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Modeling the Requirements Based on Contexts in Mobile Native Apps

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Abstract

Objectives: This research study provides an analysis model which is used to analyze the requirements of mobile native apps contextually under any domain. **Methods/Statistical Analysis:** Based on the background study, the research process have taken three research approaches and also have identified various activities which are performed among a native mobile app user and mobile native apps and formed them into questionnaires which are sent to different mobile native app developers of different software industries. This research process has determined the requirements based on four contexts in mobile domain such as device context, mobility contexts, user context and social contexts. **Findings:** These activities are mapped into attributes and contexts for modeling the requirements under mobile domain and for developing the sub models of the analysis model. Finally the analysis model is built and composed of four sub models. These sub models are content analysis model, interaction analysis model, functional analysis model and configuration analysis model. **Application/Improvements:** This research study provides the analysis model where the requirements are analyzed in a mobile native app under any domain such as agriculture, learning or healthcare applications. This analysis model is significant as it determines the contexts and models the contexts which are not specified in any frameworks or process models.

Keywords: Configuration Analysis, Content Analysis, Functional Analysis, Interaction Analysis

1. Introduction

Mobile devices are the dynamic systems configured with powerful processors and communication mechanisms that enable information retrieval to billions of users anywhere and anytime about any domain. Mobile native apps include e-learning, detecting sugar level of a patient and monitoring the user's current situation by enabling sensors with in mobile device. These apps are written in 'objective C' or java programming languages depending upon the OS used by the mobile device. The mobile native apps can be run on different platform and the user can run the application with or without the internet connection. The users are facilitated to avail information with or without browsing about any domain. Native mobile apps are high performing and have a great deal of reli-

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ability for the user. Since the mobile native apps are platform dependent, different versions are required to be developed for different platforms thereby increasing its cost of development. Mobile context aware applications are more effective and adaptive due to the providing of required contextual information to users without taking so much attention of users. In generic domain users need information about different domain specific entities. This information can be given to users through any mobile native apps with or without web services.

For developing mobile native apps, different frameworks or process models are used such as Scrum, MASAM (Mobile Application Software Development using Agile Methodology) and SLeSS (Scrum Lean Six Sigma)[1] and Mobile-D[2]. But the analysis phase in these frameworks or process models does not specify the requirements contextually under any domain. These process models don't build the analysis model in which the mobile contexts are modelled under any domain. Here the analysis model provides the modelling of requirements contextually about any domain. To build mobile native apps which can be used in any domain, it is necessary to identify the contexts of the mobile native apps. For providing context aware information, it is required to build the mobile native apps under different contexts in mobile domain. We have found out the different contexts under mobile domain and these are such as device context, user context, mobility context and social context. These context elements have identified as requirements for developing mobile native apps with optimum usage under any domain.

We have specified various activities and arranged them into questionnaires and send them to various mobile native app developers of different software industries. Further an analysis model is drawn through mobile contexts by mapping with various activities performed by user with the mobile device. Here the research process is to model the requirements using object oriented approach and provide an analysis model for mobile native apps which incorporates the different context elements that are modelled with in it and its sub models.

The rest of the paper is organized as follows. Section 2 discusses related works on contexts in ubiquitous systems and context-awareness in mobile apps. Section 3 provides the research approach for the development of analysis model in mobile native apps. Section 4 provides an analysis model for the development of mobile native apps and section 5 provides discussion. Section 6 provides conclusion and Section 7 gives future work respectively.

1.1 Contexts and Context Awareness

Context is information which is used for identification of the situation of entities, i.e., whether a person, place or object that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context[3] can be segregated into different dimensions such as external context and internal context or physical context and logical context. Context can[4] also be divided into four categories such as computing context, physical context, user context and time context. It is a fact that context has no uniform or standard definition. So everyone can give his understanding about context and it can be classified into any dimension. However in mobile computing area, the target of using context is to enable the device to better serve for people, either human computer interaction or context-aware mobile application/service.

