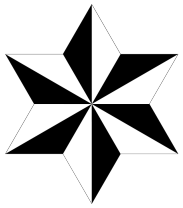

University of Brighton

Department of Computer Science

CI604 Usability Evaluation

Usability Evaluation of Microsoft Excel's Data Visualisation Features

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A report submitted in partial fulfilment of the requirements of
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Abstract

The usability evaluation of Microsoft Excel's data visualisation features was conducted using a mixed-methods approach, focusing on efficiency, effectiveness, and user satisfaction. Background research highlights the critical role of accessible data visualisation tools in informed decision-making. Methods include heuristic evaluation based on Nielsen's principles and user testing with System Usability Scale (SUS) questionnaires. Heuristic evaluation identified key usability challenges, further supported by user testing. User testing consisted of participants completing predefined tasks, such as creating charts, applying conditional formatting, and exporting visualisations. Ethical considerations, such as informed consent and data anonymisation, were ensured throughout the study. Quantitative data, such as task completion times and SUS scores, were thoroughly analysed. Additionally, qualitative insights are gathered from user observations and feedback. The results reveal significant usability issues, such as complex navigation, inadequate error feedback, and limited tutorial integration. SUS questionnaires captured user perceptions and produced an average score of 51.5, indicating below-average usability. Findings indicate performance differences between novice and intermediate users, suggesting a steep learning curve. Recommendations include simplifying the user interface, improving feedback mechanisms, and integrating accessible, interactive tutorials. Limitations include a small, homogeneous sample size and the restricted scope of evaluated features. The study concluded that while Excel offers extensive features for data visualisation, its usability could benefit from improvements. This research contributes to the broader field of usability evaluation and provides actionable recommendations for improving Excel's usability.

Keywords: Usability Evaluation, Data Visualisation, Microsoft Excel, Heuristic Evaluation, User Testing

Report's total word count: 3270

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List of Abbreviations

UI	User Interface
UX	User Experience
HCI	Human-Computer Interaction
SUT	System Under Test
TAM	Technology Acceptance Model
ISO	International Organization for Standardization
SUS	System Usability Score

Chapter 1

Introduction

1.1 Background

This evaluation project investigates the usability of Microsoft Excel's data visualisation features. Data visualisation tools are crucial for transforming complex raw data into comprehensible and insightful formats. Microsoft Excel, an industry-standard tool for data analysis, offers a wide range of visualisation features. Considering Excel's widespread use in both academic and professional environments, its data visualisation features are crucial to users who require effective data analysis and presentation. Despite its popularity, the usability of these features remains under-explored. This evaluation will provide insights into Excel's support for creating and customising visual data representations, contributing to the broader usability research on accessible data analysis tools (Frost et al., 2021, Healy, 2018).

1.2 Problem Statement

The problem addressed in this project is the usability of Microsoft Excel's data visualisation features. Many users, particularly those with limited prior experience in data visualisation, encounter difficulties when creating visual representations of data. This project aims to identify usability issues and provide actionable recommendations for improving the application's usability.

1.3 Aims and Objectives

Aim: To evaluate the usability of Microsoft Excel's data visualisation features for users with varying levels of experience.

Objectives:

- To assess the overall usability of Excel's data visualisation features.
- To identify common usability challenges and issues in Excel's data visualisation features.
- To gather quantitative and qualitative results through structured evaluation methods.
- To provide actionable recommendations for enhancing the usability, intuitiveness, and accessibility of Excel's data visualisation features.

1.4 Solution Approach

A mixed-method approach will be adopted, utilising heuristic evaluation, user testing, and questionnaires (see Chapter 4). Participants will be given predefined data visualisation tasks, with their performance and feedback collected through observation and questionnaires. Ethical considerations will be addressed through participant information sheets (see Appendix A), consent forms (not included for privacy reasons), and anonymisation of all collected data (each participant will receive a unique ID).

Chapter 2

Research

2.1 State of the Art in Usability Evaluation

Usability evaluation is a key aspect of Human-Computer Interaction (HCI), defined as the assessment of a system's effectiveness, efficiency, and satisfaction to ensure it meets the user's needs (International Organization for Standardization, 2018). Several frameworks have been developed to assess the usability of a system efficiently and systematically. For instance, Nielsen's Usability Heuristics offers a rule-based approach for identifying usability problems through expert evaluation (Nielsen, 1994). Furthermore, the Technology Acceptance Model (TAM) measures user perceptions, specifically the usefulness and ease of use of a system (Davis, 1989).

Recently, new usability evaluation techniques have surfaced, such as automated evaluation tools and hybrid models. Automated tools use algorithms to detect usability issues. Hence, they are efficient for large systems or projects. For instance, tools like eye-tracking software can provide insights into how a user interacts with the interface. However, these methods often lead to comprehensive results, as they do not collect subjective data such as user satisfaction (Healy, 2018). Hybrid models address this issue by combining methods. For instance, combining heuristic evaluation with user testing offers a more thorough approach. These approaches enhance credibility; however, they also require additional resources and expertise, which may be unfeasible for small-scale projects.

Applications such as Microsoft Excel, Google Sheets, and Tableau are renowned for converting complex raw data into comprehensible visualisations (Healy, 2018). More recently, Mahmud et al. (2024) have discussed Excel's usability strengths, highlighting its intuitive interface design and strong industry reputation. For instance, the study mentions that 71.6% of users appreciate the convenience of Excel's "Recommended Charts" feature for quickly generating suitable visualisations. Nevertheless, the study also highlighted key usability issues, such as locating specific features and navigating through the ribbon interface. Although Excel is considered an industry-standard tool, the findings suggest a steep learning curve for novice users, particularly when using advanced visualisation features. These insights emphasise the necessity for targeted usability improvements to enhance user experience (UX).

2.2 Context of the Project

Microsoft Excel is a spreadsheet application that offers customisable data visualisation features such as generating line charts, pie charts, bar charts, and scatter plots. Despite its versatility, users frequently encounter challenges in exploiting its visualisation features, particularly novice

users or those with limited technical experience. According to Evergreen (2016), users may struggle with:

- Locating and understanding tools within the interface.
- Customising and adjusting visual elements effectively.
- Leveraging advanced features for complex datasets.

This usability evaluation project focuses on closing the gap between Excel's extensive capabilities and user competence. The results will provide guidance on improving the accessibility of similar applications. Furthermore, the findings will contribute to the usability research field of HCI.

2.3 Analysis of Usability Evaluation Methods

2.3.1 Heuristic Evaluation

Heuristic evaluation is the process of assessing a system against predefined usability principles, such as Nielsen's 10 usability heuristics (Nielsen, 1994). The method is efficient at uncovering usability issues without involving real users in a relatively short period.

Advantages	**Disadvantages**
Economical and time-efficient.	Depends heavily on the expertise of the evaluator, which can introduce bias.
Identifies usability issues systematically.	May fail to identify issues that real users, particularly novice users, experience.

Table 2.1: Advantages and disadvantages of heuristic evaluation

2.3.2 User Testing

User testing involves observing real participants as they perform predefined tasks on the system. This method provides valuable insights into user behaviour, task performance, and satisfaction (Rubin and Chisnell, 2008).

Advantages	**Disadvantages**
Highlights real-world and common usability issues.	Resource-intensive (requires participants, time, and equipment).
Provides both quantitative (task completion times, error rates) and qualitative data (user feedback, observations).	Requires thoughtful task design and participant selection to ensure meaningful results.

