

# Personalized Virtual Campus Journey Adaptation to User Controlled Experience

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**Abstract.** Increasingly, educational institutes are migrating into mobile platforms and mobile app technology to communicate, advertise, and disseminate education-related information to their stakeholders using virtual campus journey mobile apps. Campus journey mobile apps generally provide standardized generic customization to their user base, incorporating a list of favorite touchpoints based on the users' frequent behaviors. In the literature, personalization, and customization, definitions are mixed-up and inter-changed with no proper separation of these two concepts. In this research, the personalized virtual journey is examined according to the user's preference. It includes creating and updating the personalized virtual campus journey path as an activity of the user and having it as an integral part of the personalized virtual campus journey application. This research presents the concept structure, design, implementation, and evaluation results of the personalized virtual campus journey mobile app development according to the user's preferences with the user given the ability to control his or her own virtual journey experience.

**Keywords.** Virtual journey, virtual campus, virtual campus app design, personalization, explicit user-controlled experience.

## 1. Introduction

A 2020 global survey among e-commerce decision-makers revealed that 78 percent of global e-commerce companies are planning on investing more into the realization of personalization [1]. As of October 2020, nearly 4.66 billion people (59 percent of the global population) are active internet users. Ninety-one percent (91%) of these users use mobile channels to access the internet [2], making mobile devices the most used devices in internet traffic.

The virtual campus journey mobile applications have appeared in the market since 2011 [3]. The virtual campus journey apps run on mobile devices, smartwatches, desktop/laptop computers, and tablet devices. Recent developments in software engineering have made it possible for software engineers to design and build apps that can run on different devices and platforms and share the same logic across the devices and platforms.

The virtual campus journey apps have become an integral part of the campus population. The users and stakeholders of virtual campus journey applications are staff,

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students, parents, guests, visitors, and prospective students. Virtual journey mobile app is bringing all campus services into a single app. Getting all services into a single place is a difficult task for software engineering. A campus has many services such as student services, library, booking room, cafes/restaurants, events, and many more. University may have more than one campus, and campus(es) can be located in different cities or countries. Each campus has its services that make the personalization of the virtual campus journey complex. Therefore, few universities have mobile applications [3]. Because planning, designing, and building an excellent virtual campus journey app is challenging. Software engineers need to collaborate with students, staff, university administration, visitors/guests of the university, prospective students, and parents in such a successful implementation path. One of the main challenges is that the university's services are legacy systems. This study closely investigated the personalization of the virtual campus journey mobile apps. For this purpose, testing and comparing mobile applications of Times Higher Education World University Ranking's [4] first top 20 universities are considered. Next, mobile applications for both IOS and Android devices are conducted, including a virtual campus journey personalization approach. This research presents a novel concept of virtual campus journey apps that is personalized according to individual user preferences giving control to users to organize their preferred virtual journey. The implementation is limited to the IOS and Android version of the mobile app.

The following research question articulates the research:

- I. What constitutes a personalized virtual campus journey mobile app that overcomes the problems in designing personalization?

The research methodology followed the Design Science Research (DSR) framework [5]. The paper consists of a review of related works, foundational principles of the conceptualization of services systems engineering and touchpoint design, designing and building a prototype of virtual campus journey mobile app implementing a personalized virtual campus journey, feature evaluation, benchmarking leading to a comparison of mobile educational apps, and conclusions.

## **2. Related Works**

Mobile applications provide additional functionality with each new version release. Displaying the many features of the application at the same time makes it challenging to use it. Every user has their preferences. Some features of the application might not be relevant to the user's interest. Users may not want to see some features in their application interface or screen. There is a need to manage the interface, providing users with easy access to the features they use, making personalization increasingly important [6]. The classical characterization of personalization is presented in table 1.

Personalization is a process of changing the system's functionality, interface, and information content to increase its user's relevance. Personalization is initiated by the system or user [7]. The system saves the user's preferences and adapts them to the user's needs. Adaption of the system is essential in the personalization process [5].