Classification of context should establish the human-centric essence. It includes classification of context[5] into three dimensions such as physical context, internal context and social context. Physical context refer to the real world nearby user, making up physical things. Internal context is composed by abstract things inside people, such as feeling, thought, task, action, interest, goal etc., which is very related to people. Social context means user's social surrounding, that is social relationship of user. This social context consists of persons related to user. The Generic Context Management Model consists of three basic components such as context semantics, context instance data and context related rules. Context semantics represents the semantics, concepts and relationships in the context data. It is formed by ontology that describes domain independent generic contexts and domain specific contexts. Context data represent instances of contexts. These are classified into various classes such as user context, device context, application contexts, network contexts, and resource context etc[6]. Rules represent derivation axioms that are used by context aware systems to derive decisions and conclusions about the actions that follow. These rules have two sources; rules that are explicitly given by the users through the user interface and rules that are implicitly learnt by the system itself.

Mobile learning is the learning of different contexts. Mobile learning is unique in the sense that it is the

combination of mobile technology and its affordances that create a unique learning environment and opportunities that can span across time and place[7]. Content delivery, to the user should be based on their current context. Context plays an important role while designing the m-learning environment. The mobile learning context is where the situational and learning context meets in a learning environment. Contexts are created through mobile learning and classified as[8] learning context, situational context and learning environment context. The COMET[9] provides a semantic model for designing mobile learning applications and this model designs the mobile learning system into three aspects such as learner centric context, activity context and environment context. The learner centric context is segregated into profile, preference, physiological and cognitive abilities. The environment context is composed of many other contexts such as physical environment, social environment, virtual environment and computational environments. The activity context for mobile learning is composed of many activities such as physical exercise games, participatory simulations, field trip and visit etc.

Context aware systems are able to adapt their operations to the current context without explicit user intervention and thus aim at increasing usability and effectiveness by taking environmental context into account. Due to the nature of context-aware applications, which often react to changes of the context during their execution, context server is provided a subscription-based push mechanism[10] which provides synchronous access to the context. Context data distribution[11] is the capability to gather and to deliver relevant context data about the environment to all interested entities connected to the mobile ubiquitous system. In fact, context data distribution is extremely significant from both the service and the middleware perspectives. The model of the environment[12] in which context aware applications work with is called context aware model. The context model holds all kinds of information which is categorized as context related to human factors and context related to physical environment. The Muffin is multi-sensory mobile device for providing context awareness to users. It is used as a prototype for extraction of different contexts. Here the contexts are categorized into three contexts[13] such as muffin terminal's context, user context and environmental context. Muffin's terminal context could be extracted accurately by using sensors and validating the output data. Furthermore muffin's state can be classified into exclusive classes and applies simple algorithms such as threshold analysis for finding the Muffin's state. In order to extract user context, a user has to carry Muffin in some ways. However available sensors and algorithms may change according to the position or situation in which Muffin mobile device is used. Environmental context such as air temperature and air pressure are directly extracted from sensors.

The knotti project is designed and implemented a context aware platform for providing context aware services to mobile users. The platform enables the sharing of contexts and contextual contents. It provides the context aware services to users by segregating the contexts into various types[14] such as location, mood, mode of spending time, time and social context etc. The middleware platform[15] is developed to support context aware mobile apps development. It is capable of locating and extracting relevant context data from large number heterogeneous data sources distributed over many different operating environments. This platform is designed as a service oriented architecture including various system functionalities as context data acquisition, reasoning, service registration and discovery. These are all designed and deployed as system services for developers and end-users to access. The middleware architecture consists of four logical layers such as physical space layer, context data management layer, service management layer and application layer.

A mobile guide[16] provides context dependent services, indoor and outdoor navigation to users operating on Personal Digital Assistants (PDA) and Smartphone applications. Mobile guide also provides[16] location awareness, map based navigation, bookmarking, collaboration, contextual information with multimedia mechanisms to users. The contexts in mobile guide are such as user, service, environment, system and social. Mobile guide architecture consists of three tier architecture such as application tier, middle tier and data tier. Mobile native apps can also be providing information about health care apps. For example mobile e-healthcare app[17] can be developed using HTML5 and provides context aware diabetes information to users or patients. For developing the e-health mobile apps, it uses various sensors such as accelerometer, low pass filter, magnitude filter for monitoring diabetes in the body when the user is in moving, walking or running stage.