Table 2.2: Advantages and disadvantages of user testing

2.3.3 Questionnaires and Surveys

Questionnaires gather subjective feedback on user experience and satisfaction. Established surveys such as the System Usability Scale (SUS) offer a standardised method for measuring usability perceptions (Lewis, 2014). These questionnaires are proven to be effective in gauging user satisfaction and perceived ease of use.

Advantages	Disadvantages
Easy to perform and analyse.	Subject to user biases or misinterpretation of questions.
Standardised tools like SUS enable quantitative usability benchmarking.	Neglects comprehensive observational data on user behaviour.

Table 2.3: Advantages and disadvantages of questionnaires and surveys

2.3.4 Cognitive Walkthroughs

Cognitive walkthroughs replicate a user's thought process during interactions with a user interface (UI), focusing on the learnability and ease of use for first-time users (Wharton et al., 1994).

Advantages	Disadvantages
Effective for evaluating learnability and task procedures.	Requires detailed task scenarios and evaluator expertise.
Useful for novice user scenarios.	Limited in assessing user satisfaction or overall experience.

Table 2.4: Advantages and disadvantages of cognitive walkthroughs

2.4 Selection of Methods

For this project, heuristic evaluation, user testing, and questionnaires have been selected to identify specific usability challenges associated with Excel's data visualisation features. Heuristic evaluation provides a structured approach to efficiently finding usability issues. User testing complements this by offering additional insights into how real-world users behave and their corresponding satisfaction. Questionnaires, such as SUS, enable the standardised collection of user perceptions, supporting subjective feedback collection alongside observational insights. Cognitive walkthroughs were not selected due to their dependence on detailed task scenarios and expert evaluation, which were considered impractical given the project's time and resource constraints. This mixed-method approach ensures a comprehensive evaluation of Excel's data visualisation features, addressing usability aspects such as effectiveness, efficiency, and satisfaction as defined by the International Organization for Standardization (2018).

Chapter 3

System Under Test

3.1 User Interface and Interaction

A ribbon toolbar located at the top of Excel's UI offers categorised tabs such as "Home", "Insert", and "Data" (see Figure 3.1). The majority of data visualisation features can be found in the "Insert" tab. Users can select specific chart types through drop-down menus and pop-up windows. Users can customise each chart type, including options such as changing colour schemes, styles, titles, and formats. Collectively, these features contribute to user control and personalisation.

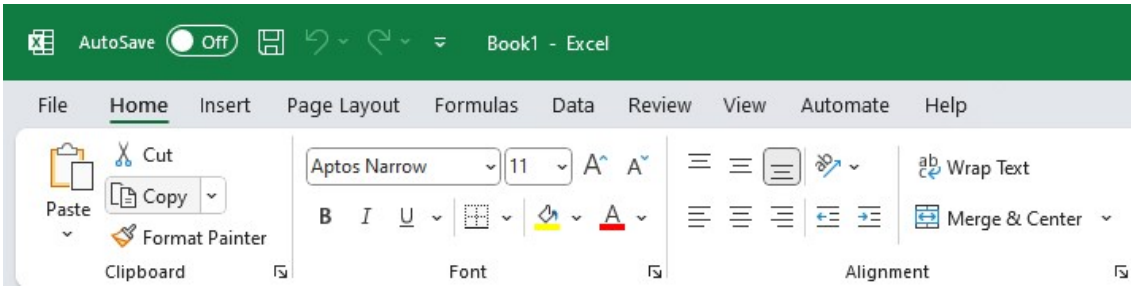

Figure 3.1: Microsoft Excel's ribbon UI

3.1.1 Chart Creation UI

In the "Insert" tab of the ribbon UI, users can directly select and insert various chart types (see Figure 3.2). Icons are used to represent these chart types. Selecting a chart type in the ribbon group will present a drop-down menu with further customisation options, such as specific layouts and formats (see Figure 3.3).

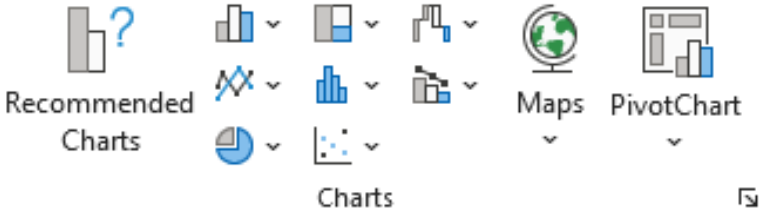

Figure 3.2: The "Charts" ribbon group of the "Insert" ribbon tab

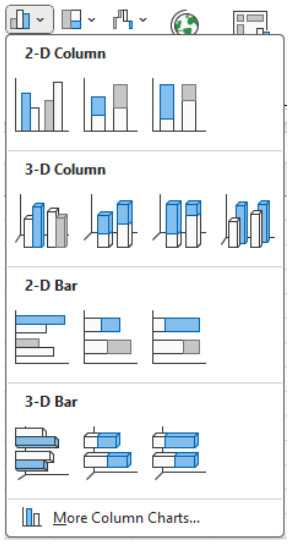

Figure 3.3: The drop-down menu for bar charts

Furthermore, users are presented with a detailed overview of all chart types after selecting the "More Column Charts..." option located at the bottom of the drop-down menu (see Figure 3.3). A pop-up window shows a list of chart types with their corresponding icons and names. After selecting a chart type, a preview of the chart is shown before the chart is added to the spreadsheet (see Figure 3.4). Additionally, Excel can recommend chart types based on the selected data (see Figure 3.5).

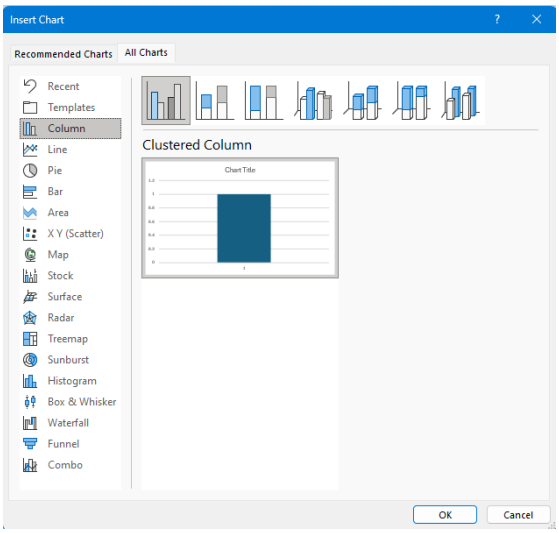

Figure 3.4: The "Insert Chart" pop-up window showing all chart types

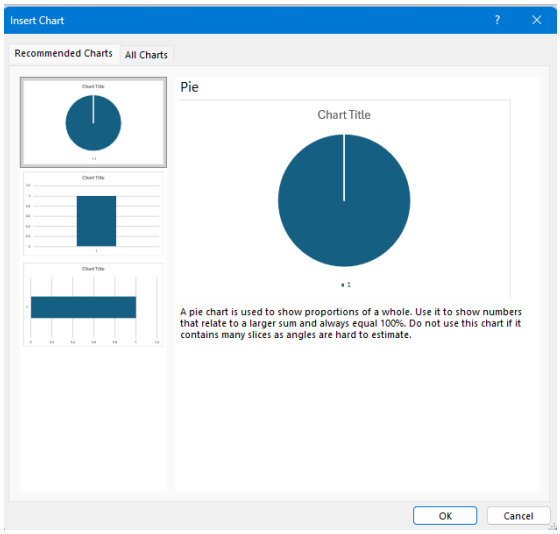

Figure 3.5: The "Insert Chart" pop-up window showing recommended chart types

When creating a PivotChart, a pop-up window allows users to specify the data to be analysed, select the location of the PivotChart, and enable the analysis of multiple tables (see Figure 3.6).