**Table 1.** The typical classical characterization of personalization

Characteristics	Action
Customize the appearance[7] [8]	The user chooses a color cover or attaches a sticker on the phone; the change persists in the system [7]. Having a customizable appearance with changeable skins or color schemes would make the app feel more personal[8].
Set preferences [8]	Recommending products based on preferences of similar-minded consumers[7].
Receiving notification on those that are of interest	The user indicates which areas she/he is interested in; the system memorizes this and will notify the user about items that fall within these defined categories [7]
Personalizing ringing tone	The user selects, orders, or composes the tone; the system memorizes the change [7].
Changing font size	The user enlarges the font size or increases the contrast of the front; the system memorizes the change. [7]

There are many types of personalization approaches. According to Li et al. [9] the types of personalization approaches are:

- Content-based personalization recommends items similar to those a user liked in the past.
- Collaborative personalization recommends items that other similar people have liked.
- Hybrid personalization is the combination of content-based personalization and collaborative personalization approaches.
- Social network-based personalization collects information from people in the same social network as the focal consumer and then recommends items liked by these people to the consumer [9].

Orji et al. [10] compare two types of personalization approaches in their research. These approaches are system-controlled personalization and user-controlled personalization. The difference between these two approaches depends on who controls the personalization. The adaptive interfaces are system-controlled, whereas adaptable interfaces are user-controlled [5]. The system's adaptability to user preferences with user-controlled interfaces is an essential contributor to virtual campus journey personalization.

### 3. Concept Structure: Touchpoints and Service Engineering fundamentals

The research [3] introduced the conceptual model of a virtual campus journey. The study [11] presented a survey conducted among the LUT University students and staff to identify the user preferences of a virtual campus journey. A total of 75 responses are collected from this survey involving university staff, students, visitors, parents, and software developers' close collaboration. These research initiatives and use cases contributed to the formulation of touchpoints and service engineering fundamentals.

Universities have many services and more than one campus location offering different services. Examples of university services are student service, student union, library, courses, timetables, Learning Management System (LMS), news services,

university mail service, restaurants/cafes/dining places. These services are located on different servers and domains. When designing a personalized virtual journey app, service systems engineering is an important conceptual underpinning [12].

A **virtual campus journey** is the discovery process and orchestration of the essential services offered at an education institute for communication, information retrieval, and dissimulation.

- Virtual campus journey is a mobile app implemented at the root level of the mobile device's interface, just like any other mobile app.

A **touchpoint** is a point of interaction offered to the user at the mobile app's user interface.

- A touchpoint is either an **atomic** or **composite service touchpoint** and is a feature of a mobile app.
- Atomic touchpoints provide access to a virtual atomic service that composes a physical service.
- Atomic service consists of only one single virtual service and a single touchpoint.
- Composite services can consist of more than one virtual service but consist of a single touchpoint, a composite service touchpoint.
- Therefore, an atomic service touchpoint represents a single service, whereas a composite service touchpoint opens up the touchpoints of the services bundled in the composite service.

The **virtual campus journey app** is a **composite service touchpoint** at the root of the mobile device's user interface. It guides the access to physical services that represent the educational services to respective stakeholders.

The *virtual campus journey's virtual space* consists of touchpoints and virtual services defined in the website of an institute and their seamless orchestration to offer physical service available at the institute.

The **physical space** of an educational institute accommodates the actual physical services of an educational institute.

The **virtual space mapping to the physical space** is accommodated by the coordination between the touchpoints and virtual services.

A **physical service** is an offering to a stakeholder (customer, consumer, etc.) that the stakeholder initiates via a physical interface. In so doing begins one or more underlying actions, whose normal and expected result is a delivered response [12]. Every physical service has an associated business process in any organization. A physical service has defined clients or stakeholders. A campus has many services

- The stakeholder can be internal or external to the organization that provides the service.

The **virtual services** corresponding to physical services are made available via a website/webpage of today's organizations via a web interface.

