Master Thesis

Fostering Social Interaction Between Heterogeneous Groups:
Creating an ICT Solution for International Students in Delft

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Fostering Social Interaction Between Heterogeneous Groups: Creating an ICT Solution for International Students in Delft

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Abstract

The city of Delft in the Netherlands is the hometown of TU Delft. The number of students attending TU Delft is 23.461 with a population of international students in the master's program of 3.676 students [TUDelft, 2018]. The larger communities of international students at the master level are from India, China, Greece, Italy, Germany, and Spain [TUDelft, 2018]. Master programs at TU Delft have a duration of 2 years for full-time students. Also, the most common option for the first year or exchange students are using the University service provided by DUWO. The services offered by DUWO consists of self-contained and non-self-contained units in new or renovated buildings [DUWO, 2018]. A resilient city requires its residents to have a sense of community to support each other in case of events. Improving information sharing in heterogeneous groups can positively affect inclusion resulting in a sense of community.

Previous research about heterogeneous groups shows that participation is difficult to achieve, and homogeneity among these groups reduces their motivations to participate [Shoji et al., 2010]. This effect found in the literature is palpable in DUWO residencies where almost no interaction among the different tenants is the norm, except for groups of tenants from the same nationality.

Living in the information age requires abilities linked to the use of Information and Communication Technology (ICT), the lack of knowledge and using computers or the Internet create obstacles to engage members of society [Gardner et al., 2012]. Therefore, it is not difficult to consider the use of ICT in daily activities a certainty, not only by individuals and companies but across a vast field of applications. Furthermore, it is expected that international students in Delft to be in contact with ICT (applications and devices) on a regular basis and for different uses.

The previous information is the base to understand the problem of international students in Delft. The problem defined in this research is: In the city of Delft, it is possible to see in the international student population, groups of students from the same nationality interacting mostly between each other with few interactions with students of other nationalities. It is possible to recognize these groups of students more frequently when the nationality of the students is from India, China, or Greece matching the groups with a population majority at TU Delft. Literature indicates that in these cases are limited participation and willingness to interact. As a result, is it possible to identify several problems from different perspectives: 1) The idea of community is missing among international students along with a reduce exchange of information. At the same time, fragmented groups in a student city create societal problems that require attention: 2) Isolation leads to loneliness and at the same time can result in feelings of sadness or depression [Cacioppo and Cacioppo, 2014] [De Jong Gierveld et al., 2006]. 3)

Another problem is the lack of willingness among residents to support each other in case of emergencies due to a lack of community sense. Therefore, this segment of the population is not resilient. 4) People that feel isolated have the motivation to seek connectedness but at the same time experience an increase of vigilance for social threats [Cacioppo and Cacioppo, 2014].

As a result of this problem definition, this thesis addresses the problem of connectedness between different international students in the city of Delft and proposes a solution to create a community using information sharing via an ICT artifact.

After the problem formulation, the research performs a literature review to find the gaps in previous research and formulate the research questions. The results of the literature research are the recognition of four essential aspects needed to stimulate interaction and networking: information, activities & space, multicultural approach, and key actors. The literature review also provides gaps in previous research addressing community engagement and social interaction. There are three gaps address in this study: 1) most of the studies focus on improving resilience for communities for a long period of time and assumes a stable community presence. 2) the benefits of having a physical space that reflect the identity of different groups in other fields are not present. 3) it is unusual to find literature with more than two different perspectives at the same time.

In order to address the gaps identified in the literature and the problem defined a research question has been formulated along with three sub-questions:

How can information-sharing apply in an ICT artifact foster connectedness between individuals from different nationalities in Delft's international student community?

1. What are the main requirements for an IT artifact to stimulate information sharing?

2. What type of information shared using the IT artifact change the perceived level of connectedness among their users?

3. What functionalities of the IT artifact are necessary to stimulate communication apart from the shared information?

The research approach selected for this case is design research and specifically design science due to the benefits and goals that offer. In design science achieving knowledge and understanding of the problem's domain requires building an application or designing an artifact in a way that the application or artifact contribute to finding a solution of a problem or general interest [Johannesson and Perjons, 2014] [Hevner et al., 2004].

Johannesson and Perjons [2014] present a framework with five main activities: 1) explicate the problem, 2) define requirements, 3) design and develop artifact, 4) demonstrate artifact, and 5) evaluate artifact. Therefore, there is a need for different methods during the execution of the five

main activities of design-research science. This research employs 5 different methods depending on the activities of the design research framework. The methods are literature review, survey, data analysis, case study, and interviews.

The survey address four topics but the most important topic is related to the identification of potential requirements for the ICT artifact.

The process of elucidating requirements needs the outline of the ICT artifact as well. In this case the ICT artifact should be an application that permits sharing information from different users in different digital spaces, create events, allow identification of landmarks, and permit the participants can be distinguished or rewarded. The type of application that can offer these functionalities is an online platform. The requirements obtained from the literature review and the results of the survey can be summarized next. The platform must:

• Allow registration of members • Allow user's roles with access levels • Include useful information • Support multiple communication channels • Protect personal data • Present a clear interface • Implement a robust infrastructure • Incorporate narratives • Use a positive message • Manage the number of participants in events or groups • Allow personalization of user's content • Allow the creation of user's events • Support multiple digital spaces • Support location sharing • Allow free expressions of users • Store data from members • Allow different sharing formats (picture, text, video) • Create a process to promote the artifact • Track posting & viewing activity • Implement web-based tools

After obtaining the necessary requirements, the next activity of the framework is the design and elaboration of the ICT artifact. The design selected that match the requirements is an online platform that uses a modular design

Each module of the platform tries to accomplish one or several requirements. The lists of modules that the platform have are backbone, frontend, authentication, membership, blog, scheduler, forum, chat, privacy and contact form.

The implementation of the platform requires a process. The first step involves having all relevant stakeholders involved in the process. After having the target group in mind, the process requires engaged individuals. The next part of the process is finding community champions. These champions need to have good writing skill and the willingness to share information with others. The next step is locating community partners. In the case of this research, community partners are second-year students that have experience and can contribute to the potential questions, or information request in the platform.

The next stage after having the platform ready is testing the platform. The platform is going to be monitoring in the context of a case study using

real international students in the city of Delft as defined in the problem definition. The use of the platform generates and collects different information about the interaction of the students with the platform. Some general data about the users, services, and formats shared by the participants give a better understanding of how users interact with the platform and validate certain requirements.

The results of the case study include the number of visitors during a two weeks period. Also, the percentage of mobile visitors and the interactions of International students interact with four services of the platform. Finally, the case study collects a detail interaction of the students with the blog and forum services.

After the period of test, some participants are selected to perform an interview and understand the causes of the interactions with the platform and be able to answer the research questions related to type of information and functionality of the platform.

The information resulting from the survey, case study and interview provide answers to the sub-questions. After the analysis of the sub-questions, it is possible to have an answer to the main research question. The answer provided by this research is: *Information sharing can foster connectedness between international students from different nationalities in the city of Delft using an online platform. The information in this platform must be useful, relevant, and interesting with the purpose of support other members. Also, the platform must have multiple communication channels working together to reach users and facilitate information exchange. This communication channels must be implemented in different modules with specific functionalities. However, the number of modules should grow according to the number of users to avoid low use and desertion. The platform should have information that transmits a positive message to stimulate students to connect into the platform and share information. Furthermore, the platform must allow the users to share information using a different format like text, videos, pictures, and permit communication with external sites using hyperlinks in forums or blogs that permit fast responses and have recognition for the information. Finally, the platform must have a process to reach experience students that can provide the necessary information.*

Finally, the research present limitations and future research. One of the most important limitations of this research is the time and the season of its execution. Therefore, it is advisable to continue this research in a different season and if possible, extend the demonstration of the platform. Also, the number of participants in the survey is only 45 which gave a margin of error of 14,6%. Therefore, it is necessary to expand the number of participants in the survey in future research. Some of the modules of the platform have no interaction (scheduler and chat) which means that some requirements and functionalities related to these modules could not

be validated. Therefore, it is recommended that before ruling out some of the requirements or functionalities that future research address these two limitations and a redesign of modules. The survey indicates that academic assignments are the major cause followed by financial pressure. However, the problem analysis indicates that the lack of interaction also affects TU Delft and the municipality of Delft. Therefore, further research should include the results of this research and develop means to institutionalize solutions at the university and the municipality regarding the first two obstacles. The last chapter of the research presents the conclusion based on the results of the research questions, the limitation, and recommendations for future research as well.

1   Introduction

The first chapter provides an initial research context and problem definition.

1.1   Research Context

The city of Delft in the Netherlands considers itself a student city [GemeenteDelft, 2019]. The number of students attending TU Delft is 23.461 [TUDelft, 2018] which is 23% of the total population of the city. Statistics from 2018 show that the total population of Delft is 102.253 inhabitants, with a non-Dutch population of 14.232 people [CBS, 2019]. According to TU Delft official statistics, in 2017 the number of international students in the master's program was 3.676 students [TUDelft, 2018]. The larger communities of international students at the master level are from India, China, Greece, Italy, Germany, and Spain [TUDelft, 2018]. Table 1 shows the statistics of the city and the university, where the three major minorities are from India, China, and Greece representing 41.9% of the international student population.

Table 1: City of Delft & TU Delft statistics

City of Delft	
Non-Dutch population	14.232
Total population	102.253
TU Delft	
International master students	3.676
Total student	23.461
International master student's distribution	
India	*18,6%*
China	*15,2%*
Greece	*8,1%*
Italy	7,4%
Germany	6%
Spain	5,2%

Master programs at TU Delft have a duration of 2 years for full-time students independent of their nationality. However, it is possible for students of other universities in the European Union to attend a semester as part of their program at TU Delft. Therefore, the total population of master students considers exchange students as well.