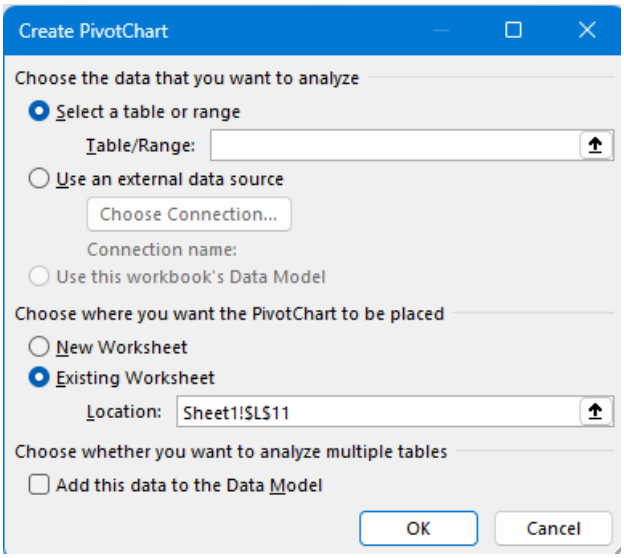

Figure 3.6: The "Create PivotChart" pop-up window

3.1.2 Formatting and Customisation Screen

Once a chart has been created, users can further adjust the Chart Design and Format through two new ribbon tabs (see Figure 3.7 and 3.8). The Chart Design tab offers features such as adding chart elements, changing styles and colours, and converting the chart to a different type, whereas the Format tab provides more general features that are not specific to charts.

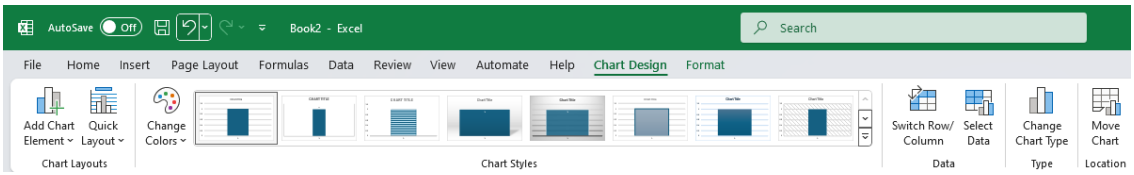

Figure 3.7: The "Chart Design" ribbon tab

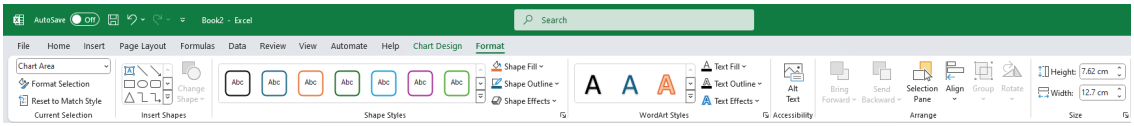

Figure 3.8: The "Format" ribbon tab

Additional customisation options can be found by interacting with the graph directly. Users are presented with a wide range of features upon right-clicking the graph (see Figure 3.9). For instance, users can conveniently change the chart type, select the data to be visualised, or save the graph as a picture. Furthermore, chart elements, styles, and colours can be adjusted through drop-down menus located to the right of the selected graph (see Figure 3.10, 3.11 and 3.12). These menus enable users to fine-tune their visualisations, enhancing clarity and alignment with visualisation objectives.

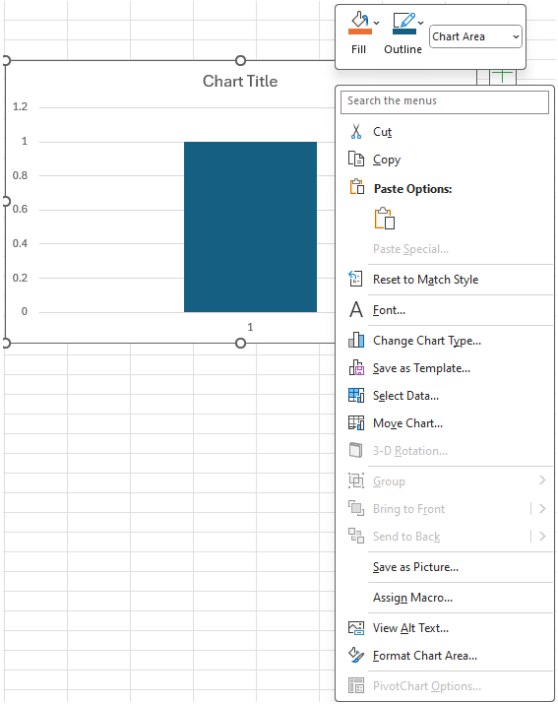

Figure 3.9: The options menu shown after right-clicking on the graph

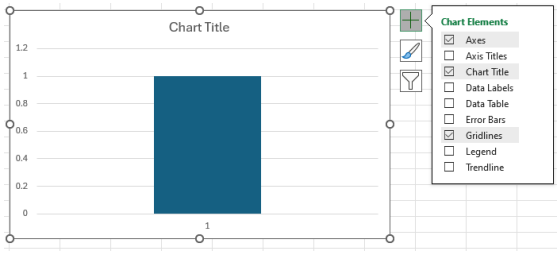

Figure 3.10: The "Chart Elements" drop-down menu

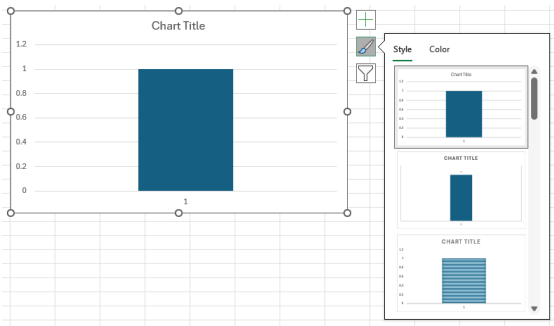

Figure 3.11: The "Style" drop-down menu

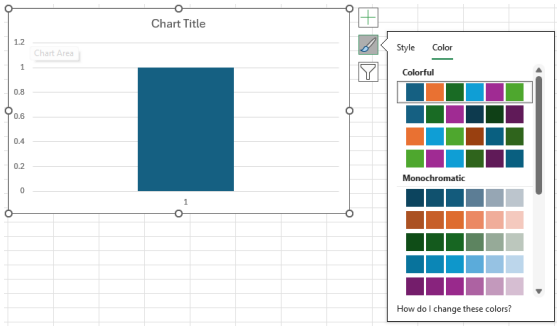

Figure 3.12: The "Color" drop-down menu

3.1.3 Conditional Formatting

The conditional formatting features are located in the "Home" ribbon tab for easy access. The drop-down menus offer features such as highlighting cell rules, which enables users to emphasise specific data entries based on conditions (see Figure 3.13). Additionally, data bars represent values within cells as horizontal bars, offering a compact visual representation of values relative to other data points. Similarly, Color Scales and Icon Sets use gradient-based formatting and intuitive symbols, respectively, to represent ranges of values. Collectively, these tools improve data readability and enhance decision-making by enabling users to identify patterns and relationships within datasets quickly.

