

## AN EVALUATION OF TIMELINE VISUALIZATION AND TREE VIEWER IN CRIME NEWS

NAZLENA MOHAMAD ALI<sup>1,\*</sup>,  
NURUL FARHANAH MOHD MOKHTAR<sup>1</sup>, MASNIZAH MOHD<sup>2</sup>

<sup>1</sup>Institute of Visual Informatics (IVI), Universiti Kebangsaan Malaysia

<sup>2</sup>Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia

\*Corresponding Author: nazlena.ali@ukm.edu.my

### Abstract

Finding good and relevant information in crime news is one of the most challenging tasks faced by users. An increase in the amount of information from news media has caused difficulties for users in obtaining relevant information. Hence, visualization is one of the important aspects to enhance user's understanding when browsing or searching for news. Crime news requires a proper approach to visualize a variety of important information such as suspect, victim, location, time and evidence. Visual navigation is more interactive than linear. This has motivated us to develop a prototype called Crime News Visualization (CNV), which implements a timeline and tree viewer to assist users when browsing crime news chronologically. The prototype follows several phases of development starting with design concept, implementation and evaluation. News corpus used in this study is from the Bernama Library & Infolink Service (BLIS) resource, with a sample of 247 crime news documents from year 1997 to 2012. A user experiment was conducted with 20 undergraduate students from the Faculty of Social Science and Humanities, Universiti Kebangsaan Malaysia in order to evaluate the acceptance and perception of interactive browsing of crime news using news portal (baseline) and CNV (experimental). Findings revealed that more than 90% of the respondents indicated that the use of timeline visualization and tree viewer was helpful and had potential to improve the way users browse for crime news content.

Keywords: Crime news, Visualization, Timeline, Tree viewer, User evaluation.

### 1. Introduction

Searching for crime news or event has received a great deal of attention as it is a part of the information that the public are monitoring now-a-days. Users are

interested to follow and seek relevant information about crime such as the chronology, suspect, victim, crime scene and the evidence [1, 2]. Thus, media tends to create public awareness by monitoring and spreading the latest crime news using portals, websites and other online applications. As a result, the public get aware of the crime reported around their residential areas and take essential precautionary steps. Currently, news websites and portals are the main sources of information. Most of these sources do not organise crime news chronologically. Users need to read the news line by line for the full details of a crime and they have to spend extra time in finding relevant news. This has motivated us to develop the CNV prototype that applies timeline and tree viewer visualization techniques. We believe the timeline visualization technique applied in CNV will help users to read and understand crime news chronologically, while the tree viewer visualization technique will provide users with an interactive tree-like structure of the crime details. The tree viewer can also help users to get an overview of the crime news.

This study evaluates user perception over the timeline and tree viewer visualization techniques for crime news. 20 students from the Faculty of Social Science and Humanities, UKM majoring in journalism and criminology studies were selected as the participants in this user evaluation.

## **2. Background Work**

The amount of previous work focusing on timeline and tree viewer features is sparse [1, 2]. Most of the crime news available lacks the ability of presenting a timeline overview to the user. Timeline visualization improves user's understanding of crime news with better representation of crime entities in the news content [3]. Hence, users are able to browse crime news chronologically. This is where we believe that an overview perspective based on the time variables is a highly valued feature in CNV. Therefore, we would like to evaluate user perception of the timeline visualization technique implemented in a prototype called CNV.

Visualization is the process of forming a mental model or mental image of something and involves only human cognitive activities without computer interaction [4, 5]. Data visualization is a tool or method for interpreting image data fed into a computer and for generating images from complex multi-dimensional datasets [6]. Text visualization is a process to overcome constraints in the form of time and attention to textual content and meaning for analysts without them having to read it in the manner that the text normally requires [7].