TU Delft provides information about renting accommodation on its website. There are three options: 1) using the accommodation service of TU Delft, 2)

finding private accommodation via rental agencies or landlords, or 3) lodging with families, friends or relatives [TUDelft, 2018]. The most common option for the first year or exchange students are using the University service provided by DUWO. The services offered by DUWO consists of self-contained and non-self-contained units in new or renovated buildings [DUWO, 2018]. One example of DUWO's building can be seen in Figure 1.

Figure 1: DUWO's residential building. Image source: Author's own

The result is a group of international students living abroad for a relatively short period of time in private accommodations, and between them, three major groups can be identified. The configuration mentioned resembling a heterogeneous group with homogeneity inside different subgroups. For example, Figure 2 shows a group composes from different subgroups, and each subgroup shares a common language. Previous research about heterogeneous groups shows that participation is difficult to achieve, and homogeneity among these groups reduces their motivations to participate [Shoji et al., 2010]. This effect found in the literature is palpable in DUWO residencies where almost no interaction among the different tenants is the norm, except for groups of tenants from the same nationality.
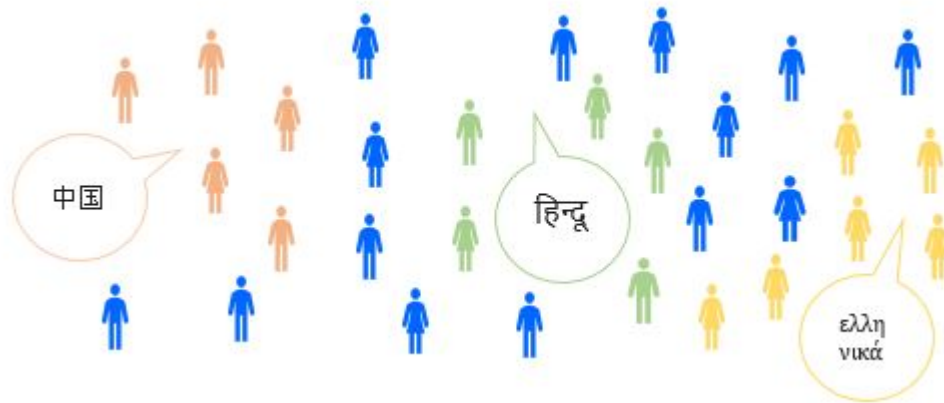
Figure 2: Heterogeneous group with homogeneity in each subgroup

Nowadays, major cities around the world are preparing to adapt themselves in adverse scenarios using the City Resilience Framework (CRF) proposed by the Rockefeller Foundation [100ResilienceCities, 2019]. One of the four dimensions of the framework focuses on economy and society issues. In this category, promoting cohesive & engaged communities creates a sense of collective identity and mutual support [100ResilienceCities, 2019]. Therefore, a resilient city requires its residents to have a sense of community to support each other in case of events. One factor that affects the interaction among heterogeneous groups is information sharing [Singletary Walker et al., 2019]. Improving information sharing in heterogeneous groups can positively affect inclusion resulting in a sense of community.

Living in the information age requires abilities linked to the use of Information and Communication Technology (ICT), the lack of knowledge and using computers or the Internet create obstacles to engage members of society [Gardner et al., 2012]. ICT is the focus of attention of different actors and fields. For example, policymakers try to enhance social environments in communities [Gardner et al., 2012], researchers use mobile technologies for language learning [Petersen et al., 2008], areas like health care uses ICT for creating feeling of presence, connectedness, and awareness [Heidari et al., 2015], companies like Facebook uses social media to enable connection among users [Alias, 2013], and it is impossible to overlook the use of ICT in organization supporting operations and innovation [Koskinen and Luomala, 2012]. Therefore, it is not difficult to consider the use of ICT in daily activities a certainty, not only by individuals and companies but across a vast field of applications. Furthermore, it is expected that international students in Delft to be in contact with ICT (applications and devices) on a regular basis and for different uses.

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1.2 Problem Definition

The previous section provides a general idea of the situation in the city of Delft and the international student population attending TU Delft. The present section introduces the problem:

In the city of Delft, it is possible to see in the international student population, groups of students from the same nationality interacting mostly between each other with few interactions with students of other nationalities. It is possible to recognize these groups of students more frequently when the nationality of the students is from India, China, or Greece matching the groups with a population majority at TU Delft. Literature indicates that in these cases are limited participation and willingness to interact. As a result, is it possible to identify several problems from different perspectives: 1) The idea of community is missing among international students along with a reduce exchange of information. At the same time, fragmented groups in a student city create societal problems that require attention: 2) Isolation leads to loneliness and at the same time can result in feelings of sadness or depression [Cacioppo and Cacioppo, 2014] [De Jong Gierveld et al., 2006]. 3) Another problem is the lack of willingness among residents to support each other in case of emergencies due to a lack of community sense. Therefore, this segment of the population is not resilient. 4) People that feel isolated have the motivation to seek connectedness but at the same time experience an increase of vigilance for social threats [Cacioppo and Cacioppo, 2014].

The problems resulting from the lack of interaction among the international students living in Delft has a series of complications. First, the level of resilience of this segment of the population and the city of Delft is low due to the lack of community sense. Second, the number of students that interact in a limited number of social networks have a higher risk of social loneliness [De Jong Gierveld et al., 2006] putting extra stress in the support services of TU Delft. Finally, the experience and quality of life of international students are not optimal and the benefits of belonging in a multicultural community are not capitalized. Therefore, it is necessary to stimulate the level of connectedness between different international students living in the city of Delft generating a sense of community and understanding which improve the resilience of the city, reducing the risk of social loneliness, and improve the wellbeing of the students.

One way to reduce the levels of loneliness is improving the opportunity of interaction by removing barriers or bringing people together [De Jong Gierveld et al., 2006]. On the other hand, ICT creates a great number of opportunities for social interactions [Chan, 2015]. Since ICT has the potential for individuals and community empowerment and in certain segments of the population an effective tool to reduce social exclusion [Gardner et al., 2012]. Also, different initiatives use ICT to improve the mental health and wellbeing of the young

people stimulating the creation of social connectedness [Metcalf et al., 2008]. *Therefore, an approach to provide a solution to the problems and complications of international students in Delft involve the creation of opportunities for interaction using ICT.* Moreover, ICT permit improvements, lower costs and facilitate research via the introduction of new products or services [Mustafa, 2015].

This thesis addresses the problem of connectedness between different international students in the city of Delft and proposes a solution to create a community using information sharing via an ICT artifact. Therefore, the next chapter presents a more detail analysis including stakeholders, research gap and introduce the research questions. The approach presented involve the use of ICT, as a result, the third chapter presents the methodology necessary to develop an ICT artifact to improve the connectedness of the international students living in Delft. The fourth chapter presents the necessary requirements of the ICT artifact. In this case, the ICT artifact requires a definition (outline) and the subsequence requirements. The requirements are based on the results of the literature and information collected from international students attending TU Delft. The fifth chapter introduces the design and development of the artifact. The design of the artifact uses concepts based on literature and standards to describe the artifact components. Furthermore, the development of the artifact considers the tradeoffs resulting from the implementation. The sixth chapter introduces the finalized ICT artifact and its evaluation. The evaluation of the artifact takes place in the city of Delft and involve international students. Moreover, to have a proper evaluation of the artifact's effectiveness, the results of using the ICT artifact are in this chapter as well. The seventh chapter presents a discussion and reflection based on the results of the previous chapter. Moreover, the limitations of the research and further steps are part of this section. Finally, the ninth chapter presents the conclusions of the thesis.

2 Problem Analysis

Problem analysis requires an overview of some key definitions with the appropriate context, understand the different stakeholders involved, and pay attention to gaps in previous research to contribute with novel solutions. The first part of this section covers concepts and definitions based on the reality presented previously. Moreover, this section expands the main topics of the problem defined in chapter 1. The second part of the analysis focus on the stakeholders in the city of Delft where the international master students reside. The analysis includes the main interactions between stakeholders, goals, and interests. Finally, the third part presents the literature research and the main research gaps from previous studies. The documentation includes several fields or research going from resilience to health care. The result of this analysis concludes with the main research question and sub-questions.

2.1 Main Concepts

In order to understand the problems of this study from different perspectives, it is necessary to define some concepts. The previous chapter indicates that one of the problems is the lack of community sense. Therefore, it necessary to have a clear definition of the community. Another topic introduced previously is the problems that international students in Delft experience (i.e. issues about housing, or lack of understanding). These problems can affect the levels of resilience of this segment of the population in Delft. Therefore, understanding the concept of resilience comes in place, the information includes perspectives from 100 Resilience Cities. Finally, the literature points out that international student groups have low willingness to interact and act carefully when establishing new relations. Understanding these problematics requires the introduction of concepts like social capital. These concepts and the problems of the international students in Delft provide a clear understanding of the problem.