2. Research Approach

In order to explore the issues for modeling the requirements in an analysis model for developing mobile native app and describing the sub models in an analysis model, we have established two Research Questions (RQ1to RQ2). These are as follows.

RQ1. How the analysis model is defined and identified for the development of mobile native apps considered in existing process models or frameworks under mobile native app domain?

In order to defining the analysis model in developing mobile native apps, RQ1 was established to examine the current process trends into analyzing mobile applications and developing analysis model for building mobile native apps.

RQ2. How the sub models are defined and identified in mobile native apps considered in existing process models or frameworks under mobile app domain for effective analysis?

In order to defining and identifying sub models in developing mobile native apps, RQ2 was established to examine the current process trends into analyzing mobile applications, with a particular focus towards mapping different mobile native app user's activities with the models of analysis for building mobile native apps.

We undertook an extensive set of questionnaires (60) based on these research questions and send these questionnaires to different mobile app software developers (10) of different software industries of India having international offices as well. The questions were placed in Google forms and sent to different mobile app developers of different software industries. After getting their responses, we are able to find out different attributes or elements used in requirement specification and analysis model under mobile native app development. Here we have provided some questions with their responses below.

Q.1. What is the screen density of a device for any mobile apps?

a.mdpi
b.hdpi
c.xhdpi
d.all

No of respondents for a=0
No of respondents for b=0
No of respondents for c=0
No of respondents for d=10

Q.2. Which type of menus are used for mobile native app development?

a. popup menu
b. context menu
c. option menu
d. All
e. None

No of respondents for a=1
No of respondents for b=2
No of respondents for c=1
No of respondents for d=6
No of respondents for e=0

Q.3. Is it possible for a device to be inbuilt with all types of sensors so that it measures user's location, orientation and various environmental condition's?

a. Yes
b. No

No of respondents for a=6
No of respondents for b=4

Q.4. Which gestures are used in a mobile native app, while interaction is done among user and mobile device?

a. Drag
b. Drag and Drop
c. Pinch
d. Zoom in and Zoom out
e. All

No of respondents for a=0
No of respondents for b=0
No of respondents for c=0
No of respondents for d=0
No of respondents for e=10

Q.5. Among them which one provides efficient usage of a user with the mobile native apps?

a. E
b. A,B,D and A,B,C
c. B, C, D and C, D, A

No of respondents for a=6

No of respondents for b=2
No of respondents for c=2

3. Analysis Model

The analysis model is designed by taking into consideration the requirement analysis as discussed in the paper[18].The analysis model provides the framework for constructing the design and development of the mobile native apps for any domain of the user application.

We have taken numerous activities of various components in mobile native apps and organized them into a set of questions through Google forms and send to various mobile app developers of different software organizations for designing the analysis model. We have received their response and the analysis model is built based upon the responses.

Getting the responses from various mobile native app developers in various software industries, we have identified their attributes. Further these activities and their attributes are classified into contexts and the analysis model which is built for mobile native application about any domain.

3.1 Mapping of Various Activities into Mobile Contexts

At first we have taken various activities which are done among mobile native user and mobile device and put them into a set of questions and collect the responses from various mobile native app software developers. Depending upon the responses, the activities are specified and classified into attributes and contexts under generic domain for mobile native apps. Further these activities are classified into different attributes and contexts which are shown in Table 1.

Table 1. Mapping of various activities into contexts

Activity	Attributes	Context
Doing operations on screen of mobile device	Screen size and density	Device context
Doing operations on app widgets of a mobile app	Layouts or app widgets	Device context
Doing operations on menus of an mobile app	menus	Device context
Accessing the content of an mobile app	Content providers and content size	Device context
Saving the data in an mobile app	Storage	Device context
Providing controls to a user for selecting the input field	Input control elements	Device context
Extending the app widgets with the screen size	Margin	Device context
Drag and drop	Gestures	Device context
Finding location and weather data	Sensors	Device context
Connecting the mobile app with web server	WLAN	Mobility context
Connecting the mobile app with web server	GPRS	Mobility context
Connecting the mobile app with web server	EDGE	Mobility context
Retrieving information from the mobile app specified on user's role and task	Based on role	User context
Finding effectiveness on information from app	Based on preferences	User context
Finding efficiency on information from app	Based on preferences	User context
Finding ease of use on the mobile app	Based on usefulness	User context
Obtaining trust on the retrieved information	Based on usefulness	User context
Accessing the audio and video files	Blogs	Social context
Sharing of information among users	Social networking	Social context
Searching relevant information	Wikis	Social context