In case of crime, people are more concerned about the victims, time and location of the incident and probably the instruments used and the instruments involved [1]. In addition, spatiotemporal crime analyses too have gained public attention [8, 9]. According to Nath [10] a new approach for crime pattern discovery, each record is composed of the many attributes describing the crimes, such as date/time, location, outline, demography and weapon. The crime-related information is then presented using overview and detail techniques. Overview techniques allow the inspection of multiple objects and multiple points in time, whereas a detailed view presents information about a selected object at a selected point in time [11]. Overview and detail visualizations distribute the data either temporally or spatially over two or more views [12].

Features such as visualization techniques play an important role in the user's interaction and satisfaction. A number of works have been done in applying visualization techniques to crime data. For example, Oakland Crime Spotting (<http://oakland.crimespottting.org>) provided an exploration tool for crime data. Their system provides a function for panning and zooming a geographical type map representation, and filtering the types of crime. The application also has a feature to dynamically browse both the time and day of a crime and a temporal form of data visualization. Another similar application is the New York Homicides Map (<http://projects.nytimes.com/crime/homicides/map>). Its interface also provides a geographical map representation to visualize the location of crimes. It has a search function to browse for crimes according to their types, along with a temporal view of crime data. These are just two examples of the many interesting crime news systems with visualization techniques that are available online. The visualization component seems to be an important component in all applications to make it more intuitive and interactive. Furthermore, these applications also support various types of filtering functions, categories and navigation.

However, there is a lack of research that focuses on chronological visualization techniques in current crime news and evaluates user perception of it. Users are instead forced to do a lot of switching between alternative views in an attempt to manually compare crime news content with each other. This is where we believe that timeline visualization would be a highly valued feature by users to enhance their understanding of crime news content.

### **3. Crime News Visualization Prototype**

The main purpose of the Crime News Visualization (CNV) prototype is to allow browsing of textual crime news content in a visual form. CNV provides different way of browsing and an interesting way of representing crime news. It presents crime news content in a visual form using a timeline and tree viewer, also allows users to browse crime news chronologically. The crime content is visualized into a tree viewer that allows the user to get an overview of the crime with interactive functionality.

CNV contains six popular Malaysian high profile crime news cases namely, the Canny Ong, Mona Fandy, Noritta Samsuddin, Nurin Jazlin, Sharlinie Mohd Nashar and Sosilawati. The news corpus used in this study is from the Bernama Library & Infolink Service (BLIS) of the Malaysian National News Agency (BERNAMA) for a sample of 247 crime news documents from year 1997 to 2012. The main interface layout consists of (a) Timeline, (b) News Case List and (c) Tree and News Viewer. Figure 1 shows the main interface of the CNV prototype.

#### **3.1. Part a – Timeline**

Part (a) is a timeline view representing the crime news in chronological order as shown in Fig. 2. The mouse-over function allows the user to view events of the crime news at a certain period. The dotted symbol on the timeline represents the news reported at the time. The timeline also shows the crime news pattern.

