002). In the 1980s, laboratory usability testing was the primary evaluation approach through user performance assessment (Hartson, Andre and Williges, 2001). This testing allowed increased product competitiveness and reduced risk by increasing user satisfaction and acceptance. The 1990's brought about a need for new models with reduced costs and time associated with the traditional usability testing approaches (Hartson et al., 2001). These approaches include heuristic evaluations, cognitive walkthroughs, usability walkthroughs, ergonomic criteria and thinking aloud techniques (Hartson et al., 2001; Hertzum and Jacobsen, 2003; Sears, 1997).

However, usability is meaningful only in terms of what it achieves. Benbunan-Fich (2001) maintains that usability defines the extent to which a user can interact with the system's interface to perform functional tasks. Such a view encompasses both 'ease of use' and 'usefulness' aspects, the former in terms of a system whose interface is easy to use, and the latter in terms of the ways the system supports utilitarian task-focused objectives. These facets of usability are perceptual, based on users' attitudes towards a system, and are also central to information system acceptance (Acton, Golden and van der Heijden, 2005; Davis, 1989; Hong, Thong, Wong and Tam, 2001; Keil, Beranek and Konsynski, 1995; Lederer et al., 2000; Szajna, 1996; Venkatesh, Morris, Davis and Davis, 2003). Doll and Torkzadeh (1988) argue that there is "increasing evidence that the effective functioning of an application depends on its ease of use". Some authors argue that system use is affected by the system's perceived ease of use and perceived usefulness, and that perceived ease of use has a positive effect on an individual's attitudes and intentions toward using an information system (Davis, Bagozzi and Warshaw, 1989; Hassenzahl and Wessler, 2000b; Mathieson and Keil, 1998; van der Heijden, 2003; Venkatesh and Davis, 2000).

There is much discussion in human computing aspects of the information systems literature regarding the importance of using effective methods for evaluating the usability, user satisfaction and acceptance of information systems (for example, see De Angeli et al., 2003; Nielsen, 1993). Nielsen (1993) argues that the design of an intranet is predominantly the same as that for an Internet-based website because the fundamentals of usability do not change from one to the other for the user. However, he outlines that poor usability of intranets result directly in organisational losses of efficiency and productivity due to users not accepting the new system, resulting in unanticipated costs for the organisation.

The measure of system success lies generally in its evaluation (Acton, Golden and van der Heijden, 2008; Molich and Dumas, 2008; Nielsen and Faber, 1996) and assessed centrally through measures of usability, user satisfaction and usage of the system (Chin, Norman and Diehl, 1988; Christie, Klein and Watters, 2004; Garrity, Glassberg, Kim, Sanders and Shin, 2005). The achievement of the final objectives of the system can be evaluated from the user's perspective, through measures of usability (Acton et al., 2008; Choi, 2007; Hix and Schulman, 1991). Indeed many of the factors that affect ease of use have a direct effect on usability, and so must be accommodated in usability metrics (Morris and Dillon, 1997).

3 Evaluation Models for Usability and Acceptance

3.1 Heuristic Evaluation

Heuristic evaluation is a popular form of usability evaluation (Barnum, 2002), and is applied widely in varying contexts (Blandford, Hyde, Green and Connell, 2008; Conte, Massolar, Mendes and Travassos, 2009; Hwang and Salvendy, 2009; Molich and Dumas, 2008). In performing evaluations, evaluators assess the information system's compliance with a set of recognised usability heuristics or principles (De Angeli et al., 2003; Fichter, 2004; Hertzum and Jacobsen, 2003; Molich and Dumas, 2008; Nielsen, 2005; Sears, 1997). Major and minor usability problems can be quickly identified through heuristic evaluation models (Fichter, 2004). Nielsen (2005) explains heuristics as principles or rules, which describe usable interface elements and are best used early in the design process. However in themselves, heuristic evaluations do not provide solutions to usability problems identified, but

seek to explain the difficulties identified (Nielsen, 2005).