3.2 Mapping of Various Activities with Models of Analysis in Mobile Native Apps

Also these activities are again classified into various analysis models which are shown in

Table 2. Mapping of activities into models of analysis

Activity	Content analysis	Interaction analysis	Functional analysis	Configuration analysis
Doing operations on screen of mobile device		✓	✓	
Doing operations on app widgets of a mobile app		✓	✓	
Doing operations on menus of an mobile app		✓	✓	
Accessing the content of an mobile app		✓	✓	
Saving the data in an mobile app		✓	✓	✓
Providing controls to a user for selecting the input field		✓	✓	
Extending the app widgets with the screen size		✓	✓	
Drag and drop		✓	✓	
Finding location and weather data		✓	✓	✓
Connecting the mobile app with web server		✓	✓	✓
Connecting the mobile app with web server		✓	✓	✓
Connecting the mobile app with web server		✓	✓	✓
Retrieving information from the mobile app specified on user's role and task	✓	✓	✓	
Finding effectiveness on information from the app	✓	✓	✓	
Finding efficiency on information from app	✓	✓	✓	
Finding ease of use on the mobile app	✓	✓	✓	
Obtaining trust on the retrieved information	✓	✓	✓	
Accessing the audio and video files			✓	
Sharing of information among users			✓	
Searching relevant information			✓	

Figure 1 is the class diagram illustrates the analysis model and its sub models with their associations on the basis of their commonalties taken in terms of the four contexts of the native mobile apps. This to found out here is that

a. 5 numbers of activities are specified in content analysis, interaction analysis and functional analysis

b. 7 numbers of activities are taken in interaction analysis and functional analysis

c. 5 numbers of activities are taken in interaction analysis, functional analysis and configuration analysis

d. 3 numbers of activities are taken only in configuration analysis.

Hence the analysis model is drawn through taking the sub models as content analysis, interaction analysis, functional analysis and configuration analysis. These interaction analysis, functional analysis and configuration model are drawn against device context and its attributes. In Table 1, the 5 numbers of activities are taken in user contexts and its parameters. Also these activities are specified in content analysis and hence this analysis model is drawn against user context and its attributes.

The 14 numbers of activities are specified under device context and user context. Further the same activities are specified under interaction analysis and hence it is modelled using UML against device context and user context. Hence this interaction analysis model also specifies the relationship "has Device Usability With" between the device and user context classes. All the 20 numbers of activities are classified under device context, user context, social context and mobility contexts. Further all these activities are specified under functional analysis and hence it is built against device context, user context, mobility context and social context classes. Similarly only 5 numbers of activities are classified in device context and mobility contexts. Further the same activities are specified in the configuration analysis and hence the configuration analysis model is drawn against device context and mobility context classes through UML diagrams.

The analysis model which is shown in Figure 1 is composed of sub models on the basis of content, interaction, functional and configuration analysis. Hence it is modelled through UML specialization relationship with the sub analysis models such as content analysis model, interaction analysis model, configuration analysis and functional analysis model.

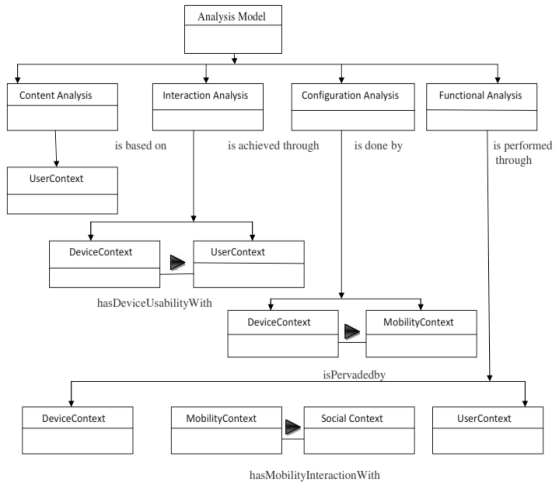

Figure 1. Analysis Model for Mobile Native Apps.