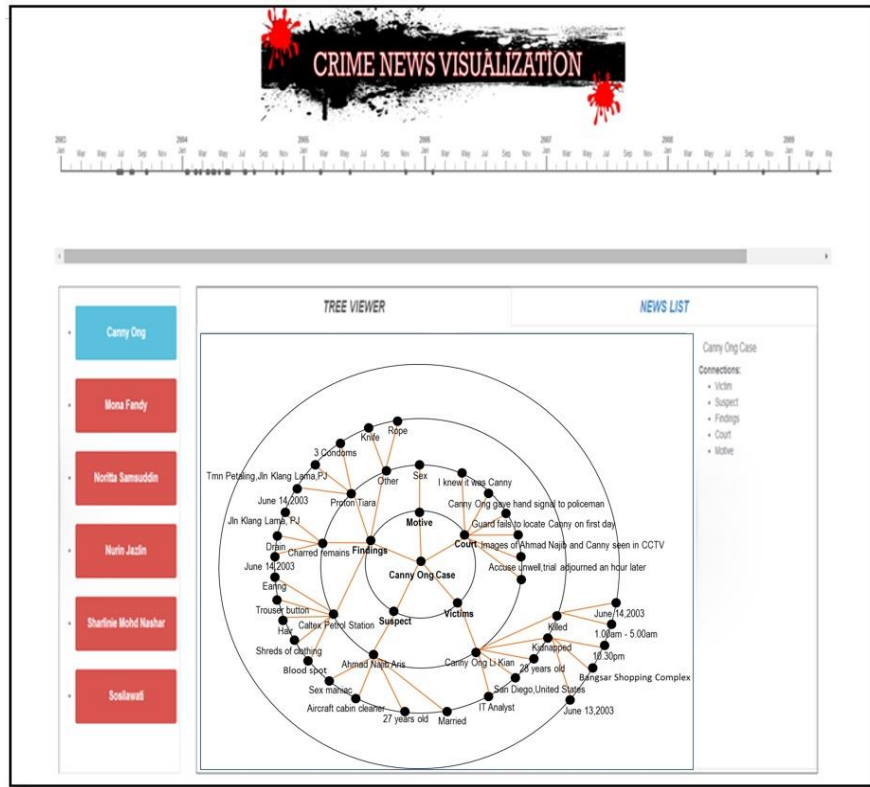


Fig. 1. Main interface of CNV.

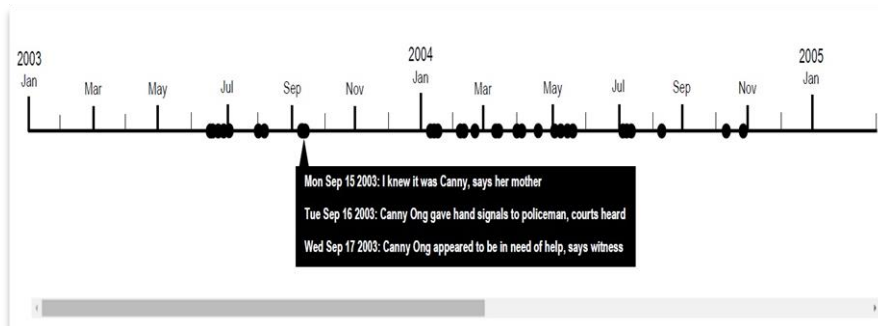


Fig. 2. Timeline visualization in CNV.

### 3.2. Part b – News case list

News List View shows the navigation tabs for the tree viewer and the news list. The navigation tabs are used to overcome the space limitation problem. Cases such as Canny Ong, Mona Fandy, Noritta Samsuddin, Nurin Jazlin, Sharlinie Mohd Nashar and Sosilawati are listed to make browsing crime topics easier for the user. Additional information was provided in Part (a) and Part (c) of CNV when the user clicked a specific case from this list.

### 3.3. Part c – Tree and news list viewer

Figures 3 and 4 show the interfaces for the navigation tabs for tree viewer and the news list. The tree viewer gives an overview of the criminal case. The facts gathered from the crime news reported are presented in a tree-like structure. The tree viewer allows the user to interact with the tree by panning and zooming in. The information in the tree structure is moveable. The user needs to click the tree node and it will move to the centre.

The news list is the news reported for the criminal case. These are sorted according to the case. All the news is chronologically arranged on the timeline. The user merely needs to mouse over to the timeline and click on the news. They may choose the news from the news list on the left section. The list allows them to read the news content in detail.