2.1.1 Communities

Resilience must be addressed in a community spirit, therefore, defining the term community is important to point the necessary efforts in the correct direction. In the context of this study, a community will be addressed in term of networks. A community can be identified as a collection of cliques instead of a collection of individuals [Zubcsek et al., 2014]. According to Zubcsek et al. [2014], a clique is an optimal cohesive group of individuals that interact with each other and transmit information in an efficient way due to their high connectivity. Figure 3 shows three different cliques and community diagrams. Cliques present a high

level of connectivity; all the individuals are linked to each other. The community diagram is composed of several cliques and it can be seen how some individuals have connections outside their cliques.
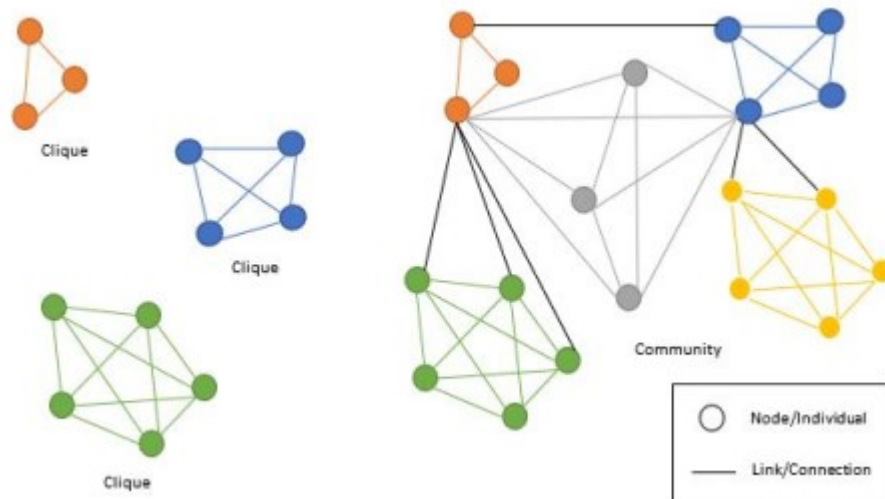
Figure 3: Cliques and community diagrams

A clique in the context of our study makes a match with the groups of international students that gather together due to their nationality since it provides a sense of identity and security. Cliques are one of the most important components of individual identity and sense of belonging, a clique has the potential to improve the relationships between individuals [Zubcsek et al., 2014]. Moreover, it is important to notice that a community can form a collection of different cliques sharing bonds (heterogeneity). The more bonds it can be created among these cliques, the more robust the community can be against disruptions or disconnection of some members of the community. Therefore, the idea is creating a community that acknowledges the existence of group differences and try to make a bridge in the divide.

There are scenarios in which individuals are in groups where there is no numerical majority to allow the creation of subgroups [Singletary Walker et al., 2019]. These individuals are the minorities inside the international student community, and they would not form a clique since their numbers are not high enough. However, this does not necessarily mean that they do not belong to a clique but that the main integrator of the clique is not nationality. Moreover, in heterogeneous networks, the willingness to share information among members is higher if the members have the same characteristics, and it is lower if the members are different [Larson, 2017].

Another reason to define a community in terms of networks is due to the way people exchange information nowadays. ICT technology is creating virtual spaces to exchange information among individuals or communities. A virtual community is an online social network that gathers people with common interests, goals, or practices to interact and share information [Suh et al., 2015]. However, there are some significant differences, between a regular network and a social network, in the latter a person may not have the opportunity to share information, and in case that the opportunity is presented she/he may not be willing to do it [Larson, 2017]. Also, in a virtual community, members remain active when there are information sharing and emotional ties [Suh et al., 2015].

2.1.2 Resilience

There is a great number of definitions about resilience, in general terms we can associate it with terms like rebound, robustness, graceful extensibility, and architectures for sustained adaptability [Woods, 2015]. However, Goldstein et al. [2015] present a definition that suits the context of the research: Resilience is the ability to change with the circumstances to adapt and transform instead of doing the same actions better. At the same time, community adaptation is manifest in population wellness, defined as high and non-disparate levels of mental and behavioral health, functioning, and quality of life [Norris et al., 2008]. Therefore, a community cannot achieve resilience if their members experiment problems and act by themselves.

In Delft, it is easy to find information about the struggle of students around topics like language, experiences related to being away from home for the first time, or food [Manivannan, 2018a]. Some columns presented in TU Delta talks about mental health, stress, anxiety, and depression that international students suffer during the first year at TU Delft [Manivannan, 2019] [HOP, 2019], and how the programs in place are not enough [Russell, 2017]. Under these circumstances, it is not possible to have a resilience community among international students. Most of the problems are related to the lack of a community that offers support to students in need. Therefore, it is necessary to strive for a resilience international community in Delft to address the problems of this population segment.

Urban resilience is the capacity of individuals, communities, businesses institutions and systems in a city to resist, grow and adapt to any kind of situations and shocks that the city can experience [100ResilienceCities, 2019]. Urban communities' resilience requires economic development, social capital, information and communications, and community competence [Norris et al., 2008] [Bach et al., 2015]. Therefore, apart from economic resources, a city requires its residents to be connected, communicated and trained. Moreover, the goal of resilience as well as planning is to achieve a healthy and vibrant community [Goldstein et al., 2015].

The most important aspects of achieving resilience can be seen in Figure 4.
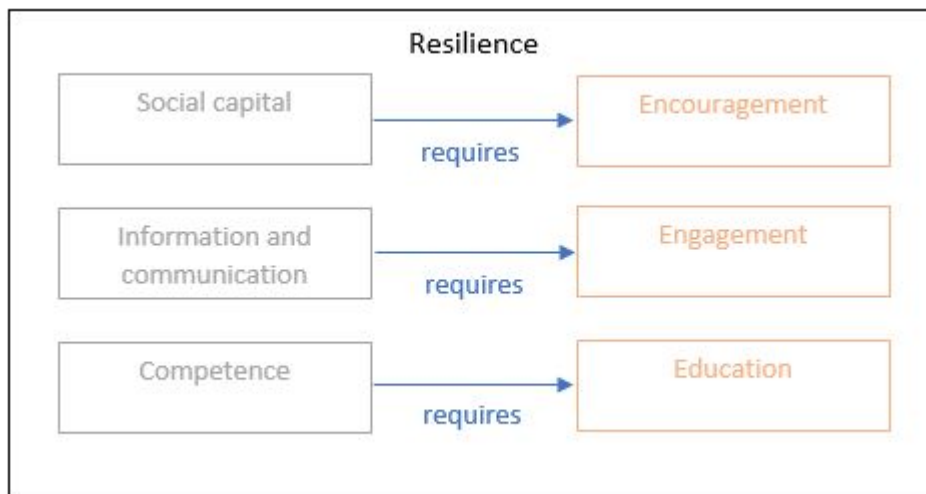
Figure 4: Resilience relations

Resilience communities require 1) empowerment by raising awareness of the situation, 2) engagement from stimulating communication and networking, 3) education by communicating the frameworks and use of technology, and 4) encouragement to stimulate active participation [Comes, 2016]. Therefore, it is not enough to continue with the practices that were effective in the past, new challenges require novel solutions and the willingness to implement them. In this case, the ICT solution strives to stimulate connectedness and participation.

Urban communities enhance their resilience by making sense of their current conditions and possible futures, using collaborative problem-solving and reflective analysis to incorporate diverse knowledge into a shared vision that incorporates differences [Goldstein et al., 2015]. In the case of Delft, to create resilience, it is important to understand the differences between these different groups and create a united vision from different perspectives. Moreover, international students require to be united, communicated and well informed.

2.1.3 Social Capital and Social Context

One important factor for a resilient and healthy community is social capital. In the context of virtual communities, the definition of social capital is the invisible bonds that connect individuals into small or larger social groups, allowing the members to work together in cooperation for the common good [Chu, 2009]. Moreover, social capital facilitates information exchange through continuous interactions based on trust and understanding [Chu, 2009][Mathwick and Klebba, 2003]. Therefore,

the level of social capital that a community has is related to the level of resilience that the community can execute [Kitagawa, 2019], and conversely, lifestyle options affect the community i.e. people moving from their local communities reducing the social capital of the community [Kelkar and Spinelli, 2016]. In the case presented in this study, the international community of Delft displays a lower level of social capital due to the temporal relocation to the Netherlands abandoning their local social networks. TU Delta includes topics about stereotypes, gender, and international groups [Manivannan, 2018b] [Bonger, 2019]. Different international student associations confirm integration problems and the struggle of international students after their relocation in Delft [Montague, 2019]. One of the causes according to student associations is lack of understanding between international students and Dutch students as well [Montague, 2019]. It is possible to find also the efforts of international student association to improve the situation by organizing events directed for all international students [van der Veldt, 2018b].

Information cannot be completely studied without their correspondence social context [Fisher et al., 2004]. The work of Pettigrew [1999] about social context let to the identification of information grounds. Information grounds are places where people go to perform a given task, however, a social atmosphere emerges encouraging information sharing in spontaneous and accidental ways [Fisher et al., 2004] [Pettigrew, 1999]. Information grounds can occur anywhere at any time, which means that they can be physical (i.e. bus stops, hair salons, coffee stores, etc.) and virtual (i.e. social networks) [Fisher et al., 2004] [Counts and Fisher, 2008]. Therefore, the places in which information among individuals is exchanged could be virtual and physical and are complementary one from another.

Social capital and social context are important in understanding how and where people in the community share information. Furthermore, it is important to also understand some social aspects of the community. McMillan and Chavis [1986] identify four social elements that can define a community: 1) membership, 2) influence, 3) integration & fulfillment of need, and 4) shared an emotional connection. Membership is related to boundaries, the effort needed to become part of the group, and a common symbol like language [McMillan and Chavis, 1986]. In Delft these aspects are directly related to nationality, having language and a common set of rules working as boundaries. Another important element of this study is a shared emotional connection. Emotional connections are based on shared histories – narratives [McMillan and Chavis, 1986] [Bamber, 2016]. These histories need to trigger a sense of identification with members of the community. Moreover, when addressing these narratives, it is important to avoid subjectivity and ideological interpretation [Bamber, 2016] to be able to integrate multiple perspectives and achieve a shared emotional connection.