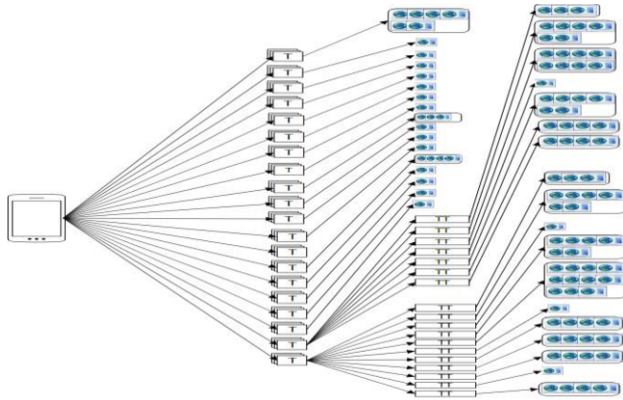
A **virtual educational service** can be of **virtual atomic service** implemented in the virtual space (website) corresponding and interacting with the educational institutes' physical space of service offerings.

The **composite virtual services** are services bundles of aggregated services mapping to a composite virtual touchpoint.

- Composite virtual touchpoints expand into a set of atomic touchpoints during the interaction with a user.
- The **Atomic virtual services** map to atomic touchpoints to reach an independent service via virtual space.

This way of conceptualization allows the advantage of defining virtual services to be acquired in Webservices and APIs.

**Figure 1** shows the simple mobile touchpoints and virtual services tree.



**Figure 1.** Mobile touchpoints and services tree.

Virtual services are subject to the following characteristics [13]:

- Loosely coupled: no direct dependencies among individual virtual services.
- Abstract: a virtual service hides its logic from the outside world.
- Reusable: support potential reuse.
- Composable: comprise of other virtual services to form a composite virtual service.
- Stateless: not maintains state information specific to an activity.
- Discoverable: let a virtual service consumer discover and understand service descriptions.
- Virtual services flow the data to touchpoints.
- The user uses services by interacting with touchpoints. Therefore, the features are considered touchpoints.

Through service discovery and composition, SOA-based application development identifies three stakeholders [13]: A service provider (or developer) is the party who develops and hosts the service. A service consumer is a person or program that uses a service to build an application. A service broker helps service providers publish and market their services and helps service consumers discover and use the available services. **Figure 2** illustrates the summary of the service systems engineering and touchpoint association at the user interface to accommodate the user preference integration foundation to virtual campus journey apps.

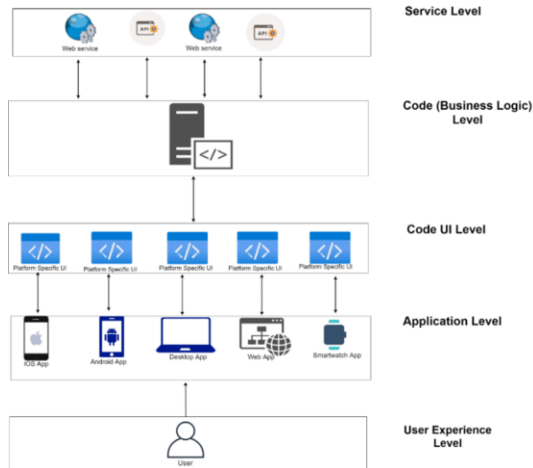


Figure 2. Virtual Journey Software Architecture Levels

The concept of personalization is defined as "a process that changes the functionality, interface, information access, content, or distinctiveness of a system to increase its relevance to an individual or a category of individuals" [18]. The core elements of personalization are:

- "a purpose or goal of personalization."
- "what is personalized." Four aspects of information systems may be personalized: the information (content), the presentation of information (user interface), the delivery method (channel), the action
- "the target of personalization." The target can be a group of individuals or a specific individual.

Personalization enables users to acquire information specific to their "needs, goals, knowledge, interests or other characteristics" [19]. The personalization principle of the virtual campus journey app is based on the following criterion:

- **The goal of personalization:** is to allow the user to select and orchestrate a virtual journey according to the user's preferences of services and a user being able to control his or her actions of controlling the revision, updates, and order of services self.
- **What is personalized:**
  - *The user interface* of the virtual journey app allows the user to select useful and dynamically adaptable touchpoints according to user needs.
  - *Actions:* of drag-drop, create a journey with favorite order of services, update and revisions of favorite services, activate an improved personalized user experience.
  - *Content:* the services that have a use for the user selected by the user
  - *Channel:* the delivery method as touchpoints
  - **The target of personalization:** is to provide a personalized user experience that supports the user preference adaptation adaptable to user-controlled actions in a dynamic user interface by:
    - Settings
    - Layout

- Navigation home screen
- Dynamic, adaptable Touchpoints

Therefore, this approach's novelty can dynamically adapt the user interface at the touchpoint level – which is the user-experience level. Then service system adapts according to the user's preference and provides a seamless and improved user experience.