3.3 Content Analysis Model

The content for mobile native app is done according to the user context and its elements. This analysis helps to define the user's context, which takes into account the user's aspect of the relevant content to be included in the mobile native apps. Hence the content analysis is modelled using UML association relationship "is based on" with the User Context class. The sub classes under User Context are such as Based on Role, Based on Preferences and based on usefulness. The subclasses under the Based on Role are Category A, Category B etc. which is explained in requirement analysis[19]. The Based on Role sub class is modelled in an ordered association relationship "has a preference" with the Based on Preference sub class. Again Based on Role sub class is modelled in an ordered association relationship "has Usefulness" with the Based on usefulness sub class which is shown in Figure 2.

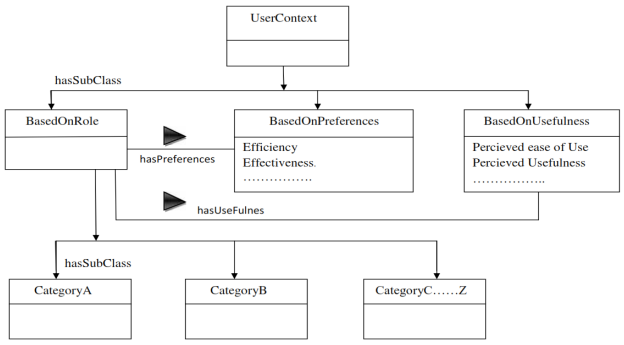

Figure 2. Content Analysis Model for Mobile Native Apps.

3.4 Interaction Analysis Model

This analysis helps to define the user's interaction with the mobile device or system, which takes into account the user's expectations by the interacting with the device by using its numerous features represented as the device context parameters. The interaction analysis model is modelled through UML ternary association diagram with Device Context and User Context classes. Further The Device Context class is associated with User Context class in a ordered association relationship "has device usability with". Further the User Context class is specialized into sub classes such as Based on Role, Based on Preferences and based on usefulness and is modelled using UML specialization class diagram.

In the interaction analysis as shown in Figure 3, the user through the user context class interacts with the device context and its parameters with respect to its role, preferences and usefulness for user when it chooses a particular device feature. It provides the basis of the design of native apps in mobile domain which is beneficial to user's interaction with the device.

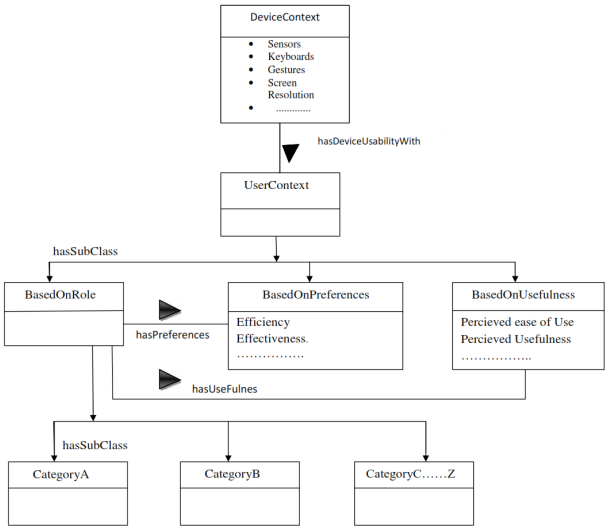

Figure 3. Interaction Analysis Model for Mobile Native Apps.

3.5 Configuration Analysis Model

In this analysis model, the association between the device context and the mobility context determines the configuration features according to the pervasiveness of the device in the network environment determined by the mobility context parameters. Hence Device Context class is associated with the Mobility Context class in a relationship "is pervaded by" and it is modelled using UML ordered association diagram which is shown in Figure 4.

In the Figure 4, the Device Context class and its parameters are pervaded by the Mobility Context class and its sub classes according to the requirements of the particular domain which the native apps work with. The pervasiveness of the Device Context class is shown by an association to the Mobility Context class and its subclasses.