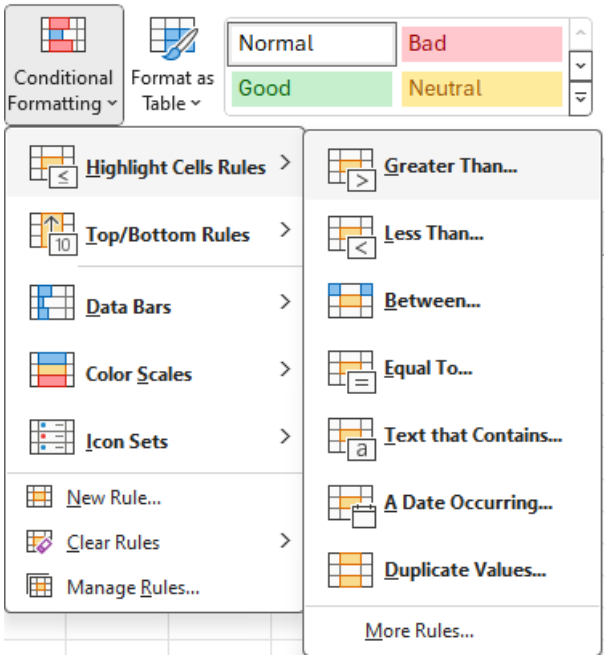

Figure 3.13: The "Conditional Formatting" drop-down menu

3.2 Tested Features

The usability evaluation focuses on the following aspects of Excel's data visualisation tools:

Test Feature	Description	Task Number(s)
Chart selection and insertion	Testing the ease of UI navigation to select and insert specific chart types, such as bar charts and line charts.	Task 1
Customization and formatting	Assessing options for modifying visual elements, including chart styles, colours, axis titles, and adding data labels.	Tasks 2, 3, 4
Advanced charting features	Evaluating the process of adding trendlines and converting existing charts to different types.	Tasks 5, 6
PivotCharts	Testing the creation of PivotCharts using multiple data columns and visualising data in dynamic, grouped formats.	Task 7
Conditional formatting	Observing the application of rules to highlight specific data values, such as using thresholds to emphasize critical points.	Task 8
Export and output options	Evaluating the process of exporting visualisations, such as printing a chart or worksheet to a PDF in landscape orientation.	Task 9

Table 3.1: Tested features including corresponding task numbers

Chapter 4

Methodology

4.1 Heuristic Evaluation

4.1.1 Analysis and Rationale

A detailed discussion of heuristic evaluation, including its strengths, limitations, critiques, and rationale for selection, can be found in Section 2.3.1.

4.1.2 Process

Using Nielsen's 10 usability heuristics (Nielsen, 1994), the evaluation was conducted focusing on key principles such as:

- **Visibility of system status:** Ensuring the user is informed about the current state of the system.
- **User control and freedom:** Supporting undo and redo functionalities to facilitate correction.
- **Consistency and standards:** Maintaining uniform terminology and designs across the UI.

4.2 User Testing

4.2.1 Analysis and Rationale

A detailed discussion of user testing, including its strengths, limitations, critiques, and rationale for selection, can be found in Section 2.3.2.

4.2.2 Participant Recruitment

In order to recruit participants, recruitment flyers and participant information sheets were distributed throughout the academic environment. Five participants, ranging in experience from novice to intermediate, were recruited. All participants signed a Participant Consent Form prior to the participation, guaranteeing ethical compliance and transparency throughout the study.

4.2.3 Procedure

The user testing sessions followed the following structure:

1. **Pre-test questionnaire:** Gathered demographic data and user experience levels.
2. **Task execution:** Participants completed predefined tasks such as creating bar charts, customising visual elements, and applying conditional formatting. Each task is linked to real-world use cases. For instance:
    - **Creating bar charts:** Relates to generating sales reports or visualising performance metrics.
    - **Customising visual elements:** Covers requirements such as branding consistency or visual preferences.
    - **Applying conditional formatting:** Focuses on quick data interpretation, such as highlighting over-budget values.
3. **Post-test questionnaires:** Captured subjective feedback on usability and user satisfaction, including responses from the SUS questionnaire (Brooke, 1996).

Observations focused on task execution, including completion times, error patterns, and participant feedback.

4.3 Questionnaires

4.3.1 Analysis and Rationale

A detailed discussion of user testing, including its strengths, limitations, critiques, and rationale for selection, can be found in Section 2.3.3.

4.3.2 System Usability Scale

The SUS is a widely used questionnaire to evaluate usability. It consists of ten Likert-scale questions, alternating between positive and negative statements. Each response is scored, adjusted, and converted to a value between 0 and 100 Brooke (1996). See the following equation for the scoring process:

$$\text{SUS Score} = \left(\sum_{i=1,3,5,7,9} (\text{Response}_i - 1) + \sum_{j=2,4,6,8,10} (5 - \text{Response}_j) \right) \times 2.5$$

4.4 Ethical Considerations

The following measures were implemented to ensure ethical compliance during the evaluation:

- Participants provided informed consent before testing.
- Data was anonymised to protect privacy.
- Participants were informed of their right to withdraw at any point.

Chapter 5

Results

5.1 Quantitative Results

5.1.1 Task Completion Metrics

Table 5.1 provides an overview of task completion times across participants, with total times highlighting significant differences in performance between novice and intermediate users. Participant 4 achieved the fastest overall time at 5 minutes and 6 seconds, whilst Participant 3 set the slowest time at 14 minutes and 7 seconds, which is expected as a novice user. Table 5.2 expands on the collected data by analysing average times, standard deviations, and performance ratios. Tasks 1, 2, and 7 show the greatest difference between skill levels, with performance ratios exceeding 2, indicating a significant gap between novice and intermediate users. Task 5 shows the largest performance gap, with a performance ratio of 6.92, suggesting that familiarity with advanced features significantly impacts task efficiency. Contrarily, Task 4 resulted in a performance ratio of below 1, which can be explained by the task's simplicity.

Figures 5.1 and 5.2 summarise the variability in task completion times. Tasks 1 and 7 show significant variability, indicating challenges across skill levels, while Task 3 displays relatively low variability, suggesting a consistent level of ease across all participants. Participant 3 consistently showed longer completion times, as highlighted in Figures 5.2 and 5.4. In contrast, Participant 4 demonstrated consistently efficient performance, particularly excelling in complex tasks such as Task 7, where other participants often struggled (see Figure 5.3).