3.2 TAM

The TAM model is one of the most influential models of evaluating information technology acceptance and usage (Chau, 1996; Garrity et al., 2005). TAM was designed to be applied to computer usage behaviour in order to model user acceptance of information systems, (Davis, 1989; Davis et al., 1989; van der Heijden, 2003). The goal of TAM is to explain the usability factors that determine user acceptance and usage. TAM uses the Theory of Reasoned Action (TRA) as a theoretical basis for specifying relationships between two key beliefs: perceived usefulness and perceived ease of use, and users' attitudes and intentions towards actual system adoption behaviour. Previous studies using TAM have indicated the appropriateness of certain constructs and their applicability to examining perceptions towards different and various systems; however these studies have also shown a lack of consistency in the identification and strength of relationships between the constructs in different contexts. Horton et al. (2001) suggest that TAM is appropriate for modelling intranet acceptance. Indeed, as discussed earlier, ease of use and usefulness are central aspects of usability. Support for TAM for websites and web applications is also provided by Lederer et al. (2000).

4   Method

This case study research compares the results of an external heuristic-based usability audit of an intranet undergoing design changes with those from an alternative tool comprising the Technology Acceptance Model (TAM) with some questionnaire-based heuristic equivalents to the audit. In this paper we refer to the external usability audit as the 'external' approach, and to the internal questionnaire-based method involving TAM and some heuristics as the 'internal' approach. Consultants conducted the heuristic-based audit independently. In previous TAM studies ease of use and usefulness have been consistent predictors of acceptance, particularly in the case of systems with utilitarian functions, with enjoyment and attractiveness becoming more influential in more hedonic instances and scenarios of use. Considering the largely utilitarian usage of the intranet investigated, we expected enjoyment and attractiveness to perhaps take a back seat. We collected data capturing the redesign of an organisation's intranet, enabling an investigation of the suitability of these metrics as potentially valid and useful indicators of usability. The study used a quantitative survey approach conducted through two questionnaires. The organisation was in the process of switching from an old intranet version to a new version. The questionnaires were within-subjects, and were completed by users of the intranet at that point in time when the design of that intranet was changing and the new version was in the process of implementation: in stage 1 questionnaires were completed based on the old outgoing design, and in stage 2 the same users completed questionnaires based on the new design.

Twenty-six participants completed questionnaires in both stage 1 and stage 2. The participants were all employees of a large government department and regular users of that department's intranet. The sample covered low-level staff through to high-level management providing a broad range of the organisation's intranet users. The overall data collection process for this case comprised three sources: the usability audit conducted by independent consultants on the old intranet and the two within-subjects

questionnaires conducted by the researchers on the old and new intranets respectively. The TAM and usability heuristic indicators employed in this research measured very similar aspects of usability. To investigate the value of the audit and also to determine if equivalent findings could be generated using an internal questionnaire approach, the heuristic aspects to the internal approach mirrored those used in the external audit. The usability audit used eight heuristic indicators, which were mirrored in the internal questionnaire approach using multi-question constructs, and verified using reliability analyses: 1) optimising the user experience, 2) homepage design, 3) page layout, 4) navigation, 5) headings and labels, 6) text appearance, 7) graphics and images, and 8) content organisation. As the intranet had some hedonic usages, TAM's more hedonic indicators (enjoyment and attractiveness) were included. As such, the complete set of indicators from the Technology Acceptance model findings were those commonly found in the TAM literature, and were four-fold: 1) perceived usefulness, 2) perceived ease of use, 3) perceived enjoyment, and 4) perceived attractiveness. The instrument used Likert scaled response items for component questions belonging to each of the respective model's constructs.

5 Findings

This section outlines the research findings stemming from statistical analyses of the data obtained from the internal questionnaire-based approach compared with the external usability audit. In each case, paired sample t-tests were used to investigate within-sample differences and correlations.

5.1 Optimising the User Experience

The external usability audit found that documents and images on the old intranet did not provide sufficient information (table 1). Using the internal approach, the mean value for imagery 'optimisation' construct on the old intranet design was 4.0641 (table 1), a similar result to the usability audit. Correlation between the old and new intranet was insignificant. The new design failed to optimise the user experience.

Table 1: User Experience

Optimising the User Experience	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	4.27		
Stage 1	4.0641	.828	
Stage 2	4.4936		
Stage 1 / Stage 2			>0.05

5.2 Home Page Design

The audit found that the home page was problematic for the old intranet. Using the internal approach, the mean value for the home page design heuristic on the old intranet was 4.2628 (table 2), a higher result than the audit. Correlation between the old and new intranet was insignificant. This suggests that home page design on the new intranet had not improved.