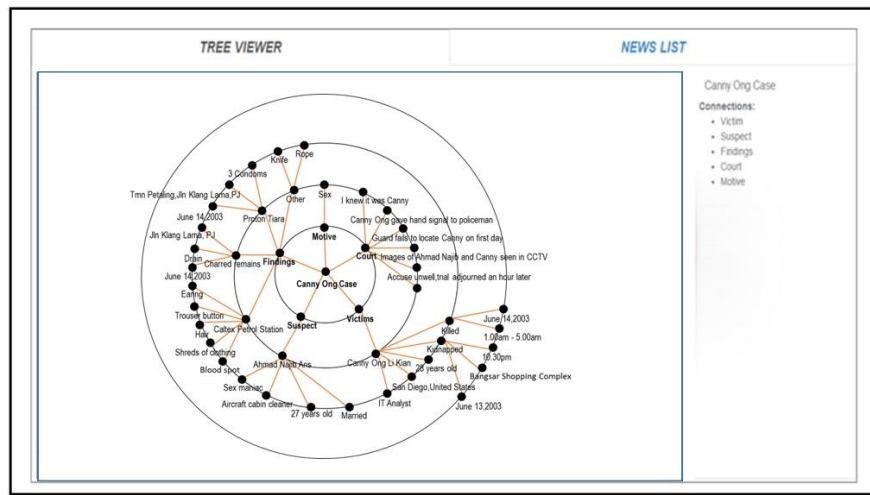


Fig. 3. Navigation tab for tree viewer.

The interface shows a list of documents on the left, numbered Doc 5 to Doc 27. The main content area displays a news article titled 'PRIME SUSPECT ARRESTED IN CANNY ONG CASE' with a date of 20-06-2003. The article text discusses the arrest of a suspect in the Canny Ong case.

Fig. 4. Navigation tab for news list.

#### 4. User Experiment

Questionnaire and observation are ethnographic techniques in the HCI literature today that can be used to better understand end user needs, expectations and their contexts in designing a more usable system [13]. The main objective of this user experiment was to obtain an insight of user perception and opinions of the timeline and tree viewer visualization techniques implemented in CNV prototype. 20 undergraduate students from the Faculty of Social Science and Humanities, UKM were selected. Before the experiment, a brief introduction about CNV and a short demo were given. All the participants were asked to complete an experimental task in 20 minutes. Participants had to complete four tasks using the news portal (<http://www.utusan.com.my/>) and the CNV prototype as shown in Table 1. The time taken for completing each task was recorded.

**Table 1. User experiment tasks.**

No.	Task
1	Based on the Noritta Samsuddin case, state the <i>date</i> and <i>place</i> she was killed.
2	Name all the <i>six suspects</i> involved in the Sosilawati case.
3	Identify the <i>month range</i> and <i>year</i> where a high number of news pieces were reported for Nurin Jazlin and Sharlinie Mohd. Nashar cases.
4	State the <i>published date</i> for the news below: a. DNA Results Confirm It Is Canny's Body b. Mona Fandey, her husband and their assistants were executed

After the tasks were completed, the participants had to complete a questionnaire. The questionnaire measured comparisons of the tasks using CNV prototype and the online news portal, evaluated the timeline and tree viewer visualization, made comparisons between user perception of CNV prototype and news portal based on the tasks given. The administered questionnaires consisted of four parts as shown in Table 2.

**Table 2. Section and items of questionnaire.**

Section	Items
A	Demographic Information
B	Part A: News Portal Part B: Task Experiment
C	Part A: CNV Part B: Task Experiment
D	Exit Questionnaire

In this paper, the results will only cover the evaluation of the user perception and usability of the CNV prototype. We categorised the questionnaires into 9 components and have analysed it in Section 5 (Results and Discussion). The components are:

- A. Timeline visualization of the crime progress
- B. Timeline visualization of the date and event
- C. Timeline visualization of the crime news pattern
- D. Tree visualization of an overview of the crime

- E. Interface consistency
- F. Attractiveness of browsing crime news
- G. Browsing time
- H. The importance of CNV in visualizing crime news
- I. Overall process in CNV