Task	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Task 1	4:06.6	0:52.2	3:11.2	1:10.7	0:38.5
Task 2	0:19.6	0:58.0	2:55.2	0:18.6	0:31.7
Task 3	0:14.0	0:13.4	0:27.4	0:15.3	0:09.7
Task 4	0:56.9	2:00.1	0:33.7	0:58.0	0:20.7
Task 5	0:03.8	0:06.1	1:10.0	0:05.1	0:41.6
Task 6	0:40.5	0:25.1	0:16.7	0:14.3	0:17.4
Task 7	1:46.7	1:17.0	3:09.6	0:36.3	1:31.9
Task 8	1:08.5	1:02.2	1:02.6	0:39.6	1:07.4
Task 9	0:39.2	0:14.1	1:21.0	0:48.7	0:28.7
Total	**09:55.8**	**07:08.2**	**14:07.4**	**05:06.7**	**05:47.7**

Table 5.1: Task completion times (in minutes:seconds)

Task	SD (s).	Avg. (s)	Novice Avg. (s)	Inter. Avg. (s)	Perf. Ratio
Task 1	93.23	119.83	158.77	61.42	2.59
Task 2	65.96	60.64	75.51	38.34	1.97
Task 3	6.74	15.97	17.04	14.37	1.19
Task 4	38.23	57.90	37.11	89.08	0.42
Task 5	29.61	25.32	38.49	5.56	6.92
Task 6	10.69	22.83	24.90	19.74	1.26
Task 7	56.41	100.30	129.40	56.65	2.28
Task 8	11.77	60.06	66.15	50.92	1.30
Task 9	25.12	42.32	49.61	31.40	1.58
Total	**221.06**	**505.17**	**596.98**	**367.46**	**1.62**

Table 5.2: Analysis of task completion times, including standard deviation in seconds, average times (including novice and intermediate user averages) in seconds, and performance ratios (novice/intermediate).

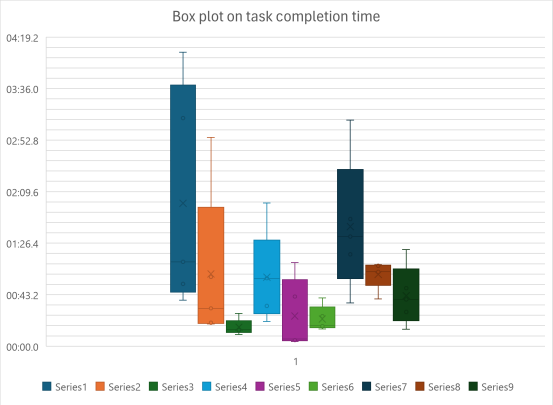

Figure 5.1: Box plot on task completion times sorted by task number. Notable variability observed in Tasks 1 and 7.

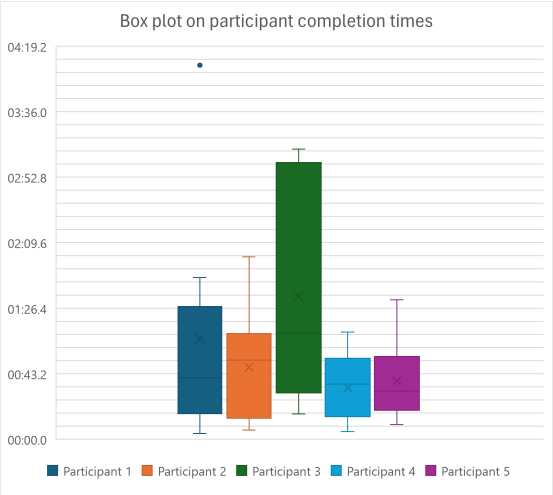

Figure 5.2: Box plot on task completion times sorted by participant. Participant 3 showed consistently longer completion times.

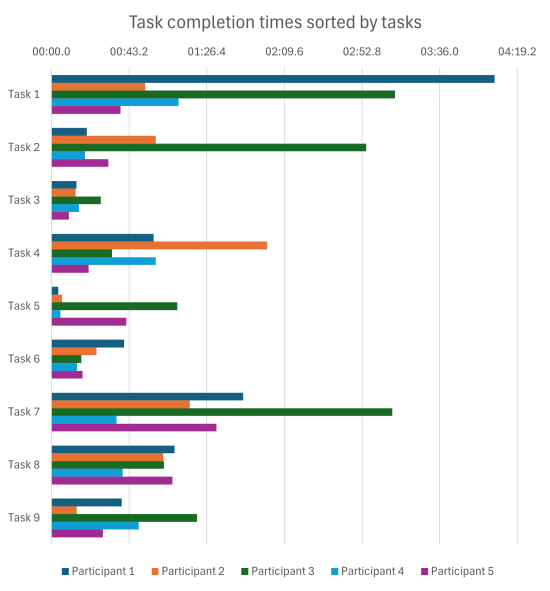

Figure 5.3: Bar chart on task completion times grouped by task number. highlighting significant challenges in Task 1 and 7.

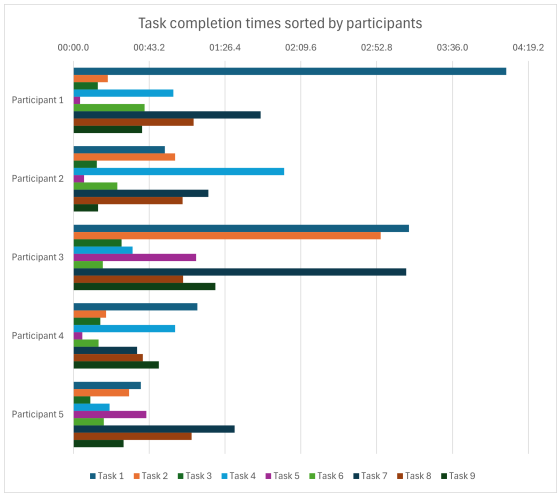

Figure 5.4: Bar chart on task completion times grouped by participant. Significant discrepancy observed for Participant 3.

5.1.2 System Usability Scale

The SUS scores, calculated using the formula provided by Brooke (1996), ranged from 12.5 to 95 (see Table 5.3). The average SUS score across participants was 51.5, indicating a mixed perception of usability. A SUS score of 51.5 falls below the general usability benchmark of 68, suggesting that the system may require significant improvements to meet standard usability expectations (Brooke, 2013). In particular, the high average score of intermediate participants highlights the system's potential for providing an excellent UX for users who are familiar with its features and interface. However, the low average score of novice participants emphasises usability challenges faced by less experienced users.

Participant	SUS score
Participant 1 (Novice)	42.5
Participant 2 (Intermediate)	75.0
Participant 3 (Novice)	32.5
Participant 4 (Intermediate)	95.0
Participant 5 (Novice)	12.5
Average (All)	**51.5**
Average (Novice)	**29.2**
Average (Intermediate)	**85.0**
Median	**42.5**
Min Score	**12.5**
Max Score	**95.0**

Table 5.3: SUS scores including averages, median, min and max scores.

5.2 Qualitative Results

5.2.1 Heuristic Evaluation Results

The heuristic evaluation of Microsoft Excel's data visualisation features identified several key usability issues based on Nielsen's 10 heuristics:

- **Visibility of System Status**: While Excel provides real-time previews when customising charts, it lacks clear indicators for errors, such as attempting to create a chart without selecting data. Users receive no feedback or guidance in such scenarios.
- **User Control and Freedom**: Excel offers undo and redo functionalities, which support error correction. However, these features are buried in the ribbon toolbar, making them less accessible for novice users.
- **Help and Documentation**: While Excel has a comprehensive help feature, it is not directly integrated into the workflow. Novice users often struggled to locate relevant guidance when performing unfamiliar tasks.
- **Error Prevention**: The system does not proactively prevent common errors, such as creating a chart without data selection. Adding pre-checks or contextual prompts could significantly improve usability.

These findings highlight areas where Excel could enhance its data visualisation features to better align with user expectations and improve overall usability.

5.2.2 Participant Feedback

Feedback from the post-test questionnaire highlighted the following points of concern:

- **Ease of use**: Participants valued the variety of visualisation options but experienced challenges when locating specific features.
- **Navigation issues**: Some participants recommended placing chart-related tools into a new, separate ribbon tab, instead of a ribbon group.
- **Recommendations**: Suggestions included adding step-by-step tutorials and clearer indications that users need to select data prior to creating charts.