Table 2: Homepage Design

Home Page Design	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	3.71		
Stage 1	4.286	.916	
Stage 2	4.8462		
Stage 1 / Stage 2			>0.05

5.3   Page Layout

The audit found that the page layout length and information positioning on the old intranet was problematic (table 3). Using the internal approach, the mean value for the page layout heuristic on the old intranet was 3.7949, a lower result to the usability audit. Overall, the mean increased by 1.01282 ($p < .05$), indicating that the page layout improved in the new design.

Table 3: Page Layout

Page Layout	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	4.76		
Stage 1	3.7949	.885	
Stage 2	4.8077		
Stage 1 / Stage 2			<0.05

5.4   Navigation

The audit identified navigation as a problematic area on the old intranet design (table 4). Using the internal approach, the mean value for the navigation heuristic on the old intranet was 3.8205, a similar result to the audit. Correlation between the old and new designs was significant, indicating that there is a positive relationship between the perceptions of the old intranet and the perceptions of the new intranet. Overall, the mean increased by .70513 ($p < 0.05$), illustrating that there is a significant difference for the navigation construct from the old intranet to the new intranet: page navigation was improved in the new design.

Table 4: Navigation

Navigation	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	3.71		
Stage 1	3.82	.778	
Stage 2	4. 5256		
Stage 1 / Stage 2			<0.05

5.5   Headings and Labels

The audit found that the headings and labels need to be more meaningful, unique and more easily understood by existing and new users of the old intranet. Using the internal approach, the mean value for a 'headings and labels' construct on the old design was 4.3333 (table 5), a higher result than the audit. Correlation between the old and new values for this construct was significant. Overall, the mean increased by .60256 ($p < 0.05$) illustrating that there is a significant difference for the headings and labels' usability value from the old design to the new, and suggesting that headings and labels were improved in the new design.

Table 5: Headings and Labels

Headings and Labels	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	3.50		
Stage 1	4.333	.886	
Stage 2	4. 9359		
Stage 1 / Stage 2			<0.05

5.6 Text Appearance

The audit found the text appearance on the old intranet to be good and consistent. Using the internal approach, the mean value for the text appearance construct on the old intranet was 4.8846 (table 6), a lower figure than that identified by the audit. Correlation between values on the old and new designs was insignificant: overall, the mean increased by only .34615 (p > 0.1), suggesting that although the old design's text appearance was good, this had not improved in the new intranet design.

Table 6: Text Appearance

Text Appearance	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	5.60		
Stage 1	4.8846	.869	
Stage 2	5.2308		
Stage 1 / Stage 2			>0.1

5.7 Graphics and Images

The audit (and the internal questionnaires) investigated whether graphics and images aided users in the comprehension of information on the intranet. The audit suggested insufficient use of graphics and images in this regard (table 7). Using the internal approach, the mean value for the graphics and images construct on the old design was 3.6346, substantially lower than the audit. Correlation between values on the old and new design was significant at .496. Overall, the mean value increased by .92308 (p < 0.05), illustrating a significant difference for values on the graphics and images construct. Graphics and images were better in the new design in terms of aiding users in comprehending information.

Table 7: Graphics and Images

Graphics and Images	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	6.16		
Stage 1	3.6346	.933	
Stage 2	5.2308		
Stage 1 / Stage 2			<0.05

5.8 Content Organisation

The audit found that content organisation was important, with a need for the home page and home page sections on the old intranet to provide important and well-structured information. The internal approach constructed a 'content organisation' construct: the mean value for the content organisation construct on the old design was 4.0385 (table 8), a lower result to the audit. Correlation between values was

significant. Overall, the mean increased by .64103 (p < .05), indicating that there was a significant difference for the content organisation construct: it was improved in the new design.

Table 8: Content Organisation

Content Organisation	Likert value	Cronbach Alpha	p (t-test)
Usability Audit	4.20		
Stage 1	4.0385	.805	
Stage 2	4.6795		
Stage 1 / Stage 2			<0.05

The following TAM-based usability indicators were employed in the internal approach only.

5.9   Perceived Enjoyment

Correlation between enjoyment on the old and new intranet was significant at .644 (table 9). Overall, the mean increased by .39560 (p < 0.05), showing a significant increase in perceived enjoyment from the old to the new design. This indicates that use of the new design was more enjoyable.