2.2 Stakeholders

The proper formulation of the problem requires a precise definition and a clear context [Johannesson and Perjons, 2014]. The first chapter presents the problem definition, and, in this section, the review of the stakeholders brings more context. Different columns and opinions posted in TU Delta report the lack of efforts by part of TU Delft, DUWO, and the municipality of Delft to provide a correct environment for international students and bridge the gaps between Dutch and international [van Vliet, 2018] [HOP, 2019]. Another recurrent topic in TU Delta is the intuition prices for non-EU students and housing problems that put extra pressure for the international segment [Manivannan, 2018c] [van der Veldt, 2018a]. These reports point to the lack of official communication to internationals and the rising fees for this segment of the students from part of the university. Therefore, it is important to analyze the main stakeholders and their interactions to understand the causes of the problems and possible solutions that an ICT solution can bring.

The first stakeholder is the international student community of Delft, to be more precise the master students attending TU Delft. Nowadays globalization requires for students to migrate to different countries in the post to acquiring the necessary skills to be part of today's workforce. Delft's master international students as any other group of students seek for a good education and a proper environment during their education time. TU Delft fulfills these requirements. First, the level of education according to the international ranking place the university as one of the best [TU Delft, 2019]. Moreover, the intuition fees for international students are relatively cheap in comparison with other countries at the same level of education (i.e. United States, Canada, United Kingdom). Second, the Netherlands is a multicultural country with approximately 23% of its population first or second-generation immigrants [CBS, 2019]. Moreover, the population shows high participation in education than the average EU countries [CBS, 2019]. Finally, the Metropolitan Region Rotterdam-The Hague, the area where most students interact, the use of English in daily activities is highly used.

The second stakeholder is TU Delft. The international community of students arriving in the country requires the services provided by TU Delft to fulfill the main reason for their relocation, education. The main goal of the TU Delft is providing education, however, diversity and inclusion (D&I) have been identifying as one of the main factors in the university's strategy [TU Delft, 2019].

The third stakeholder is the Municipality of Delft. The inclusion of a community perspective in this study requires the inclusion of the system of a system approach [McDermott, 2018]. In this case, our main actor is not alone, the municipality of Delft acknowledge that the city is a student place [GemeenteDelft, 2019]. The Municipality of Delft has as a goal not only make sure that the legal requirements and norms are met in the case of expats but the integration of all their inhabitants

[GemeenteDelft, 2019].

The fourth stakeholder is DUWO, a company that provides single or shared accommodation for a student in Delft [DUWO, 2018]. Most international master students stay in TU Delft for a period of 2 years and use the service of DUWO for accommodation [TU Delft, 2019]. International students are expected to spend 1 or 2 years in these residential units since the contracts with DUWO prevent students to leave before a year and demand payments in advance. Therefore, a good part of the interactions or the lack of them occurs in these spaces. Moreover, one of the goals of DUWO is to integrate students to the new environment [DUWO, 2018].

The main stakeholders interact with each other in different stages as can be seen in Figure 5. The international students are accepted in TU Delft, which puts pressure on the Municipality and DUWO to accommodate students. The city of Delft has a shortage of accommodations for the students in general [DUWO, 2018], which increase problems for the community and special to the international students. The result of this first interaction is the allocation of efforts from DUWO and the Municipality of Delft into solving the shortage of housing displacing integration to a secondary problem.
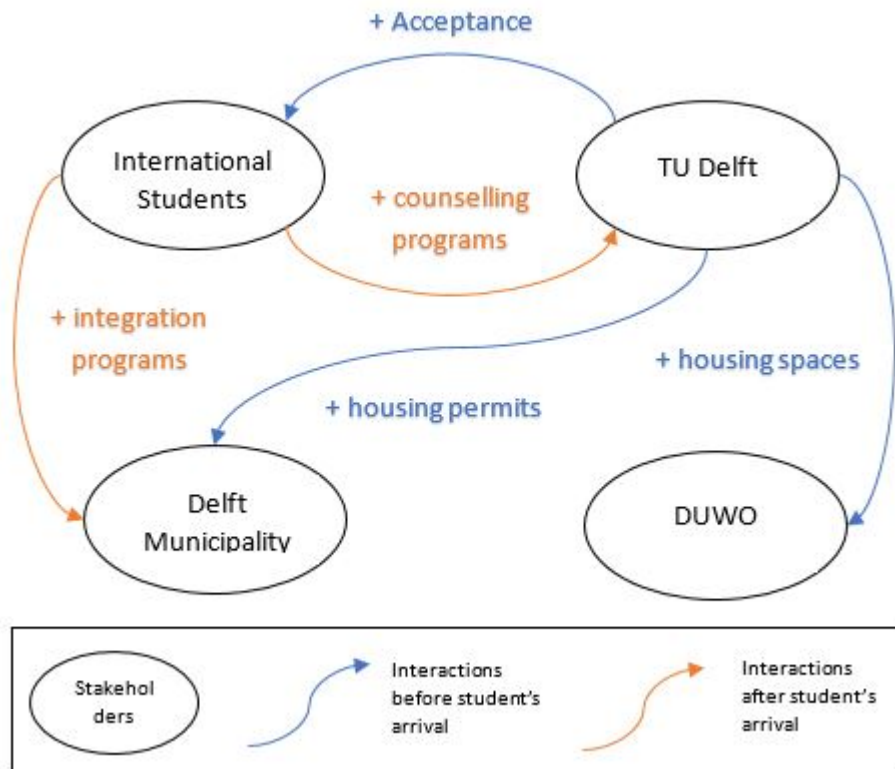
Figure 5: Interaction among stakeholders

The second interaction occurs after the expats are in Delft. The newly arrived population requires distraction and counseling to adapt to a new environment. Otherwise, young and new immigrants show disinterest about attachments to neighborhoods [Bach et al., 2015]. The Municipality and TU Delft put in place programs and counseling to offer entertainment alternatives for the international community and support respectively [GemeenteDelft, 2019] [TUDelft, 2018]. However, the events presented for the municipality allocate a couple of events in the city itself and the others are in cities like Amsterdam, Rotterdam or The Hague [GemeenteDelft, 2019]. At the same time, TU Delft's counseling programs have a large demand and waiting list of several months are the norm. The result is a lack of effectiveness from the main stakeholders to address the international master student adaptation to the city. Finally, the lack of interaction among the international students in their accommodations and/or outside the academic environment lead to the fragmentation of the city community. The result is more pressure over the programs and initiatives that the stakeholders put in place. Moreover, the lack of interaction in the international student community can lead to sadness and

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depression [Cacioppo and Cacioppo, 2014].
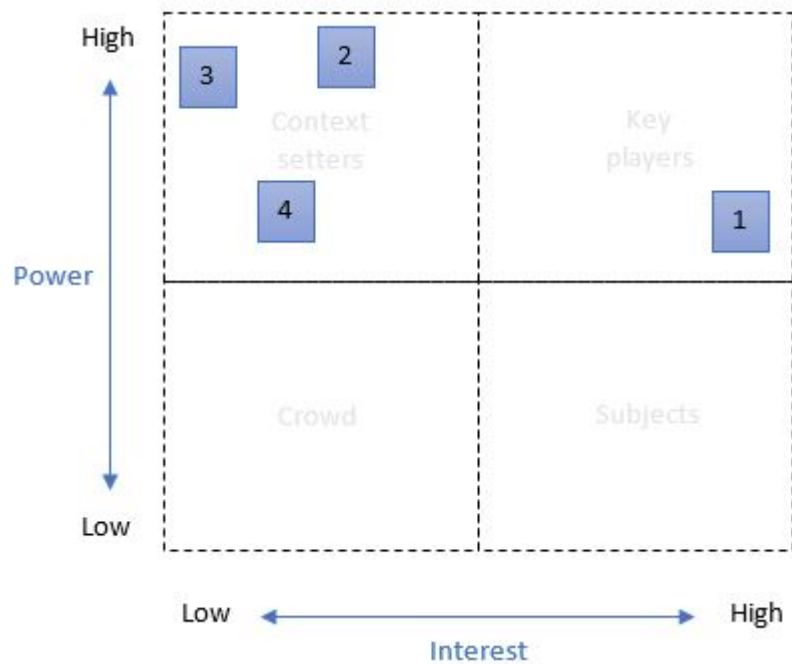
Figure 6: Power-interest matrix

Figure 6 shows the power-interest matrix of the four stakeholders. It is possible to see that the international students (1) have high interest but a limited amount of power. Nonetheless, this stakeholder is part of the key players. On the other hand, we have the rest of the stakeholders, which possess power but limited interest. This can be noticed by their official position capture in different articles of TU Delta. TU Delft (2) has limited communication towards international students and have proposed raising fees for non-EU students. The municipality of Delft (3) have power but their position respect to housing and almost no projects targeting international students puts them in a low-interest position. Finally, DUWO (4) has power but it is not completely autonomous since the guidelines and regulation about the use of the space comes from the municipality. Furthermore, their policies about renting and support to international students evidence the lack of interest to improve the situation of international students. In summary, the only key player is the international student population. Therefore, a top-down intervention would be ineffective or simply not put in practice. A viable solution is adopting a bottom-up approach with the participation and organization of international students. In other words, *it is necessary to empower the main stakeholder using ICTs to improve their networking and information sharing. The rest of the stakeholders (outside of the key player's section) are not actively address in this research.*

2.3 Literature Review and Research Gap

This section analyzes the existing literature based on communities, resilience, and social capital to have a more complete perspective and identify the gaps in previous research. The complete description of all documents analyzed is in Annex B. The results of the literature research are the recognition of four essential aspects needed to stimulate interaction and networking: information, activities & space, multicultural approach, and key actors. Finally, the identification of the main gaps in previous research take place and the formulation of the research question and sub-questions.