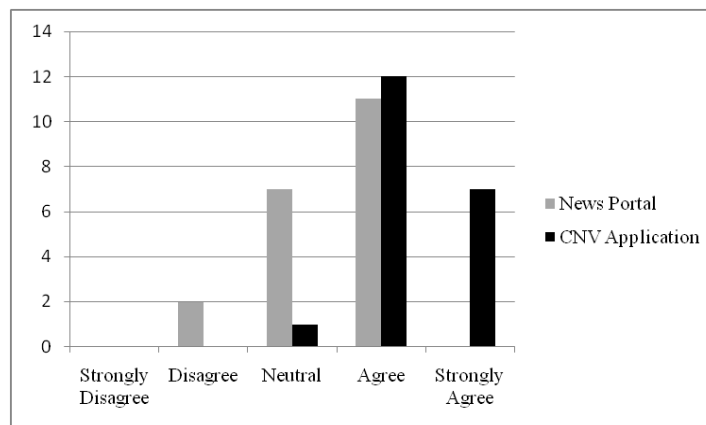
## 5. Results and Discussion

Based on the demographic information, of the 20 participants (3 males, 17 females), 19 were in the age group of 20-25 years and one was in the age group of 26 and above. Majority of the participants were using the news portal to read the news, 40% ( $n=8$ ) accessed the news portal more than 10 times a month, 25% ( $n=5$ ) accessed the news portal 5-9 times a month, 20% ( $n=4$ ) accessed the news portal 3-4 times a month and 15% ( $n=3$ ) accessed the news portal 1-2 times a month.

### A. Timeline visualization of the crime progress

The first question (Q1) was about timeline visualization for identifying the crime progress. 19 students (95%) stated “Agree” (60%,  $n=12$ ) and “Strongly Agree” (35%,  $n=7$ ) to the item that CNV helps in monitoring crime progress. Meanwhile, there were 11 students (55%) who marked “Agree” to the statement that news portal helps in monitoring crime progress, as shown in Fig. 5. It can be concluded that the timeline visualization feature in CNV helps users to monitor crime progress better as compared to a news portal. One of the participants said, “The timeline feature is absolutely interesting and useful in monitoring crime news”.

However, there were a few respondents who rated “Neutral” and “Disagree” for news portal that represents the inability to assist them in carrying out their tasks. This is shown by the findings related to aspects being evaluated in the news portal. One of the reasons for the “Neutral” selection is because respondents are new to the CNV prototype features and the restricted features provided in the news portal.

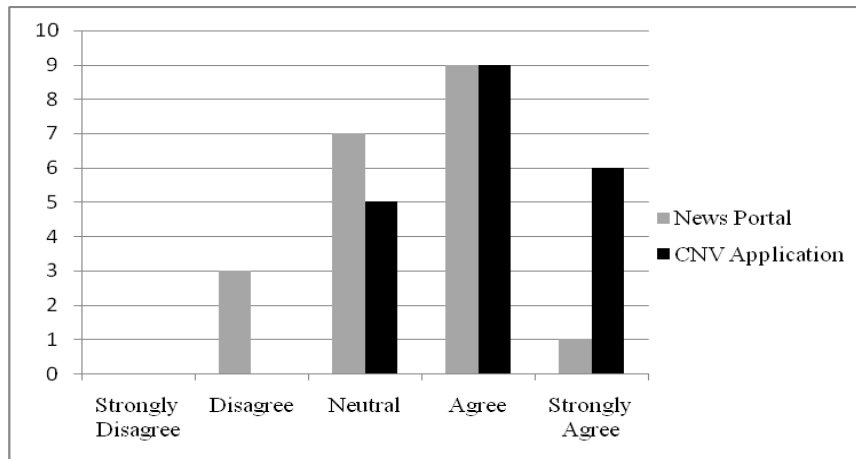


Note: y-axis is frequency number of response; x-axis is perceived as the agreement level

**Fig. 5. User evaluation of timeline in crime progress between News Portal and CNV.**

### B. Timeline visualization of the date and event

The second question (Q2) was about timeline visualization of the date and event of the crime. Findings revealed that 75% ( $n=15$ ) of the students had positive opinions of “Agree” (45%,  $n=9$ ) and “Strongly Agree” (30%,  $n=6$ ) that the timeline visualization in CNV represented the date and the event of a crime clearly. 50% ( $n=10$ ) of the students had positive opinions of “Agree” (45%,  $n=9$ ) and “Strongly Agree” (5%,  $n=1$ ) that the news portal represented the date and event of the crime clearly. From Fig. 6, it can be concluded that the date and the event of the crime in the timeline visualization was represented clearer in CNV as compared to the news portal.