Table 9: Enjoyment

Perceived Enjoyment	Likert value	Cronbach Alpha	p (t-test)
Stage 1	3.5165	.931	
Stage 2	3.9121		
Stage 1 / Stage 2			<0.05

5.10   Perceived Attractiveness

Correlation between perceptions towards attractiveness on the old and new designs was .117 (table 10). Overall, the mean increased by 1.07418 (p < 0.05) indicating a significant difference for perceived attractiveness from the old to the new design.

Table 10: Attractiveness

Perceived Attractiveness	Likert value	Cronbach Alpha	p (t-test)
Stage 1	3. 9835	. 959	
Stage 2	5.0577		
Stage 1 / Stage 2			<0.05

5.11   Perceived Usefulness

Correlation between usefulness values on the old and new intranet designs was significant at .738, indicating that there is a strong positive relationship between the perceptions of the old perceived usefulness and the perceptions of the new (table 11). There was an insignificant difference for perceived usefulness from the old intranet to the new intranet, indicating that the new intranet design did not significantly improve its usefulness.

Table 11: Usefulness

Perceived Usefulness	Likert value	Cronbach Alpha	p (t-test)
Stage 1	4. 3910	. 945	
Stage 2	4.7115		
Stage 1 / Stage 2			>0.05

5.12 Perceived Ease of Use

Correlation between ease of use on the old and new designs was insignificant at .317, indicating an insignificant relationship between perceptions (table 12). There was no significant difference for perceived ease of use from the old intranet to the new intranet design. This illustrates that perceptions towards ease of use neither improved nor declined.

Table 12: Ease of Use

Perceived Ease of Use	Likert value	Cronbach Alpha	p (t-test)
Stage 1	4. 7308	. 948	
Stage 2	5. 0545		
Stage 1 / Stage 2			>0.05

6   Discussion

The study aimed to provide a step towards a more comprehensive and insightful indicator of intranet usability, rather than sole reliance on external usability audit heuristics. The internal questionnaire-based approach showed that the page layout, navigation, headings and labels, graphics and images, and content organisation constructs were improved in the new design, while optimising the user experience, homepage design and text appearance constructs were not. These aspects were not captured in the external audit, primarily because the audit focused on the old design with the intent to identify usability problems for address. Further, the audit did not identify whether items requiring address were effectively implemented, whereas the internal approach provided indicators in this regard. This case study suggests that heuristic indicators can certainly provide usability evaluation information for evaluators in identifying specific usability problems, but that their ability to identify more fundamental usability-related issues may be lacking, in particular ease of use, usefulness, enjoyment and attractiveness. In employing TAM, these aspects were comprehensively captured by the internal approach. Considering the findings here with respect to the more hedonic aspects, namely enjoyment and attractiveness, and the strong impact these constructs can potentially have on system acceptance (see Agarwal and Karahanna, 2000; Davis, Bagozzi and Warshaw, 1992; van der Heijden, 2003; Venkatesh, 1999), the external audit failed to identify these influences, which could negatively impact any clear definition of design changes required to the intranet. Further, a limitation of heuristic evaluation such as that employed in the external audit is that the method is more effective at identifying usability problems that advanced users may encounter (see Fu et al., 2002), and so may fail to capture problems experienced across a range of user abilities or experience.

TAM's perceived enjoyment construct indicated a very strong positive correlation

between the old intranet and the new, with a significant mean improvement of users' perceived enjoyment of the new design. Participants found using the new intranet to be a more enjoyable experience than the old intranet. The perceived attractiveness construct found a low positive correlation but a significant mean difference between the old intranet and the new intranet design. This suggests that the new design improved the attractiveness of the intranet. Users' perceptions of usefulness towards the intranet design were not improved in the new design. Further, and although the construct is reliable (Davis, 1986; Davis, 1989; Horton et al., 2001; van der Heijden, 2003), users did not find an overall improvement in ease of use from the old intranet to the new intranet design. It is interesting to note that the more hedonic aspects of the new intranet design were the most influential on users' perceptions, and that utilitarian improvement was insignificant. This is somewhat surprising considering the work-related usage of the intranet. Nevertheless, together, these two hedonic factors (enjoyment and attractiveness) can positively impact acceptance of the new design, and lead to increased use.