2.3.1 Information

There are different types of communication media and their use and effectiveness are also different. Social media, for example, is effective when is quick and easy to understand [Bach et al., 2015]. On the other hand, face-to-face communication is effective when communicates the necessary details in a voluntary environment [Bach et al., 2015]. This means that part of the success of using social media comes from the information presented and the way it is presented. Furthermore, the information should come with a narrative that provides the correct message needed to communicate through the community network since a credible story can resolve issues and gather people together [Goldstein et al., 2015]. Moreover, the language used must be in line with different social groups in the community [Pascua et al., 2017] [MacDonnell et al., 2017].

2.3.2 Activities & Space

Lack of time and indifference are barriers to interaction between people, especially when the activities come from a traditional top-down approach [Kitagawa, 2019]. One way to overcome these barriers and stimulate interaction is by giving ownership to the activities directly to the community [Kitagawa, 2019][Kelkar and Spinelli, 2016] [MacDonnell et al., 2017]. Moreover, co-creation of activities & spaces increase inclusion, engagement and the sense of belonging [Kelkar and Spinelli, 2016] [Sacchetti and Campbell, 2015]. Therefore, to improve interaction, it is necessary to include self-organized activities connected to the physical space of the participants. Furthermore, connection with a place is important to resilience [Goldstein et al., 2015] [Sacchetti and Campbell, 2015]. In our case, the international student population in Delft needs to know the city and the neighborhoods close to their residences. Activities that stimulate participants to take the streets, local places around Delft, or their own buildings can generate a positive impact. The process of co-design space permits the engagement of different groups and lower the barriers for participation [Kelkar and Spinelli, 2016].

2.3.3 Multicultural Approach

Community engagement is the results from an overlap between the members' perspective of their own identity and the group identity (Algesheimer et al., 2005). To create community engagement, it is necessary active involvement of all different groups in the community [Kitagawa, 2019][Burkhart-Kriesel et al., 2019][MacDonnell et al., 2017]. The work of Burkhart-Kriesel et al. [2019] and Kelkar and Spinelli [2016] address the conditions to have active involvement of the community. They introduce flexibility for creating programs, not only in terms of schedule or location but in terms of activities. The idea is providing as many opportunities for the different members of the community to get involved and form social bonds. These activities should aim for including a cultural approach in order to empower the community [Wali et al., 2017]. Moreover, presenting activities that can be identifiable with more than one group could be beneficial to stimulate inclusion between the groups. At the same time, it is important to remember that a human-centered technology approach which considers local practices of the target population must be encouraged [Comes, 2016].

2.3.4 Key Actors

Community engagement is the intrinsic motivation of community member to interact and cooperate with other members [Laroche et al., 2014]. One of the main factors for the success of community engagement the presence of key actors [Kitagawa, 2019][Burkhart-Kriesel et al., 2019][Bach et al., 2015]. These actors create a link between different stakeholders, moreover, the role of the actor is not only establishing the connections but assume the role of leader and stimulate trust. It is possible to train these key actors to perform a specific task if needed (i.e. have a positive message to transmit or technical skill). The work of Burkhart-Kriesel et al. [2019] indicate that key actors think that after the training, they acquire a tool that benefits the community. Therefore, it is important to identify members inside the community that can act as key members to establish connections and guide the rest of the members.

2.3.5 Research Gap and Research Questions

The result of the literature review also provides gaps in previous research addressing community engagement and social interaction. There are three gaps address in this study.

The first gap identified is related to time, (1) *most of the studies focus on improving resilience for communities for a long period of time and assumes a stable community presence.* However, the case presented in the Delft requires a

long-time running program but needs to deal with an international community that changes almost completely in 2 years, which could affect the willingness in the case of the bigger minorities dampening the chances of forming a resilience community as a result. Therefore, the classical approach of integration may not be applicable which requires new solutions.

The second gap is related to physical space. The relation between participation and physical space is only present in built-environment studies. However, (2) *the benefits of having a physical space that reflect the identity of different groups in other fields are not present.* Information grounds theory indicates that physical space can complement the use of digital information grounds [Fisher et al., 2004][Counts and Fisher, 2008]. Therefore, there is a need to include physical spaces when addressing community engagement. The international student community requires not only matching activities and physical space but being able to identify places with meaning for different groups in Delft.

The third gap is related to the inclusion of multiple perspectives. Cases that include different perspectives usually address only a binary approach (i.e. gender, adults and children, or residents and developers). However, (3) *it is unusual to find literature with more than two different perspectives at the same time.* In the present study, the traditional approach to gathering local students and internationals as two groups is not a viable option. Therefore, the international student community requires a self-organization scheme. As a result, it is necessary to include multiple minorities inside the student international community.

In order to address the gaps identified in the literature and the problem defined in the first chapter, a research question has been formulated:

- How can information-sharing apply in an IT artifact foster connectedness between individuals from different nationalities in Delft's international student community?

The main research question can be answered by breaking down different elements of the research into several sub-questions:

1. What are the main requirements for an IT artifact to stimulate information sharing?

2. What type of information shared using the IT artifact change the perceived level of connectedness among their users?

3. What functionalities of the IT artifact are necessary to stimulate communication apart from the shared information?

3 Methodology

The research approach selected for this case is design research and specifically design science due to the benefits and goals that offer. In design science achieving knowledge and understanding of the problem's domain requires building an application or designing an artifact in a way that the application or artifact contribute to finding a solution of a problem or general interest [Johannesson and Perjons, 2014] [Hevner et al., 2004]. In order to construct the artifact, it is necessary to first understand the problem and its context (i.e. people, organizations, technology), use knowledge base (i.e. frameworks, theories, methodologies), and finally, the artifact requires an evaluation to verify its utility [Hevner et al., 2004]. Therefore, it makes a good match for answering the main research question.

Johannesson et al. (2014) present a framework with five main activities: 1) explicate the problem, 2) define requirements, 3) design and develop artifact, 4) demonstrate artifact, and 5) evaluate artifact. Therefore, there is a need for different methods during the execution of the five main activities of design-research science.
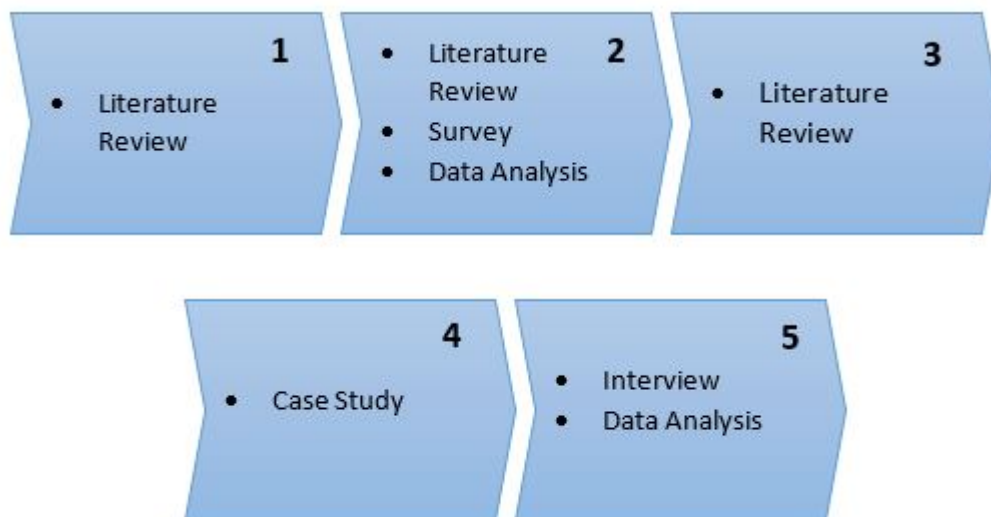
Figure 7: Activities and methods

The main research methods used during each of the activities are in figure 7. There are five methods in total: literature review, survey, data analysis, case study, and interview. The first activity uses literature review to analyze the problem and its context, also, permits the analysis of previous research to find possible solutions and gaps.

The second activity looks for the elaboration of the requirements necessary to design the ICT artifact. This activity uses three methods. The first one is literature review; it is used to analyze previous attempts and extract general requirements. This is possible by discovering the patterns in previous works [Dooley, 2002]. The second method in this activity is survey and allows the elaboration of requirements from the perspective of international students in Delft. The literature review identifies the multicultural approach as an important component to stimulate social interaction and connectedness. Therefore, the requirements of the ICT artifact require the integration of different users' perspectives. A survey is a good match since allowing the collection of complex and sensitive information [Johannesson and Perjons, 2014]. Finally, the third method is data analysis that complements the survey and allows the analysis of the responders to extract information and elaborate on the requirements. This is possible since data analysis involves the transformation of data into meaningful pieces of information [Johannesson and Perjons, 2014].

The third activity is the design and elaboration of the ICT artifact. In this case, the method involved is literature review since it is necessary to have adequate knowledge to transform the requirements into design elements.

The fourth activity requires demonstrating the resulting ICT artifact to the target group. In this case, the method selected to demonstrate the artifact is a case study. The case study requires focusing on an instance [Johannesson and Perjons, 2014] that in this case is the international student population in the city of Delft to understand in depth the different events resulting from the use of the ICT artifact. This activity allows collecting the information necessary to understand the functionalities that have the most impact between international students.