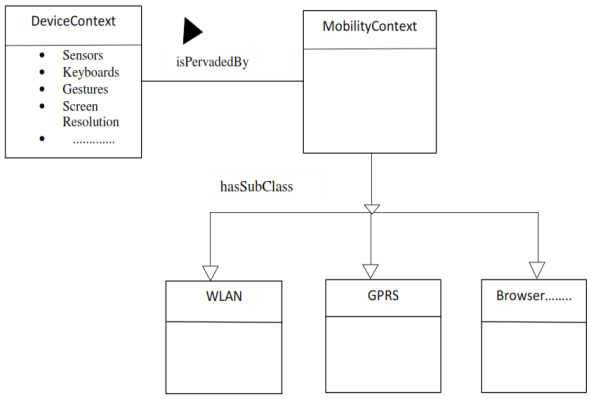

Figure 4. Configuration Analysis Model for Mobile Native Apps.

3.6 Functional Analysis Model

This model provides the accessibility of the user functionality in terms of the device, social and mobility context parameters from the user context. This analysis model provides the user's movement from one screen to another depending upon the functions it wants to use. This functional analysis model is drawn through taking all the contexts such as device context, user context, mobility context and social context which is already explained in analysis model.

In the functional analysis model, the class diagram shows the four context classes and their subclasses which are related to each other by association relationships and specializations. The class Mobility Context is associated with the Social Context class in a relationship "has Mobility Interaction With" and it is modelled through UML ordered association diagram. The Mobility Context class is specialized into various sub classes such as WLAN, GPRS and EDGE etc. and it is designed through UML specialization class diagram. Similarly the Social Context classes are specialized into various sub classes such as Wikis, Blogs, Content Hosting and modelled through UML specialization class diagram which is shown in Figure 5.

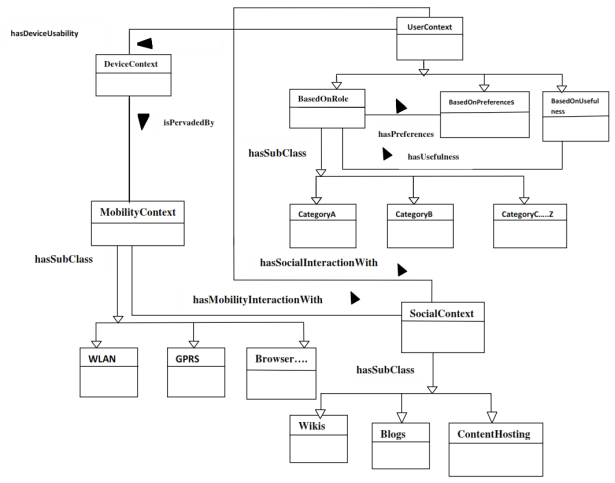

Figure 5. Functional Analysis Model for Mobile Native Apps.

4. Discussion

The contexts under mobile domain have identified such as device context, user context, mobility context and social context using empirical study in[18]. These contexts are identified as requirements and specified in requirement specification in[18]. The classes under these contexts and the commonalities among the four contexts were shown in our paper[18]. We have taken numerous activities which occur between a native mobile app user and mobile device. These activities are placed in the form of questionnaires and send to various mobile native app developers in software organizations. Among them some of the activities are mapped to attributes and mobile contexts. Again these activities are mapped into four models of analysis such as content analysis, interaction analysis, functional analysis and configuration analysis. The content analysis specifies that a mobile native app will be built taking into user context. The interaction analysis shows the interrelationship among a user and mobile device. The mobile native app should be built based on the user's usage on the mobile device. The functional analysis shows about the functionalities of four contexts and the commonalities among the four contexts. It also describes the mobile native app will work based on the four contexts. The configuration analysis describes the mobile native app is configured with device and mobility contexts. The configuration analysis shows the relationship among the device and mobility context elements. To analyse a mobile native app, the requirements and commonalities among the four mobile contexts is modelled through UML class diagram. This UML diagram shows any mobile native app should be built taking into account the four contexts and four models analysis about any domain.

5. Conclusion

Some of the questionnaires and responses are shown in section 3. Depending upon their responses, a mapping is done among the activities those are performed by the native mobile apps and native user. Further mapping is done among the native mobile app activities with different contexts under mobile apps and models of analysis as well. Finally, various analysis models for native mobile apps are built through different context classes. This analysis model specifies the mobile native app should be analysed and modelled for development based on the mobile contexts and their co-relationships.