7 Conclusions

The case study has identified possible limitations in the employment of a single heuristic-based usability evaluation method for organisational intranets. The case shows that a triangulatory approach may be more valuable by providing deeper insights. This case also indicates that a more inclusive 'toolset', for intranet evaluation may be appropriate, including a combination of usability indicators. While a single case study cannot in itself define a toolset representing best practice in intranet usability, the findings here suggest that a toolset for intranet evaluation could at least initially be constructed from the eight heuristic usability constructs and the 4 TAM constructs used in the study. The components of this initial toolset are outlined in table 13. As such, the central implication of this paper is that an holistic view to intranet evaluation can be effected through a toolset comprising aspects of disparate indicators of usability and acceptance. An initial definition of such a toolset is provided here. Further research is required to test the toolset in other scenarios and cases, to explore the inclusion of other indicators not examined in this particular case, and to identify toolset components applicable to other usage instances and scenarios.

The study has a natural limitation in that consultants carried out the external heuristic-based usability audit, yet the researchers executed the internal TAM-based assessment. In attempting to compare findings, there must be due regard to differences in data gathering techniques and associated research approaches employed, a point raised in other studies (Conte et al., 2009; Hwang and Salvendy, 2009). However, this approach provides insight into a real case in actual in-situ scenarios of intranet usage, across a cutover point in time where the organisation was moving from an old to a new design. Further, the number of participants involved in the assessment was such that statistical analyses could extrapolate findings to the larger population of intranet users in the organisation, and so offer more generality. Nevertheless, it is a limitation that the case approach taken here is applicable only at such cutover design stages. However, in terms of applicability for system designers, the approach may also be applicable for phased or parallel transitions. Further, the toolset may be useful to apply at various points in intranet development cycles, with iterative application of the metrics if user numbers allow.

It is important to note that the evaluations here were carried out on a largely utilitarian

intranet, whose focus is on work-related activity and knowledge dissemination. Previous TAM studies have shown that hedonic aspects of usage such as enjoyment and attractiveness can play a much larger part in overall acceptance in scenarios involving less utilitarian and more hedonic foci. However, the study here shows that these constructs are important in work-related intranet usage. We suggest that the impact of these constructs in other intranet scenarios requires further study: it may be the case that they may be appropriate indicators for acceptance in utilitarian scenarios than may be suggested in previous research.

Of further importance is the new design's lack of impact on ease of use or usefulness, which together form TAM's central indicators of acceptance. It is likely that the new design just wasn't easier to use than the initial design, and so in this sense the new intranet didn't increase usability. As usefulness is largely content-related, it seems that although the intranet's content changed and was reorganised, the construct did not capture this, but was captured through an heuristic. Rather than a failing in the TAM construct, this may have been due to a limitation in this case that concentrated questions on the intranet design rather than its work-related function. It follows that construct definition in terms of its sub-component questions can be impactful in a semantic and contextual sense. As such, for future examination of intranet designs, researchers should perhaps be more cognisant of internal validity in construct component definition.

We suggest that the toolset produced here requires examination and verification in other similar cases, and also in different usage scenarios. Only then can a toolset become established in such a way to be robust and appropriate for varying applications: we encourage researchers to apply the toolset or a superset to other scenarios involving intranets or web-based systems. A particular weakness thus far is that there is insufficient rationale or data in a single case to possibly identify which components of the toolset are relatively more important: indeed this may be task- or context-dependent, and requires further research. Nevertheless, the single case illustrated here indicates that a combination of indicators can provide the most insight into the value of intranet design for end users. Through the application of the toolset in other cases and scenarios, a more universal toolset may emerge.

Table 13: Toolset Items

Construct	Explanation
Perceived Usefulness (TAM)	Assesses perceptions towards the usefulness of the Intranet
Perceived Ease of Use (TAM)	Assesses perceptions towards the usability / ease of use of the Intranet
Perceived Enjoyment (TAM)	Assesses perceptions towards the enjoyment of using the Intranet
Perceived Attractiveness (TAM)	Assesses perceptions towards the attractiveness of the Intranet
Optimising the User Experience	Assesses the experiential aspects of system usage
Homepage Design	Gauges the perceived impact of the Intranet's homepage design on work practices
Page Layout	Gauges the perceived impact of informational layout on work practices
Navigation	Gauges the degree to which the Intranet enables access to information
Headings & Labels	Gauges perceptions towards page headings & labels
Text Appearance	Gauges perceptions of the clarity and usability of page text
Graphics & Images	Gauges perceptions towards the purposes of page imagery
Content Organisation	Gauges perceptions towards the organisation of page information

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