Finally, the last activity is the evaluation of the artifact. This activity is related to the demonstration of the ICT artifact. The case study permits the use of different methods to obtain substantial information about the case [Johannesson and Perjons, 2014]. In this case, the methods selected to evaluate the artifact are interviews and data analysis. The purpose of the interview is collecting data directly from the user to understand the type of information and motives behind sharing this information. The data analysis supports the analysis of the data from the interviews and data from the use of the ICT artifact in the previous activity.

After the general overview of the activities and method, the next sections explain each of the five methods in more detail.

3.1 Literature Review

In Figure 7 is possible to observe that literature review is a method used in the first three activities. Therefore, the problem analysis, the elaboration of requirements, and the ICT artifact design depend on previous research about similar problems or other solutions and how different are from the intended artifact [Johannesson and Perjons, 2014]. Figure 8 presents an overview of the literature review during the three activities.
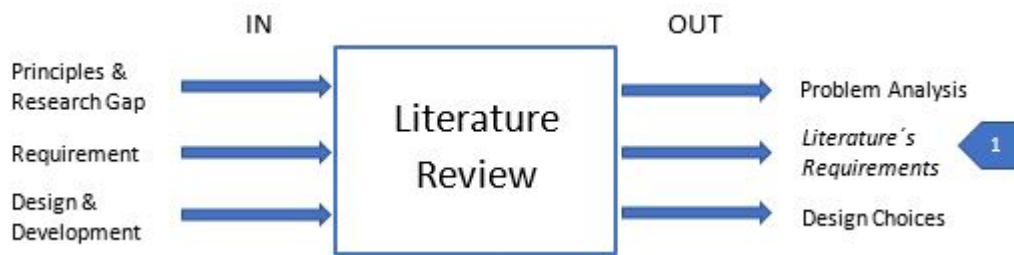
Figure 8: Literature review overview

In the first activity uses two different research parameters, the first used for the problem definition and main concepts, and the second for the research gaps. Both reviews are complementary between each other since the initial understanding of the problem requires both reviews at the beginning of the study.

3.1.1 Main Concepts

The first literature research looks for defining concepts related to societal challenges in the context of this study. The literature research uses Google Scholar as a search engine, and the search parameters were: *"community elements", "community resilience", "information grounds", "heterogeneous groups" + "information sharing".* The documents resulting from the search require selection, the parameter used for the selection are connections between community and networks, resilience in cities, and social capital in communities.

3.1.2 Research Gap

Finding the research gap requires literature research to analyze how different studies approach the construction of resilience in communities. The results of the analysis are in Annex B. The literature research was performed using Google Scholar as a search engine, and the search parameters were: *"information diffusion" + "digital platforms", "ICT improving connectedness", "community resilience" +*

"engage communities". The documents resulting from the search required selection, in this case, the parameters used are the four dimensions of the CRF to have a more holistic vision. At the same time, this literature review uses snowballing of the documents resulting from the main concept review to expand the number of documents analyzed for the research gap.

The second activity requires a literature review for the elaboration of requirements. Therefore, the parameters switch to include more technical features but still retain engagement of the community as its goal.

3.1.3 Systems Requirements

The literature research used for the identification of the main concepts and the research gap is the baseline for the system requirements. The articles search uses Google Scholar as a search engine and the parameters are: *"digital platforms"*, *"community engagement" + "ICT"*. The resulting documents require an analysis to determine their contributions to define: 1) Requirements to create a community sense. 2) Best practices used in different scenarios to promote community engagement. 3) Principles for the creation of ICT artifacts in community participation and information sharing. Finally, members of the supervising committee proposed some documents to complement the initial research.

Finally, the third activity uses a literature review to support the design choices. Therefore, the parameters are completely technical and include terms related to the outline of the ICT artifact which defines the type of artifact to be designed.

3.1.4 Artifact Design and Development

Finding information about the ICT artifact and their different components required literature research. The research used as a baseline the documents corresponding to the I&C Service Design course of the CoSEM program at TU Delft. The information in these documents support the main search parameters used in Google Scholar. The parameters are: *"digital platforms" + "platform ecosystem" + "platform architecture"*. The resulting documents were selected base on their complementary nature with the baseline documentation.

3.2 Survey

The second activity of the research uses not only a literature review but survey as methods. Surveys allow the collection of data from the possible users of the artifact and complement the elucidation of requirements. Therefore, the survey and literature review permit answering the first sub-question after the finalization of the first two activities.

Surveys are tools used to elicit requirements directly from stakeholders [Johannesson and Perjons, 2014]. There are several modes of data collection in a survey like self-administered, face-to-face, or remote interview [de Leeuw, 2001]. The model selected for this study is self-administrated since its confidential nature present more accurate responses when sensitive questions exist [de Leeuw, 2001]. Each of these modes has computer assistance variations, in this case, the self-administer survey uses an online questionnaire. The selection of an online questionnaire allows an easy and fast administration of the survey and permit easy integration with data analysis tools since the results do not require digitalization. Therefore, the option selected offers accurate responses and the simplicity/flexibility of computer assistance applications. Figure 9 present the survey overview.

Figure 9: Survey overview

3.2.1 Purpose and General Details

The main purpose of the survey is collecting information from international students in the city of Delft to elicit the requirements that the ICT artifact requires to share information and foster connectedness. However, the survey includes other questions related to a better understanding of the reality of students. Therefore, the questionnaire has five sections that aim to collect different information. Moreover, this section only presents the information related to the main goal of the survey. The complete questionnaire used in the survey is in Annex C.

The first section of the questionnaire introduces the necessary consents to use the responses of the participants in this research according to the guidelines of the ethics committee at TU Delft. The second section addresses the nationality of the participants. These questions permit tracking the participants to make sure that the different minorities presented in the problem definition are in the study. The third section of the questionnaire looks for the relation between the participants and communication technologies. The results of this section are used to elaborate on the requirements of the ICT artifact and its outline as well. The fourth section collects information about the social networking of the participants. However, this section has no impact on the requirements elicitation. The fifth section addresses the information and activities that the participants are willing

to share. The results of this section are going to be part of the requirements and are in direct connection to the second sub-question of this research. In summary, the five sections have a total of 7 pages and 23 questions, and it is in Annex C.

The target group of the survey includes four groups to be consistent with the heterogeneity of the community. The groups include the three main nationalities and a fourth group from the rest of nationalities. Finally, the participants are first- and second-year international master students since the necessities of the students are different depending on the time that students have in the city. Also, since the main approach is bottom-up, it is expected that information sharing goes from veteran students to novice ones.

The internet-based platform selected to perform the online survey is Survey-Monkey. The service provider allows several options to contact the participants: email, link, social media connection [SurveyMonkey, 2019]. The online survey uses email as distribution media and the selection of potential participants uses the snowballing technique. The email list with the addresses of the potential participants has a 20-80 distribution. The 20% of participants of each group have a connection with the researcher. The remaining 80% of participants in the list are the result of their connections with the initial participants. This process permits the reduction of bias in the responses of the survey.

In order to have a confidence interval of 95% from the universe selected, a minimum of 10 participants per each group is necessary. Furthermore, the email lists include between 10% to 50% extra participants to compensate for the typical low response rate to surveys [SurveyMonkey, 2019]. Also, the snowballing selection allows the capacity to include willing participants to the list or the capacity to reach the participant with a personalized remainder using the platform to assure the responses. Finally, the participants present a balanced ratio of women and men.

The nature of the survey is anonymous and confidential. The content of the survey does not collect personal or identifiable information of the participants. However, the survey requires the participants to provide their nationality. Moreover, the use of online platforms and their controls over the responses can compromise total anonymity [MIT, 2011]. Therefore, it is necessary to protect the information via controls or manually anonymizing data and forcing the platforms to collect no metadata.

3.2.2 Questionnaire and Design

The design of the survey includes the questionnaire and the email text for the initial communication with the participants. The design considers the type of questions, number of questions, presentation, time, confidentiality, and the failure of the responders to answers the questions [de Leeuw, 2001]. Therefore, the survey must

be short, in this case, complete the questionnaire will take in around 10 minutes. The survey has structured and unstructured questions, the former includes fixed response questions and the later open-ended questions. The unstructured questions have two options, the participant can write freely their responses or can have several options and multiple choices.

The first section uses only one structured question to facilitate the response of the participant about the different consents of the survey. The second section uses unstructured questions to collect the nationality of the participants since they can identify themselves in different ways (i.e. Hong Kong instead of China, Catalan instead of Spanish).

The third section addresses the use of different communication media (for receiving and sending information) and event preferences. The questionnaire tries to understand which and how often the participants use ICT application. This type of questions presents pre-selected alternatives to rank or rate. When it is necessary to rank or rate responses, the survey uses structured questions [MIT, 2011]. All questions have the option of select 'N/A' in case that the proposed answer is not used, or the field 'Other' for allowing the participants to choose options not foreseeing by the researcher. It is important to notice that these options are related to the great number of ICT applications in the market. Finally, some of the question in this section investigate about the trust that participants have for determinate application. In these cases, the participant requires space for an open response to provide their responses (i.e. which option do you trust the most?).

The fourth section of the survey does not have a relation with the requirements of the ICT artifact. Finally, the last part of the survey aims to understand the activities (type, place, and time) that participants look to be part of and the type of information that are willing to share among other students. These cases require a mix of structured and unstructured questions to allow the participant to elaborate on their responses in cases where the preselected answers do not match their preferences.