#### 4. LUT Prototype: The LUT Mobile App

This section describes how the above-described novel personalized service and touchpoint engineering is integrated into the implementation.

##### 4.1 Technical Details

Xamarin.Forms framework is used for designing the virtual journey mobile app. Xamarin.Forms [14] is an open-source mobile UI framework Microsoft for building iOS, Android, & Windows apps with .NET from a single shared codebase using C# programming language. Xamarin.Forms share the code across the platforms. Business Logic, Platform APIs, and User Interface codes are shared across the platforms by Xamarin Forms. The main reason for choosing Xamarin.Forms is designing and building the same mobile app for IOS and Android devices. The design uses the Model-View-ViewModel (MVVM) software architectural pattern [15].

##### 4.2 Platform decisions

The mobile apps for IOS and Android versions are created. The application runs on both platforms. Because IOS has a different user interface than Android, a decision is made to create a cross-platform mobile app to analyze IOS users' preferences at the same time. IOS and Android share most of the mobile app marketplace.

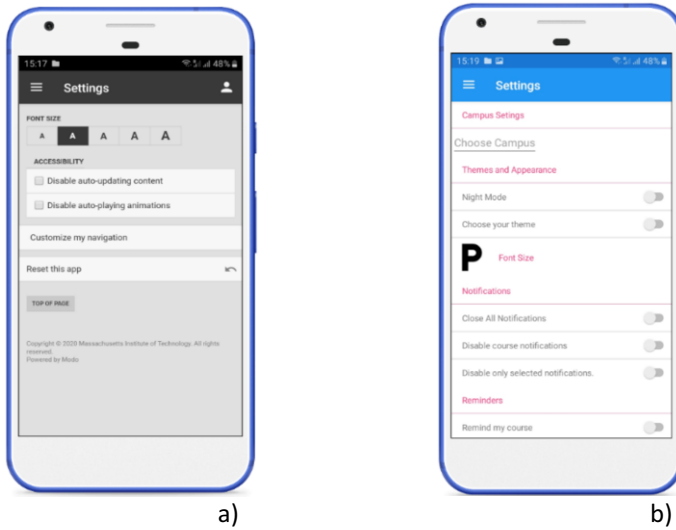
##### 4.3 Platform Specific UI.

Platform-specific UIs have resources such as photos, which have been used for the application. In this phase, touchpoints are created according to the platform. This is a crucial point for developers. A cross-platform solution can be good practice; however, these solutions do not give 100% representative native user interface and native codes for the platform.

USE CASE: LUT University has two campuses in different cities. Each campus has services that are reachable within that campus.

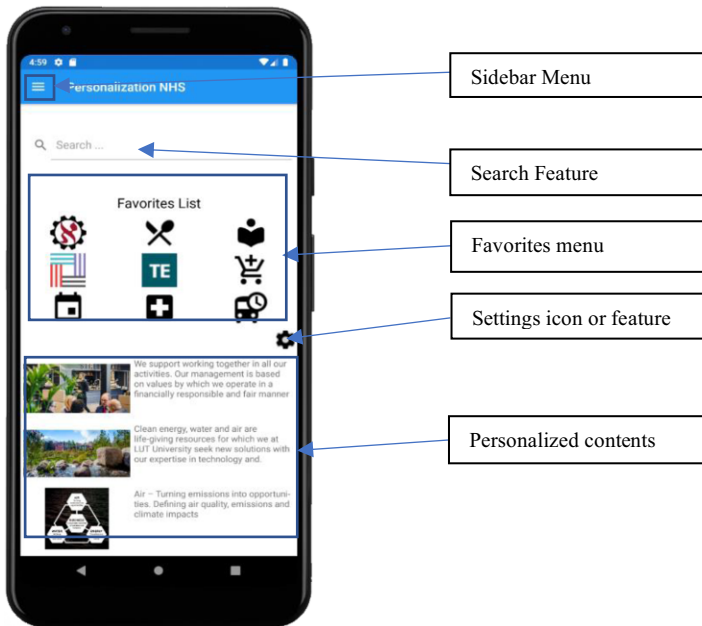
Personalization of mobile app can be in 3 ways in a mobile app:

- Navigation Home Screen (NHS) Personalization (Figure 5)
- Touchpoint personalization which happen in touchpoint, user can select services in this touchpoint; for example, users can select their preferred touchpoints representing news, food, and events. (Figure 6)
- Settings-personalization happens in settings (Figure 3)



**Figure 3.** Comparison of ordinary Settings section with LUT mobile a) Ordinary settings in benchmarked mobile apps b) Settings section in virtual tour journey – prototype.

Figure 4 shows the Navigational Home Screen interface.



**Figure 4.** Navigational Home Screen

Touchpoints are considered as features according to the above-formulated foundation.

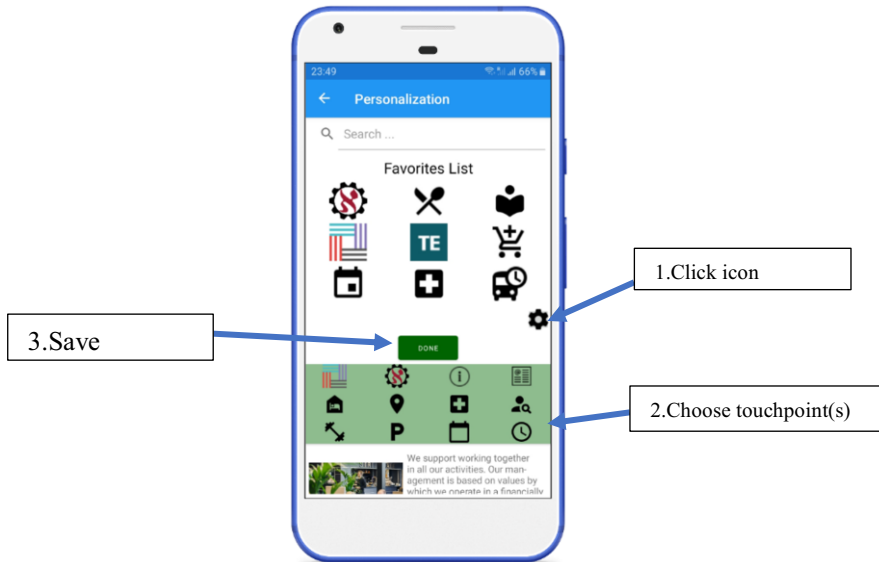
The navigation home screen is the main interface where users can see important touchpoints.



The settings button is where all the touchpoints are located. The user triggers the setting icon by clicking on it, and a list of touchpoints appears. **Figure 5** shows the home screen touchpoint personalization. In the first step, the user clicks the settings icon, and all touchpoints appear. In the second step, the user can drag and drop touchpoint(s) to the favorites list, remove touchpoint(s), adjust the position of touchpoints in favorites, and remove touchpoints from the favorites list. In the final step, the user clicks the "Done" button to save the changes.

Personalized content is the content that appears according to the user's preferences.

Sidebar Menu is a menu where the settings and other essential touchpoints are located.



**Figure 5.** Navigational Home Screen Personalization of LUT Mobile

## 5. Comparison and evaluation

The virtual journey mobile app prototype is evaluated and compared to other universities' mobile apps.

A close look at mobile apps with touchpoints such as courses, campus maps, directories, timetables, and libraries to be considered for this evaluation. Mobile apps not related to education purposes removed from the list. A decision is made to compare the first 20 universities of Times Higher Education World University Ranking 2021 [4] campus journey mobile apps. The universities selected have their mobile apps for the use of their students. In the end, a total of 14 universities' mobile apps are selected. The main reason for selecting top-ranking universities is that most universities do not own their virtual campus journey apps. Few universities have mobile apps in Finland, and the data on personalization is not enough for making the comparison because they have not considered personalization in their present implementations.