6. Future Work

In this analysis model, a detail analysis is made by identifying the specific classes that represents the contexts and its parameters for the mobile native apps in generic domain which is used for the users. Hence from this analysis model, it is concluded that the interrelationship between the context classes can be analysed based on the various sub models and this analysis can be translated into a design model, which acts as a basis for design and development of the mobile native apps in generic domain in future.

7. References

1. Corral L, Sillitti A, Succi G. Software development processes for mobile systems: Is agile really taking over the business. IEEE, 2013 1st International Workshop on the Engineering of Mobile-Enabled Systems (MOBS). 2013 May; p. 19–24.
2. Spataru AC. University of Edinburgh: Agile development methods for mobile applications. Master of Science Thesis submitted to Computer Science School of Informatics. 2010.
3. Baldauf M, Dustdar S, Rosenberg F. A survey on context-aware systems. International Journal of Ad Hoc and Ubiquitous Computing. 2007 Jan; 2(4):263–77. Available from: Crossref
4. Chen G, Kotz D. Dartmouth College: A survey of context-aware mobile computing research. Technical Report TR2000-381. Department of Computer Science. 2000 Nov.

5. Han L, Jyri S, Ma J, Yu K. Research on context-aware mobile computing. IEEE, 22nd International Conference on Advanced Information Networking and Applications-Workshops. 2008 Mar; p. 24–30. Available from: Crossref
6. Ejigu D, Scuturici M, Brunie L. An ontology-based approach to context modelling and reasoning in pervasive computing. IEEE, Fifth Annual IEEE International Conference on Pervasive Computing and Communications Workshops. 2007 Mar 19; p. 14–19. Available from: Crossref
7. Koole ML. A model for framing mobile learning. Mobile learning: Transforming the delivery of education and training. 2009 Mar; 1(2):25–47.
8. Stanton G, Ophoff J. Towards a method for mobile learning design. Issues in Informing Science and Information Technology. 2013 Jan; 10:501–23.
9. Ahmed S, Parsons D. COMET: Context ontology for mobile education technology. Heidelberg: Springer Berlin: Proceedings of International Conference on Artificial Intelligence in Education. 2011 Jun 28; p. 414–16.
10. Hofer T, Schwinger W, Pichler M, Leonhartsberger G, Altmann J, Retschitzegger W. Context-awareness on mobile devices-the hydrogen approach. IEEE, Proceedings of the 36th Annual Hawaii International Conference on System Sciences. 2003 Jan; p. 10. Available from: Crossref
11. Bellavista P, Corradi A, Fanelli M, Foschini L. A survey of context data distribution for mobile ubiquitous systems. ACM Computing Surveys (CSUR). 2012 Aug; 44(4):24. Available from: Crossref
12. Nijhuis K N. Context-Aware Services For Constrained Mobile Devices. Thesis Paper and Research project. 2007; p. 1–66.
13. Yamabe T, Nakajima T. Possibilities and limitations of context extraction in mobile devices: Experiments with a multi-sensory personal device. International Journal of Multimedia Ubiquitous Engineering. 2009 Oct 4; p. 37–52.
14. Kolari J, Laakko T, Hiltunen T, Ikonen V. VTT Publications: Context-aware services for mobile users. 2004.
15. Zhu J, Chen PA, Pung H, Oliya M, Sen S, Wong W. Coalition: a platform for context-aware mobile application development. Ubiquitous Computing and Communication Journal. 2006; 6:722–35.
16. Emmanouilidis C, Koutsiamanis RA, Tasidou A. Mobile guides: Taxonomy of architectures, context awareness, technologies and applications. Journal of Network and Computer Applications. 2013 Jan; 36(1):103–25. Available from: Crossref
17. Preuveneers D, Berbers Y, Joosen W. The future of mobile e-health application development: exploring HTML5 for context-aware diabetes monitoring. Procedia Computer Science journal. 2013 Dec; 21:351–59.
18. Pani S, Mishra J. Contextual requirements for developing native mobile apps. London: Springer: Communicated to Requirements Engineering Journal.