The final version of the questionnaire (Annex C) is the result of several changes from its original version. The supervisory committee reviews the original questionnaire, each member proposed suggestions and the researcher incorporated them or not accordingly to the purpose of the question or section. After finishing the round of revisions, the questionnaire was tested by 4 master students who not participated in the study. The purpose of the test was twofold, verify that the language and questions were clear, and try the online platform to avoid any technical issues during the real deployment. The questionnaire includes the feedback of the test participants. Finally, a test related to the functionality of the service shows no issues or problems.

3.3 Case Study

The fourth activity is the demonstration of the artifact. The method selected to test/monitor/understand the final ICT artifact and its application in a real scenario is a case study. The main research question and the problem definition indicate that this is a complex problem that involves different perspectives. Also, the demonstration of the artifact takes place in a determinate time and situation. A case study focusses on one instance of the situation and offers rich, in-depth information about the instance [Johannesson and Perjons, 2014]. Therefore, a case study matches the conditions for analysis the use of the ICT artifact and collect insides about its effectivity.

A case study considers not only one instance but requires a natural setting of the phenomenon [Johannesson and Perjons, 2014], in this case, the use of the ICT artifact. Furthermore, the case study requires the inclusion of the process and the relationships in the instance [Johannesson and Perjons, 2014]. The present study involves individual using the resulting artifact making it a socio-technical system that requires address the process as well as the technical considerations. The case study allows the incorporation and analysis of the process that comes with the demonstration.

The case study selected for this research is an *explanatory case study.* The main idea is the description of the event plus the identification of the relationships that can explain why some events happen [Johannesson and Perjons, 2014]. In this case, the explanation of the reasons that make some functionalities of the platform stimulate social interaction permits to answer the third research sub-question.

Demonstrate ICT artifact and information require some considerations. The first consideration is related to the internal behavior of the artifact. If the result requires an understanding of the internal behavior of the artifact then the experiment must address the artifact as a white box -testing the implementation of the artifact, otherwise, as a black box - testing how the artifact operates [Tschantz et al., 2015]. In this research, the case study considers the artifact as a black box since the important is the inputs and outputs of the artifact. A black box analysis can use for testing, experimenting, or monitoring depending on the control over the inputs. In our case, the inputs provided by the participants are outside of our control. Therefore, in cases where there is no control over the inputs, the correct analysis is monitoring [Tschantz et al., 2015]. Figure 10 shows the overview of the case study.
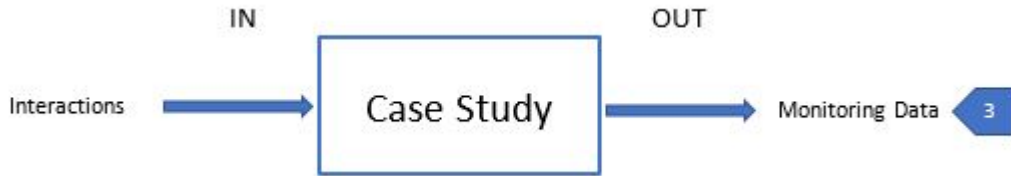
Figure 10: Case study overview

3.3.1 Stages

The instance of the case study has a fix duration in which is possible to analyze the results of the ICT artifact use. The instance has three stages: 1) Invite participants, 2) monitoring interaction, and 3) interviewing participants. The case study involves the presentation of the solution to a group of students, the participants are free to create the information or interact with the different functionalities of the ICT artifact. Finally, it is necessary to analyze the results of the interactions recorded in the artifact and the data collected from the participants as well.

The instance takes place during the month of July 2019; however, different stages have a duration of weeks or days depending on activities. The first stage requires to invite potential users to visit the platform and become an active member to evaluate the artifact. Therefore, this stage uses an invitation directed to international students via email as the main source. The first set of emails has the directions of the survey participants that agree to be part of the research in later stages. The second set of email has directions of international students that the researcher has direct contact. Finally, the third set contains the direction of international students resulting from snowballing. The communication includes a brief explanation of the research and includes a hyperlink to reach the artifact.

The second stage requires the monitoring of the interactions in the ICT artifact. The collection of the data from the system only runs for two weeks. The case study requires the ICT artifact to be fully operational and accessible from the Internet to make possible for participants to access the artifact at any moment and from any device. Figure 11 shows the stages of the case study.
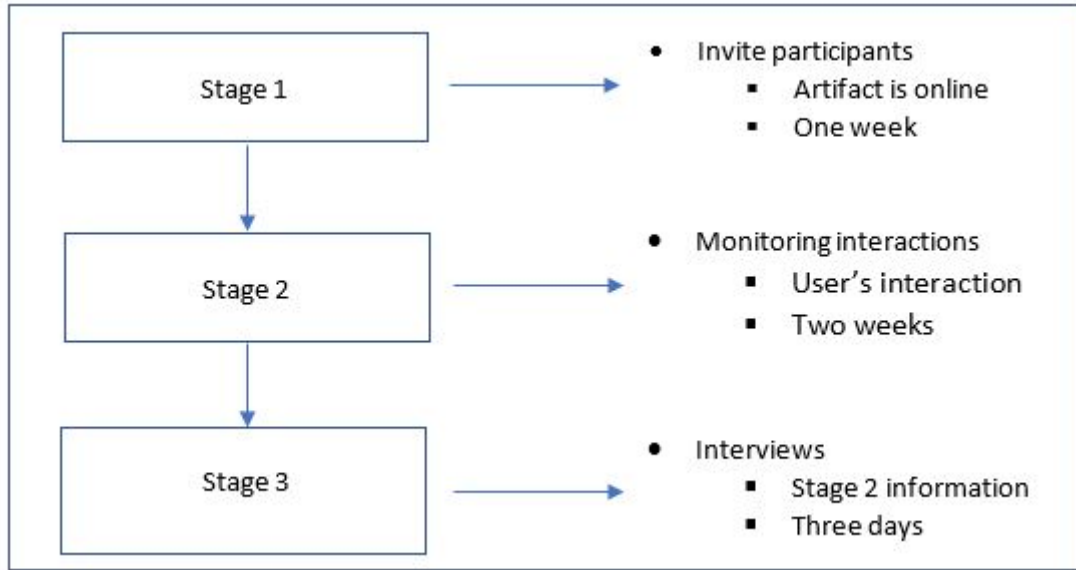
Figure 11: Stages of the case study

The purpose of the second stage is tracking the use of different elements of the artifact and the type of information shared via the artifact. This stage uses an automatic collection of the data, which means that the researcher does not waste resources in the monitoring. The collection of data includes the type of device used to access the service (i.e. mobile or fixed devices), the number of visits, the number of members, the type of information shared (i.e. based on pre-determined categories extracted from the results of the survey (See Annex D), interaction between users, and reactions to the information.

The final stage requires the collection of data directly from the participants using a face-to-face interview. The interview is a complement of the automatic monitoring to understand the motivations for using or no certain sections of the artifact and the reason behind the information shared via the artifact. Therefore, this stage requires the results of the second stage after two weeks of the platform operation. The selection of the potential interviewees uses the second stage results to determine active and passive participants. Moreover, the analysis requires both types of participants to understand the effect of the artifact over the users.

3.3.2 Resources and Limitations

The case study requires the allocation of resources depending on the different stages. The first stage requires one week to collect potential participants information and complete the delivery of the invitations. The second stage requires two weeks for the operation and collection of data. Moreover, the third stage requires

three days to perform the interview. The case study costs only consider basic costs related to putting the artifact online. Therefore, the interviews are going to be from participants in the city of Delft. Finally, the case study must have more than 20 participants as active members to have a minimum of interaction and data during the demonstration of the artifact. On the other hand, the analysis requires at least 6 users as part of the interview process to have an overview of 30% of the participants.

After conducting the interviews, the platform will continue to be operational for another two weeks to allow the generation of automatic reports. However, any data outside of the two weeks' time-frame is not going to be part of the results of the current thesis project. After the artifact reaches the end of the operational cycle, members of the platform receive an email communication to indicate the termination of the project. Finally, the deletion of any data stored in the artifact after 30 days from the termination of the project is the final part of the demonstration.

3.4 Interview

The fourth method used in this research is interview. Interviews are communication sessions between the researcher and the responder to acquire more knowledge about the study topic; the researcher controls the agenda by asking questions [Johannesson and Perjons, 2014][Gill et al., 2008] [Hannabuss, 1996]. Interviews are effective to collect complex and sensitive information (i.e. attitudes, emotions, opinions, experiences, behaviors) [Rowley, 2012][Johannesson and Perjons, 2014][Gill et al., 2008] because permit the collection of rich and meaning-making data [Frels and Onwuegbuzie, 2013]. Therefore, since the results of the experimentation with the ICT solution require the collections of opinions and experiences, this method is a good fit for the research.

This section of the document presents the purpose of the interview with some general consideration about the interview, the overview of the interview schedule, and the design of the question that composes the protocol of the interview. Figure 12 presents an overview of the interview.

Figure 12: Interview overview

3.4.1 Purpose and General Details

The main goal of the interview is collecting responses of international students about three main topics: 1) the literature research concepts applied in the artifact, 2) the motives behind the information shared between participants, and 3) features of the artifact. Each of the sections is looking for collecting information from the participants to understand if the artifact is helping the international student community to improve their connectedness and social interaction.

There are three types of research interviews: structured, semi-structured, and unstructured [Gill et al., 2008] [Hannabuss, 1996]. Their differences are in the range of freedom that the researcher has when administrating the questions. Semi-structured interviews have several key questions and allow the interviewer to diverge from the topic to pursue an idea in detail to discover information not included previously [Gill et al., 2008]. Therefore, a semi-structured interview (SSI) fit the needs to collect information from the users of the ICT artifact.