Note: y-axis is frequency number of response; x-axis is perceived as the agreement level

**Fig. 6. User evaluation of timeline visualization in representing date and event of criminal case between News Portal and CNV.**

**C. Timeline visualization of the crime news pattern**

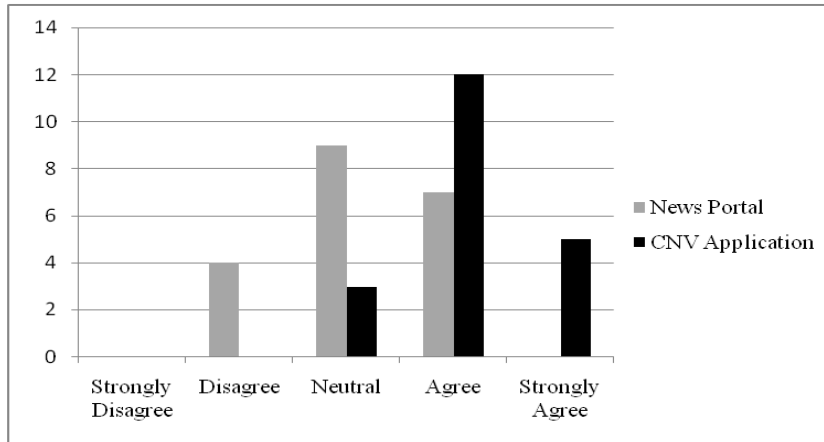
The third question (Q3) was about the timeline helping the user to compare the crime news reporting pattern. It was found that 85% ( $n=17$ ) of the students had positive opinions of “Agree” (60%,  $n=12$ ) and “Strongly Agree” (25%,  $n=5$ ) that the timeline visualization in CNV helped them compare the crime news reporting pattern. 35% ( $n=7$ ) of the students stated “Agree” about the news portal helping them to compare the crime news reporting pattern. It can be concluded that the timeline visualization helped the users to compare the crime news reporting pattern, as shown in Fig. 7.

**D. Tree Visualization for overview of the crime**

The fourth question (Q4) was about the tree viewer providing an overview of the crime. Findings revealed that 85% ( $n=17$ ) of the students had positive opinions of “Agree” (60%,  $n=12$ ) and “Strongly Agree” (25%,  $n=5$ ) that the tree viewer helped them get an overview of the crime (as shown in Fig. 8). In addition, students also provided positive and negative opinions about the tree viewer. They felt that the tree browser had an interesting design and made browsing faster. Some of the students faced difficulty with the font of the information in the tree

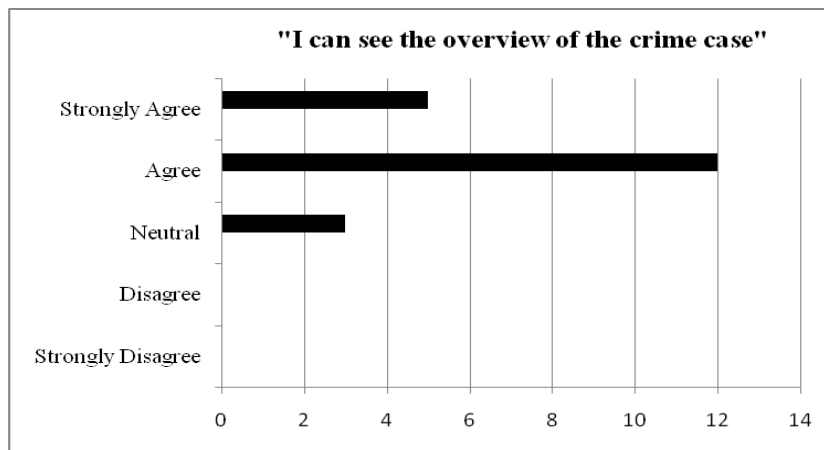


graph. The font was too small and the black background for the tree viewer made the information blurry. Feedback received from the students was very important and should be considered for the improvement of the CNV prototype.