5.2.3 Observational Insights

Observations during the evaluation revealed:

- Novice users struggled with identifying appropriate chart types and navigating the ribbon interface. This is due to their unfamiliarity with the icons and their representations. Additionally, novice users often attempted to insert graphs without selecting any data and did not receive any feedback from Excel.
- Intermediate users performed tasks efficiently by leveraging alternative techniques, such as using the search bar or right-clicking on the graph when unable to locate specific features on the ribbon bar.

Chapter 6

Conclusion

6.1 Recommendations

Based on the findings, the following recommendations are proposed, prioritised by impact and feasibility:

1. **Simplify navigation:** Group chart-related tools into a dedicated ribbon tab to reduce cognitive load and improve usability for novice users. Additionally, it enables a more descriptive and intuitive UI layout and reduces dependency on icons.
2. **Improved feedback mechanisms:** Implement real-time, contextual prompts to improve the visibility of system status. For instance, a pop-up window could inform users that data needs to be selected before creating a graph rather than inserting an empty graph.
3. **Integrated help features:** Integrate interactive support guidelines and tutorials into the workflow of the application to aid task completion and improve learnability.
4. **Simplify default UI:** Develop an optional, simplified UI layout tailored to novice users, providing more intuitive navigation by focusing on essential visualisation features. Advanced users can disable the simplified layout to leverage Excel's full capabilities.

6.2 Reflection on the Process

Each step of the evaluation process offered unique insights and challenges. The systematic application of Nielsen's principles during heuristic evaluation revealed critical design flaws, such as the inconsistent placement of chart-related tools in the ribbon UI (Nielsen, 1994). Additionally, user feedback revealed drawbacks in Excel's usability for novice users, emphasising the importance of error prevention mechanisms and user guidelines. Whilst the mixed-method approach was effective, its findings were limited by the small sample size of participants for user testing and the focus on a specific subset of Excel's capabilities.

A significant challenge was the limited pilot testing conducted to validate task clarity. While efforts were made to ensure tasks were accessible to inexperienced users, the pilot did not capture potential misunderstandings that became evident during user testing. This underscores the importance of iterative task refinement and thorough pre-testing to ensure instructions align with participant expectations and behaviours.

6.3 Limitations

Whilst the study provided valuable insights, it was subject to the following limitations:

- **Sample size and diversity:** The user testing included only five participants with experience levels ranging from novice to intermediate due to time and resource constraints. Consequently, user testing results did not represent the full spectrum of Excel users.
- **Scope of features:** The evaluation focused on a subset of Excel's features, potentially overlooking usability issues in other functionalities.
- **Time constraints:** The timeframe restricted the depth of analysis and the ability to refine task designs.

6.4 Future Work

Future research could address these limitations by:

- Increasing the pool of participants to include a more representative and diverse range of users.
- Conducting long-term research to evaluate the impact of recommended modification on usability.
- Evaluating the usability of advanced features, such as Power Pivot and Power Query, to offer a more comprehensive evaluation.

6.5 Final Remarks

This project emphasises the importance of usability in enhancing user experience and satisfaction. By addressing the identified issues and implementing the proposed recommendations, Microsoft Excel could significantly improve its accessibility for novice users whilst maintaining its appeal to expert users. Consequently, it would strengthen Excel's position as an industry-standard data visualisation tool.

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Appendix A

Participant Information Sheet

University of Brighton

BSc (Hons) Computer Science
Usability Evaluation of Microsoft Excel's Data Visualisation Features

Introduction and what is the purpose of the study/project?
My name is Max Sherman, and I am an BSc Computer Science student at the University of Brighton. I am carrying out this research as part of my coursework projects; it is entirely for educational purposes. This study aims to evaluate how effectively Microsoft Excel supports users in creating and customizing data visualizations. By understanding user interactions and identifying usability challenges, the research seeks to provide actionable recommendations for improving Excel's data visualization features, making them more accessible and efficient for a diverse user base.

Invitation paragraph
I would like to invite you to take part in my research study. Before you decide, I would like you to understand why the research is being done and what it would involve for you. To this end, please read this document so that you are clear as to the implications of your participation in the study. This will take you several minutes. I am happy to answer any questions that you may have.

Why have I been invited to participate?
You have been invited to participate in this study as I would like to establish your experience of using Microsoft Excel's data visualization features. As a fellow student in the CI604 Usability Evaluation module, your insights are valuable due to your foundational understanding of usability principles and your diverse level of experience with data visualization tasks. This variety ensures that the study captures a wide range of usability challenges and perspectives, contributing to a comprehensive evaluation of the tool.

Do I have to take part?
Your participation is voluntary, and there is no obligation to take part. If you are a student a decision not to take part will not have any negative consequences in terms of your study, work, or other academic activities.

What will happen to me if I take part?
If you take part, the study will take no longer than 1 hour to complete, and you will be required to participate only once. During the session, you will first be introduced to the study's purpose and provided with a brief overview of the tasks. You will then complete a series of usability tasks using Microsoft Excel's data visualization features, such as creating and customizing charts. While performing these tasks, your interactions will be observed, and metrics such as task completion time and error rates will be recorded. After completing the tasks, you will be asked to fill out a short questionnaire, including the System Usability Scale (SUS), to share your feedback on the tool's usability.

Will I be paid for taking part?
You will not be paid for your participation and therefore I would like to thank you for both your time and consideration during this study.

What are the potential disadvantages or risks of taking part?

Participating in this study is very low risk. If, during the study, you feel fatigued, tired or require a comfort break please tell me and you can take an immediate break.

What are the potential benefits of taking part?
There will be no direct benefit to you as a participant. The data that I am gathering from you is purely for educational purposes in the context of my study.

Will my taking part in the study/project be kept confidential?
To help maintain the confidentiality all our participants, the data that I gather from your participation will be anonymised and given a reference e.g., participant 1. Demographic data such as gender or age will be summarised e.g., 5 males and 5 females between the age of 18 to 35. You will not be personally referred to when I analyse, evaluate, and write up the study for inclusion in my coursework.
All collected data will be stored on my secure University of Brighton One Drive during analysis. Only my supervisor and I will have access to the data. The data will remain on my University One Drive until I complete my studies. On completion of my studies all data will be deleted.

1. Please follow this link to the University's Research Privacy Notice for further information on data protection. https://unibrightonac.sharepoint.com/:b:/s/public/ERAnx7fZSR9Lv6MRZ1KwpMMBcOSYGp30CAwkTzbbzHLDNQ?e=4gH9GQ).

2. If you are reading a hard copy of this document, the QR Code below also provides a link to the University's Research Privacy Notice for further information on data protection.

What will happen if I don't want to carry on with the study?
You are free to withdraw from the study at any time until the end of the data collection session. Any information that I have gathered e.g., consent form, or data captured e.g., response to tasks, will be shredded and or deleted. However, once you have submitted the anonymous data it will not be possible to remove the data of an individual participant anymore.

What will happen to the results of the project?
The results of the study will be written up for inclusion in my coursework projects. If you want to see my finished dissertation, please contact me though my email address below and I will send it to you as pdf document.

Contact details
Researcher: Max Sherman, m.sherman1@uni.brighton.ac.uk
Supervisor: Dr. Sanaz Fallahkhair, s.fallahkhair@brighton.ac.uk

What if I have a question or concern?
Please contact Dr Friederike Günzel (f.k.gunzel@brighton.ac.uk) School of Architecture, Technology and Engineering Research Ethics and Integrity Lead.