The selected universities are compared against the LUT Mobile app prototype. Table 2 shows the comparison criteria, mobile apps, and evaluation against other virtual campus journey apps.

**Comparison criterion:**

- **Home Screen Menu type:** 8 out of 14 benchmarked universities have Grid layout interfaces. Grid [16, 17] layout organizes rows and columns, which can have proportional or absolute sizes.
- **Settings:** The survey in previous research [11] is conducted among university students and staff and is informed whether a mobile app should accommodate a settings section. Surprisingly 81.34% of respondents agree that every mobile application needs to contain the settings section. Therefore, a settings personalization is included in the LUT Mobile prototype as the criterion for the comparison.
- **Navigational Home Screen Personalization:** Navigational Home Screen Personalization helps to personalize the mobile app's main screen, whether the user can see when he/she opens the mobile app every time.
  - Some mobile apps (MIT Mobile, Princeton Mobile, Harvard College, and Berkeley) have my favorites option for personalizing Navigational Home Screen.
    - My favorites can provide a list where user can remove, add his/her preferred services and these selected services appear at the top of the Home screen or Sidebar menu.
    - However, the user can not adjust the position.
  - U of T Mobile has a different design for Home screen personalization. In U of T Mobile, the user can remove, add new to the home screen from a list of available apps with the extra feature of changing the position of the list through the settings. It does not support dynamic adjustment at the user's touchscreen.
  - Imperial Mobile Navigational Home, Screen level personalization, offered to add, remove, and adjust the list on the same page using extra functionality.
  - LUT Mobile's Navigational Home Screen is shown in **Figure 4**. LUT Mobile Navigational Home Screen is a touchscreen where the user can drag-drop, add new touchpoints, adjust touchpoints on the same screen to favorite touchpoints, and give the user the control to personalize his/ her most preferred educational services.
- **Touchpoint personalization:** The bookmarking of the touchpoints is not considered personalization. Touchpoint personalization must include dynamic flexibility and adaptability as described in the personalization principles in section 3. Giving them control of personalization to be controlled by the user. The drag-drop functionality of touchpoints that is capable of:
  - changing the order of the favorite touchpoints,
  - add new touchpoints that are available in the Mobile Virtual Journey App
  - remove unnecessary touchpoints and
  - making the favorite touchpoints available each time a user opens the virtual journey app.
  - Further personalization of services with a touchpoint through the touch screen.

**Figure 6** shows the news touchpoint of the LUT mobile app. Users can add, remove news categories in news touchpoints, and users' preferred news appear at touchpoints. **Figure 7** shows the steps of touchpoint personalization.