Note: y-axis is frequency number of response; x-axis is perceived as the agreement level

**Fig. 7. User evaluation of timeline visualization in comparing crime news reporting pattern between news portal and CNV.**



Note: x-axis is frequency number of response; y-axis is perceived as the agreement level

**Fig. 8. User evaluation of tree visualization in providing overview of crime news in CNV.**

**E. Interface consistency**

The fifth question (Q5) was about interface consistency. It was found that 80% (n=16) of the students had positive opinions of “Agree” (65%, n=13) and “Strongly Agree” (15%, n=3) with the statement ‘System interface is consistent’. Based on user observation, they had become familiar with user interface elements such as the three parts of CNV (A, B, C) when performing the tasks. It was

observed that users had a consistent interaction when performing the tasks in CNV compared to the news portal. Based on the results, it can be concluded that the CNV interface design is consistent.

### **F. Attractiveness of browsing crime news**

The sixth question (Q6) was about the attractiveness of browsing crime news. Findings revealed that 90% ( $n=18$ ) of the students had positive opinions of “Agree” (45%,  $n=9$ ) and “Strongly Agree” (45%,  $n=9$ ) with the statement ‘CNV prototype provides an interesting way of browsing crime news’. This finding supports the assumption that the CNV prototype provides an interesting way of browsing crime news to users.

### **G. Browsing time**

The seventh question (Q7) was about the time consumed by browsing. The time given for completing the experimental tasks was 20 minutes. Based on the time recorded during the experiment using the CNV prototype, it was found that 35% ( $n=7$ ) of the students completed the experimental task in less than 5 minutes and 65% ( $n=13$ ) of the students completed the experimental task in a range of 5 to 10 minutes.

It was found that only 10% ( $n=2$ ) of the students completed the experimental task in a range of 5 to 10 minutes using the news portal. 60% ( $n=12$ ) of the students completed the experimental task in a range of 10 to 15 minutes and 30% ( $n=6$ ) of the students completed the task in more than 15 minutes.

Most of the students took longer to complete the experimental task because the news in the news portal was unorganised. They used the search box to browse the crime news but it appeared in the listing of the news. Users read the news in detail to find out the content of the case. From the results, it can be concluded that the CNV prototype shortens the browsing time required by users.

### **H. Importance of the CNV prototype in visualizing crime news**

Q8 was about the importance of CNV prototype in visualizing the crime news. It was found that 95% ( $n=19$ ) of the students had positive opinions of “Agree” (75%,  $n=15$ ) and “Strongly Agree” (20%,  $n=4$ ). Based on this, it can be concluded that the students found that the timeline and tree viewer visualization techniques used in the CNV prototype to be important as these techniques made them aware of the crime news content.

### **I. Overall process in the CNV prototype**

Q9 was about user understanding of the overall process in the prototype. We found that 90% ( $n=18$ ) of the students provided positive opinions of “Agree” (55%,  $n=11$ ) and “Strongly Agree” (30%,  $n=6$ ). They understood the overall process in the prototype and felt that CNV had presented the contents of the crime news interestingly using the timeline and tree viewer features. Below are some of the users’ comments about CNV prototype where most mentioned that CNV was easy, fast and interesting (as shown in Table 3).

**Table 3. User comments about using CNV.**

Respondent ID	Comments	Perceived
1	<i>Easy to use and user friendly</i>	Easy
4	<i>Easy and fast</i>	Easy, Fast
6	<i>Shortens the time for finding information about criminal cases, analysing criminal cases and presenting the crime news reporting patterns</i>	Fast
7	<i>Something new and interesting</i>	Interesting
9	<i>Fast browsing and the timeline visualization techniques help me to see the frequency of the crime news</i>	Fast
12	<i>Attractive design, easy to access the crime news within a short time</i>	Interesting
13	<i>The timeline feature is absolutely interesting and useful in monitoring crime news. It helped us read the past crime news</i>	Interesting, Useful
15	<i>Simple and easy to get information</i>	Easy
20	<i>I can read the recent crime news easily</i>	Easy