Who has reviewed the study?
The study has been reviewed given a favourable ethical opinion by the School of Architecture, Technology and Engineering Research Ethics and Integrity Committee.

Appendix B

Recruitment Flyer

Seeking volunteers for a research study: Usability and user experience evaluation of Microsoft Excel

Are you interested in contributing to research on usability and user experience design? I would like to invite you to take part in a study focused on evaluating the usability of Microsoft Excel's data visualization features.

Who can participate?

- Adults aged 18+ years old.
- Individuals with an interest in evaluating or testing software systems
- No prior experience with data visualization tools is required.

What Does the Study Involve?

This study involves testing and evaluating Microsoft Excel's data visualization features through a series of structured activities. The session will take place at the University of Brighton or online and will last approximately 1 hour.

Sequence of Activities:

1. Introduction and Pre-Test Questionnaire (10 minutes): Participants will complete a brief questionnaire to provide background information.
2. Usability Testing (40 minutes): You will perform data visualization tasks on a computer while being observed to gather insights into your interactions.
3. Post-Test Questionnaire (10 minutes): A short feedback survey will capture your thoughts on the usability and experience.

Why Participate?

Your participation will help identify usability challenges and contribute to recommendations for improving Microsoft Excel's data visualization features. This research may also inform broader insights into user experience design.

Interested?

For more information, please refer to the attached Participant Information Sheet and Consent Form or contact Max Sherman (m.sherman1@uni.brighton.ac.uk).

Thank you for considering participating in this study!

Appendix C

The Risk Assessment

University of Brighton

Please do not save and reuse copies of this form locally. The form is updated regularly, and you can find the most current version from the links on the SharePoint ethics and integrity page or from the information following question L5 of the BREAM ethics application form.

Risk Assessment Form Research

Name of the risk assessor	*Max Sherman*	**What School or Department are you in?**	ATE	**Authoriser's signature**	*Max Sherman*
Assessment title	Usability Evaluation of Microsoft Excel's Data Visualisation Features	**Date of assessment**	13/01/2025	**Location of the activity**	Elm House 206
Description of the work area or activity being assessed	The usability evaluation involves testing and evaluating Microsoft Excel's data visualization features with participants. The activity will take place at Elm House 206 or online, with 2-5 participants. Participants will interact with computers to complete predefined tasks. The study will last approximately 1 hour and include the following steps: 1. Greeting and pre-test questionnaire (10 minutes) 2. Observational study with tasks using Microsoft Excel (40 minutes) 3. Post-test questionnaire (10 minutes)				

What is the hazard?	People affected and how they might be harmed	Measures in place to control the risk	Risk Rating			Additional controls required and by whom	New Risk Rating		
			S	L	R		S	L	R
Software and data privacy failure	Research participants and researcher. Potential harm due to unauthorized access to data.	Ensure all data is securely stored using GDPR-compliant services (e.g., Microsoft Cloud, Office 365). Anonymize participant data and limit access to authorized personnel only.	2	2	4	Regularly review data storage practices and ensure software updates are applied by the researcher.	1	2	2

S= Hazard severity, L= Likelihood of occurrence, R= Combined risk rating

University of Brighton

Please do not save and reuse copies of this form locally. The form is updated regularly, and you can find the most current version from the links on the SharePoint ethics and integrity page or from the information following question L5 of the BREAM ethics application form.

Contracting Covid-19	Participants and researcher. Potential harm from virus transmission.	Provide hand sanitizer, maintain social distancing, and ensure a well-ventilated room. Offer remote participation options to reduce in-person contact.	3	2	6	Clean equipment between sessions and follow University of Brighton health and safety guidelines.	2	1	2
Eye strain and posture issues	Researcher and participants. Prolonged computer use may cause eye strain or discomfort.	Set up workstations following ergonomic guidelines. Advise participants to adjust screens and seating for comfort. Encourage regular short breaks during the session.	3	2	6	Researcher to provide ergonomic setup guidance and monitor participant posture during tasks.	2	1	2
Discussion of sensitive topics	Participants may feel uncomfortable discussing usability challenges if issues arise during testing.	Provide a clear right to withdraw at any time. Use a neutral and supportive tone during facilitation. Avoid leading questions. Prepare follow-up resources or contacts for support if needed.	2	2	4	Researcher to review questions and tasks with the module leader to minimize discomfort.	1	1	1
Other risks related to the location	Participants and researcher. Potential risks from fire alarms, emergency evacuation, or environmental factors at Elm House.	Familiarize participants with the location's emergency procedures. Ensure fire exits are clear and alarms are functional.	3	2	6	Conduct a pre-session location safety check and review University emergency protocols.	2	1	2

S= Hazard severity, L= Likelihood of occurrence, R= Combined risk rating

University of Brighton

Please do not save and reuse copies of this form locally. The form is updated regularly, and you can find the most current version from the links on the SharePoint ethics and integrity page or from the information following question L5 of the BREAM ethics application form.

Likelihood	Severity				
		1 Minor	**2 Moderate**	**3 Significant**	**4 Serious**	**5 Major**
	1 Rare	1	2	3	4	5
	2 Unlikely	2	4	6	8	10
	3 Possible	3	6	9	12	15
	4 Likely	4	8	12	16	20
	5 Almost certain	5	10	15	20	25

Hazard severity

1 – Minor	Capable of causing minor injury which would not require first aid treatment but may result in temporary health conditions (e.g. temporary skin rashes etc.).
2 – Moderate	Capable of causing minor injury which would allow the individual to continue after first aid treatment on site or at a local surgery. The duration of the stoppage/treatment is such that the normal activities are not seriously interrupted.
3 - Significant	Capable of causing injury or disease likely to result in an individual being unfit for work for one or more days.
4 - Serious	Capable of causing serious injury or terminal/chronic disease to an individual
5 - Major	Capable of causing death or multiple serious injury and/or possible destruction of property. Such a hazard would include a major event such as an explosion, toxic release, building collapse etc. It may cause death and injury both on and off site and would be the subject of a major incident report.

Likelihood of occurrence

1 – Rare	An incident is possible but only under freak conditions should there be a possibility of an accident or illness.
2 – Unlikely	If other factors were present, this incident or illness might occur, but the probability is low (e.g. storing items above shoulder level, worn carpet etc.).
3 – Possible	The incident may happen if additional factors precipitate it, but it is most unlikely to occur without them. The additional factor is more than a casual slip or nudge and would require an additional action or event to trigger it (e.g. leaving a vehicle with the engine running, obstructing an access/egress route, failing to replace a defective light, obstructing emergency equipment etc.).
4 – Likely	The effects of vibration, weather, inexperience, physical state, or human carelessness would precipitate an incident, but which is unlikely to happen without this additional factor (e.g. ladder not secured, temporary electrical supply, makeshift arrangements, medical condition etc.).
5 – Almost Certain	If the activity/condition continues as it is, there is almost a 100% certainty that an incident will happen (e.g. broken stair or ladder rung, exposed electrical conductor, unstable stack of materials etc.).

S= Hazard severity, L= Likelihood of occurrence, R= Combined risk rating

University of Brighton

Please do not save and reuse copies of this form locally. The form is updated regularly, and you can find the most current version from the links on the SharePoint ethics and integrity page or from the information following question L5 of the BREAM ethics application form.