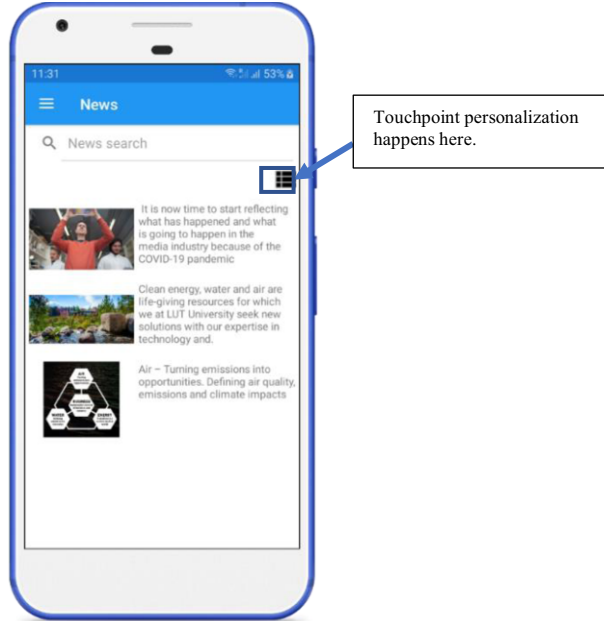


Figure 6. LUT Mobile News Touchpoint

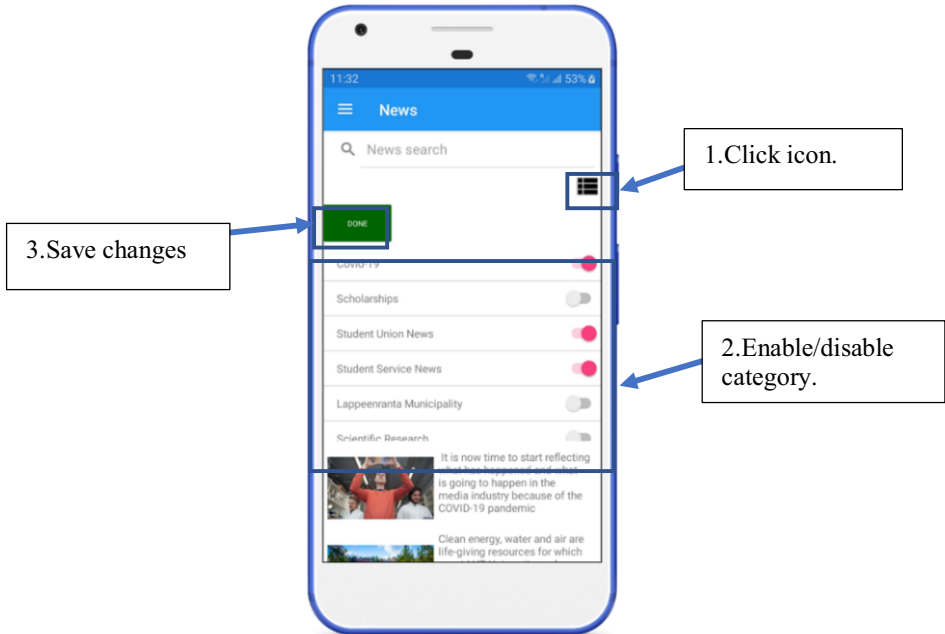


Figure 7. LUT Mobile News Touchpoint Personalization

**Table 2.** Personalization Comparison

University Name	Mobile App Name	Settings Personalization	Navigational Home Screen Personalization	Dynamic and Adaptable Touchpoint Personalization	Partial Adjustment of Touchpoints	(My)Favorites as Personalization	Home Screen Menu type
Stanford University	Stanford Mobile	No	No	No	No	No	Mix/Static
Harvard University	Harvard College	Yes	No	No	No	Yes	Mix/Static
Massachusetts Institute of Technology	MIT Mobile	Yes	No	No	No	Yes	Grid/Static
University of California, Berkeley	Berkeley	Yes	No	No	No	Yes	Grid/Static
Yale University	Yale	No	No	No	No	No	Mix/Static
Princeton University	Princeton Mobile	Yes	No	No	No	Yes	Grid/Static
The University of Chicago	Uchicago	Yes	No	No	No	No	Grid/Static
Imperial College London	Imperial	Yes	Yes	No	No	No	Grid/Static
Johns Hopkins University	JHUMobile	Yes	No	No	No	No	Grid/Static
University of Pennsylvania	Penn Mobile	Yes	No	No	No	No	Mix/Static
ETH Zurich	ETH Zurich	No	No	No	Yes	No	Mix/Static
UCL	UCL Go!	Yes	Yes	No	No	No	Grid/Static
University of Toronto	U of T Mobile	No	Yes	No	No	Yes	Grid/Static
Duke University	Duke Mobile	No	No	No	No	No	Mix/Static
LUT University (Prototype)	LUT Mobile	Yes	Yes	Yes	Yes	Yes	Grid/Dynamic

## 6. Conclusion

This research introduces the concept structure, design, implementation, and evaluation results of the personalized virtual campus journey application design and development with dynamic user-controlled adaptation to user's preferences. Within this

research, LUT Mobile virtual campus journey mobile app is designed and developed. An evaluation is conducted by comparing the personalization criteria of the created mobile app with other virtual campus journey mobile apps. It is observed that most of the virtual campus journey mobile apps are not capable of providing a dynamic user-controlled personalization.

This research's follow-up realizes the Personalized Virtual Campus Journey mobile app at LUT University based on the presented study and prototype. The test results of LUT Mobile's usability will be published in an upcoming research article.

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