Based on all the results, it can be concluded that the CNV prototype has a timeline that helps users in identifying the crime progress, represents the date and the event of the crime clearly and helps in comparing the crime news reporting patterns. The CNV prototype also provides the tree viewer that helps users to get an overview about the case, has a consistent interface, provides an interesting way of browsing the crime news, shortens the browsing time, plays an important role in visualizing the crime news and the overall process of the CNV prototype is understandable. 100% of the participants would like to use the CNV prototype again in the future. Overall, the CNV prototype was found to be useful and helpful to the users.

## 6. Conclusion

Difficulty in understanding a huge amount of information when browsing and searching is a result of improper information visualization. Results and discussions were presented based on user perception and usability questionnaires. It gave us an insight into user perception of timeline visualization and tree viewer techniques to visualize crime news data. Overall, we obtained positive feedback and support. These findings highlight several potential design elements to be incorporated in crime news systems and applications. Timeline visualization and tree viewer provide a new paradigm of monitoring news in an interesting way. Hence, it supports an effective and efficient way of browsing and searching important crime information in criminal cases.

## References

1. Mohamad Ali, N.; Mohd, M.; Lee, H.; Smeaton, A.F.; Crestani, F.; and Mohd Noah, S.A. (2011). i-JEN: Visual interactive Malaysia crime news retrieval system. *Proceedings of the 2<sup>nd</sup> International Visual Informatics Conference IVIC 2011*. Selangor, Malaysia, 284-294.

2. Mohd, M.; and Mohamad Ali, N. (2011). An interactive Malaysia crime news retrieval system. *Proceedings of International Conference on Semantic Technology and Information Retrieval (STAIR 2011)*. Kuala Lumpur, Malaysia, 220-223.
3. Olsson, J.; and Boldt, M. (2009). Computer forensic timeline visualization tool. *Proceedings of the Digital Forensic Research Conference DFRWS 2009 USA*. Montreal, Canada, 78-87.
4. Spence, R. (2007). *Information visualization: design for interaction* (2<sup>nd</sup> ed.). London: Pearson Education Limited.
5. Jenny, P.; Yvonne, R.; Helen, S.; David, B.; Simon, H.; and Tom, C. (1994). *Human-computer interaction*. Essex: Addison-Wesley.
6. Silic, A.; and Basic, B.D. (2010). Visualization of text streams: A survey. *Proceedings of the 14<sup>th</sup> International Conference on Knowledge-based and Intelligent Information and Engineering Systems*. Cardiff, UK, 31-43.
7. Wise, J.A.; Thomas, J.J.; Pennock, K.; Lantrip, D.; Pottier, M.; Schur A.; and Crow, V. (1995). Visualizing the non-visual: Spatial analysis and interaction with information from text document. *Proceedings of Information Visualization 1995*. Atlanta, USA, 51-58.
8. Herrmann, C.R. (2015). The dynamics of robbery and violence hot spots. *Crime Science*, 4(33), 1-14.
9. Grubb, J.A.; and M.R. Nobles. (2016). A spatiotemporal analysis of arson. *Journal of Research in Crime and Delinquency*, 53(1), 66-92.
10. Nath, S.V. (2006). Crime pattern detection using data mining. *International Conference on Web Intelligence and Intelligent Agent Technology Workshops*. Hong Kong, 41-44.
11. Zollmann, S.; Kalkofen, D.; Hoppe, C.; Bischof, H.; and Reitmayr, G. (2012). Interactive 4D overview and detail visualization in augmented reality. *IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*. Atlanta, USA, 167-176.
12. Cockburn, A.; Karlson, A.; and Bederson, B.B. (2009). A review of overview + detail, zooming, and focus + context interfaces. *ACM Computing Surveys*, 41(2), 1-2.
13. Lee, H.; and Mohamad Ali, N. (2014). Framing the design of novel applications inspired by emerging media technologies. *The International Journal of Visual Design*, 7(1), 1-20.