Potential hazards and measures to prevent risk

Hazard	**Lone working** Visiting locations or meeting with participants when alone, the researcher may be vulnerable to threat, intimidation or theft
Measures to prevent risk	If possible, visit location prior to data collection to assess possible risks associated with built and social environment. Where high-vis vest if working near traffic (e.g. data collection in a car park) Wear appropriate clothing for the weather Check weather in advance and adjust plans accordingly Researcher to be aware of health and safety procedures of research location: o Fire bells or other emergency warning o Location of fire alarms and exits o Emergency plan if under threat.

Hazard	**Other** Risk associated with research location. This could be from the location itself or environmental factors
Measures to prevent risk	If possible, visit location prior to data collection to assess possible risks associated with built and social environment. Where high-vis vest if working near traffic (e.g. data collection in a car park) Wear appropriate clothing for the weather Check weather in advance and adjust plans accordingly Researcher to be aware of health and safety procedures of research location: o Fire bells or other emergency warning o Location of fire alarms and exits o Emergency plan if under threat.

Hazard	**Other** Discussion of sensitive topics with potential to cause distress to participants or researcher
Measures to prevent risk	Ethics committee approval at Tier 1 or Tier 2 as required Focus group to take place in UoB premises if possible Find out what support is available if there is a problem - who would be available to assist if you called for help? Focus group schedule to be sent to participants in advance if possible Ensure participants understand their right to withdraw and option of not answering questions put to them Research relevant support options for participants and researcher to use after the discussion Consider using a Distress Protocol (such as that generated by Chris Cocking). Remain neutral if you are acting as the discussion Facilitator Students should discuss proposed questions with their Tutor

Appendix D

User Testing Resources

Pre-Test Questionnaire

Participant ID: Date:

Please complete the following questionnaire before starting the usability evaluation.

What is your age? _____

What is your experience level with Microsoft Excel? (None, Beginner, Intermediate, Advanced) _____

How often do you use Excel for data visualization tasks? (Rarely, Occasionally, Frequently) _____

Are you familiar with charts? (Yes/No) _____

Do you know how to create charts in Excel? (Yes/No) _____

Have you used other data visualization tools before? (Yes/No) _____

What is your confidence level in using Excel's data visualization features? (Low, Medium, High) _____

Usability Evaluation Tasks

Welcome to the usability evaluation of Microsoft Excel's data visualization features. Below are the tasks you will be performing during this evaluation. Please follow the instructions provided for each task and verbalise your thoughts while performing the tasks.

1. **Task 1**: Create a bar chart from the data in the Category and Value columns.
2. **Task 2**: Add data labels to the bars for better readability.
3. **Task 3**: Customize the style and colour of the bar chart.
4. **Task 4**: Change the axis titles to reflect the dataset's information.
5. **Task 5**: Add a trendline to the bar chart.
6. **Task 6**: Convert the bar chart to a line chart to improve data visualisation.
7. **Task 7:** Create a pivot chart (bar chart with three categories) using all data columns and visualise all data in the pivot chart.
8. **Task 8:** In the Threshold data column, highlight cells containing values greater than 4 by selecting the data and applying conditional formatting (Conditional formatting > Highlight Cells Rules > Greater Than…).
9. **Task 9:** Print the entire notebook to PDF format, but in landscape orientation.

Category	Values	Threshold
A	5	5
B	10	2
C	15	10
D	20	8
E	25	2
F	30	7
G	35	1
H	40	4
I	45	9
J	50	6

Table D.1: Sample data

SUS Questionnaire

1. I think that I would like to use this system frequently.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

2. I found the system unnecessarily complex.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

3. I thought the system was easy to use.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

4. I think that I would need the support of a technical person to be able to use this system.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

5. I found the various functions in this system were well integrated.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

6. I thought there was too much inconsistency in this system.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

7. I would imagine that most people would learn to use this system very quickly.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

8. I found the system very cumbersome to use.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

9. I felt very confident using the system.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

10. I needed to learn a lot of things before I could get going with this system

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5
- This scales all values from 0 to 4 (with four being the most positive response).
- Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.

Post-Test Questionnaire

Participant ID: Date:

Thank you for completing the usability evaluation tasks. Please provide your feedback below.

How would you rate your overall experience with Excel's data visualization features? (Poor, Fair, Good, Excellent) _____

What was the most challenging task for you during the evaluation? (Task number) _____

What features of Excel's data visualization did you find most useful?

_____

What improvements would you suggest for enhancing Excel's data visualization usability?

_____

Would you recommend Excel for data visualization tasks to others? Why or why not?

_____

_____

_____

Appendix E

User Testing Results

Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Q1	21	23	22	21	21
Q2	Beginner	Intermediate	Beginner	Intermediate	Beginner
Q3	Rarely	Rarely	Rarely	Frequently	Rarely
Q4	No	Yes	No	Yes	Yes
Q5	No	Yes	No	Yes	Yes
Q6	Yes	Yes	No	Yes	No
Q7	Low	Medium	Low	Medium	Low

Table E.1: Pre-test questionnaire results

Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Q1	2	4	3	4	2
Q2	4	4	4	1	5
Q3	3	5	2	5	1
Q4	4	2	3	1	5
Q5	2	5	3	5	2
Q6	2	2	3	1	5
Q7	2	4	2	4	1
Q8	3	2	4	1	2
Q9	3	4	1	5	1
Q10	2	2	4	1	5
SUS score	42.5	75	32.5	95	12.5

Table E.2: SUS questionnaire results

Task	**Participant 1**	**Participant 2**	**Participant 3**	**Participant 4**	**Participant 5**
Task 1	246.58	52.16	191.21	70.67	38.53
Task 2	19.63	58.04	175.16	18.64	31.73
Task 3	13.98	13.39	27.44	15.34	9.71
Task 4	56.94	120.14	33.69	58.02	20.69
Task 5	3.83	6.06	70.01	5.06	41.63
Task 6	40.54	25.13	16.74	14.34	17.41
Task 7	106.67	76.96	189.65	36.34	91.89
Task 8	68.47	62.23	62.56	39.61	67.42
Task 9	39.18	14.13	80.97	48.66	28.68
Total	**595.82**	**428.24**	**847.43**	**306.68**	**347.69**

Table E.3: Task completion times in seconds

Post-test questionnaire	**Participant 1**	**Participant 2**	**Participant 3**	**Participant 4**	**Participant 5**
Q1	Good	Good	Poor	Excellent	Fair
Q2	7	7	1	9	7
Q3	Bar chart, conditional formatting	Being able to create a rule that allows [/highlights] values to be higher than 4 [Conditional formatting]	Adding trend-lines	Creating charts	Task 3 was most useful, to be able to customise colour.
Q4	Something [/indication] to tell you to select data first [when creating graphs]. A separate section [/ribbon tab] for charts alongside insert [on the top options bar].	Most likely having different buttons or better navigation	Making it easier to understand like needing to highlight [/select] the data.	I have no suggestions	To add more visual step-by-step tutorials
Q5	I would recommend as it is a quick and simple method to visualise data that does not require much time to learn and is also quick to use on data if inputted.	I would, I believe having this tool can really help businesses to format data in a particular way [so] that [it] is clear and concise to read.	[I would recommend it to] Tech-oriented individuals who can Google or watch YouTube videos can get it, but [to] people who are not good with tech I would not recommend [Microsoft Excel].	Yes, it was easy to use.	Yes, as it has a lot of features [and] can help with visualisation but at times it's [a] bit complicated.

Table E.4: Post-test questionnaire results