The SSI uses a face-to-face approach to permit the interviewer to structure the interview and offer a break or support if the interviewee requires it [McIntosh and Morse, 2015]. In this case, the SSI addresses three topics related to the second and third sub-questions which requires structure and a proper explanation. On the other hand, the strengths of the researcher can cope with the disadvantages like influencing the participants or generate inhibitions. Finally, these types of interviews are costly in terms of time and money [McIntosh and Morse, 2015], therefore the interviewees should be in Delft when testing the ICT solution to control these issues.

The interview requires selecting participants from the total users of the platform. In this case, 6 international students take part in the interview. This number is based on time restrictions and the proximity to the end of the academic year. However, a careful selection of interviewees and a good design interview provide insightful results even with small groups of participants [Rowley, 2012]. Participants selected for the SSI are based on their different interactions with the artifact and trying to include participant representing the four groups of students based on nationality.

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3.4.2 Interview Schedule and Design

An SSI requires the definition of the interview schedule since it has the questions of the interview. This element is pivotal to assure the collection of the necessary information and control the order of the questions [Gill et al., 2008] [Hannabuss, 1996]. The questions of the SSI must be open-ended, neutral, sensitive and understandable [Gill et al., 2008] [Hannabuss, 1996] [Rowley, 2012]. The complete interview schedule is in Annex G.

The work of Hannabuss [1996], Gill et al. [2008], and Rowley [2012, 2015] propose a structure that must include an introduction, the collection of the consent, the main questions, and a closure that permit the participants to express themselves. Therefore, the first section is the introduction. The schedule considers 13 minutes for this section and the main idea is to communicate the goals of the research and a brief summary of the research before the interview. Also, it is necessary to present the informed consent and collect approval.

The second part includes the questionnaire divided into three sections. The first section has 7 open questions – 4 main questions, 2 follow up questions, and 1 rephrased question – and has a duration estimated of 15 minutes. Each question address one of the main principles presented in chapter 2 to stimulate social interaction and connectedness in an ICT artifact. These answers are in the results and support answering the main research question. The second section has 4 open question – 3 main questions, and 1 follow up question – the duration of this section is 12 minutes. The topic of these questions addresses the information shared by the participant in the ICT platform, the motivations, and topics for sharing. The responses contribute to answering the second sub-question. The final section has 4 open questions – 2 main questions and 2 follow up questions - the time granted for this section is 9 minutes. The questions address the different functionalities of the platform, their use and reasons for using parts of the platform. The results are going to support the answer of the third research sub-question.

The last part of the schedule is the closure. This part considers 10 minutes and the main idea is to permit the interviewee to provide any additional information that was not in the questionnaire, but they consider important. Also, during the closure, the interviewer notifies the participant the possibility to have a second contact for clarifications. Finally, the interviewer informs the next steps in the research and thank the participant for its time.

Create rapport between the interviewer and the interviewee before the interview have a positive effect on the development of the interview [Gill et al., 2008] [Hannabuss, 1996] [Rowley, 2012]. Therefore, before the interview takes place, a brief chat with the participant take place to get to know the participant before the start of the interview and to create the correct atmosphere and collect the best responses possible from the participant. Furthermore, it is necessary to used quiet

places and recordings devices to pay attention to the interviewees. In this case, the interviews take place in an office close to the university for the convenience of all participants.

It is recommended to test the final questionnaire and conduct a pilot of the interview to improve the questions, their clarity, and order [Hannabuss, 1996] [McIntosh and Morse, 2015]. Refining the questions of the interview uses the input of master students and the advice from the committee advisor. Finally, to test the protocol, one of the participants took the interview. This interview forms part of the results and helps in the process of tune the interview protocol for the rest of the interviewees.

3.5   Data Analysis

Data analysis is the last method used in this research. However, this method is present during different stages of the study. Furthermore, the survey, case study, and interview collect data that require analysis. Data analysis derives valuable from collected data to explain or describe the event under investigation [Johannesson and Perjons, 2014]. In order to get information, raw data requires several steps like preparation, interpretation, analysis, and presentation. Performing conclusions and discussions are possible after all these steps. Throughout the research, qualitative and quantitative analysis are in place depending on the data from previous methods.

The survey delivers data in the form of categorical variables as responses from different questions. The case study monitors numerical data from the users of the ICT artifact linked to the key performance indicators (KPIs). Finally, the interview delivers data in the form of text that requires classification and the identification of relations. Therefore, this section includes a review of the data analysis for these three scenarios and general background for those scenarios. Figure 13 presents an overview of the data analysis.

Figure 13: Data analysis overview

3.5.1 General Background

This section of the methodology presents general concepts for data analysis. However, in case of a more detail background, it is possible to consult the work of James et al. [2006]. The general background includes data cleaning and a brief review of quantitative and qualitative analysis to speed-up the explanation of the next sections.

Data analysis requires quality data to work. Data cleaning is the process of removing errors and inconsistencies from the data [Rahm and Hai, 2000]. The most common cause of low data quality are misspellings, missing information, or invalid data [Rahm and Hai, 2000]. Therefore, consistent data requires cleaning the raw data first.

The cleaning process starts with the detection of error and inconsistencies. Duplicated data require special attention since it is necessary for the elimination of these values. In addition, manual inspection of the data permits gaining metadata of the data properties and detect data quality problems [Rahm and Hai, 2000]. Second, depending on the level of *data dirtiness*, the data experiments several cycles of transformation and correction until is ready for its use. Third, the resulting data from the previous process is tested and evaluated. In case that the data cleaning requires more than one cycle, the verification must go accordingly. Finally, after the data is ready, the clean data replaces the dirty data at the origin. This process permits that new data analysis avoids repeating the cleaning stage in future extractions [Rahm and Hai, 2000].

Missing data is a rule in studies that have social components [Roth, 1994] [de Leeuw, 2001] [Peng and Dong, 2013]. Researchers in multiple fields uses multiple-item scales to measure important variables in social science [Roth et al., 1999]. The acceptable percentage of missing data is 5% up to 10% [Peng and Dong, 2013] [Roth, 1994]. The traditional approach in cases with incomplete data is using listwise deletion or using mean values as replace of missing data. Moreover, it is also possible to filling-in missing features to complete the data (imputation) or applying neural networks to handle missing values [Aste et al., 2014]. Imputation of missing values can handle not only missing values but sparse data problems [Aste et al., 2014]. Therefore, researchers must consider imputation as an alternative to listwise or mean values if the percentage of missing data is considerable [Roth et al., 1999] [Little and Little, 1988]. Multiple imputations (MI) is a technique that uses the benefits of simple imputation plus the inclusion of uncertainty over three steps to get an estimate with optimal statistical properties [Raghunathan, 2004][Little and Little, 1988] [Little, 1986] [Allison, 2012].

After the process of cleaning the data requires processing. The data resulting from the previous method requires a quantitative and qualitative analysis. The quantitative analysis has descriptive and inferential statistics at its disposal.

The use of descriptive statistics has as a goal the description of a sample of data [Johannesson and Perjons, 2014]. On the other hand, inferential statistics have as a goal to reach conclusions from the data collected [Johannesson and Perjons, 2014]. One of the most common analysis investigates the relationship between different variables. A common technique to indicate the strength of the relation is to calculate the correlation coefficient. However, a correlation is not enough to prove a relation between the variables. Therefore, other techniques are used in complement to the correlation factor (i.e. t-test or chi-square tests).

The hypothesis test uses standard error (SE) in its calculation, the most common test is the null hypothesis. The p-value indicates how the variable X is related to the response Y. In other words, the smallest the p-values are, the larger is the association between the predictor and the response, therefore, the null hypothesis must be rejected [James et al., 2006]. If the p-values are lower than 5% then there is a relation between the parameters measured.

The goal of qualitative analysis is the description of phenomena [Johannesson and Perjons, 2014]. There are three main approaches for qualitative data analysis: content analysis, grounded theory, and discourse analysis. Content analysis is a good match for interviews [McIntosh and Morse, 2015]; therefore, this section has a brief explanation of this method. Johannesson and Perjons [2014] present six steps to perform a content analysis: 1) Choose a sample of texts (it is necessary to present the selection factors of the sample). 2) Break the text into units, these units can be word, sentences or paragraphs if needed. 3) Develop categories for analysis, these categories must be relevant for the study. 4) Code the units according to the categories. 5) Count the frequency of the units for each category. 6) Analyze the texts in terms of the frequencies (the results could lead to further research topics).

3.5.2 Survey

The online platform SurveyMonkey offers two formats to extract the raw data collected from the responders. The first one is an individual PDF file per responder with all the questions and answers in a table look. The second one is a CSV file with all the responses in a single file. The selection of the CSV format offers advantages (i.e. unify data, easy to read, simple to clean), therefore its selection.

The cleaning process starts with the detection of errors and inconsistencies. This phase does not require much elaboration since the online survey platform eliminates errors and inconsistencies in close-ended questions and mitigates errors and inconsistencies in open-ended questions. The next step is the verification of duplicate data. Again, the online survey platform provides a unique identifier per responder. The result is a fast process with no elimination of any data.

The next step is verification of low-quality issues. The main issues are related

to data no collected and the labels of the columns. The empty data is the result of not collecting identifiable digital information to guaranty the privacy and confidentiality of the participants. The labels need to be short and simple to facilitate the construction of the metadata. Also, short labels permit fast coding during the analysis and improve comprehension. Finally, the data requires consolidation, some questions have the results spread in different columns. The resulting dataset after the consolidation is subject to a manual verification to check no accidental changes in the responses from the participants. Figure 14 provides a clear visualization of the phases and steps of each phase for the survey's data analysis.
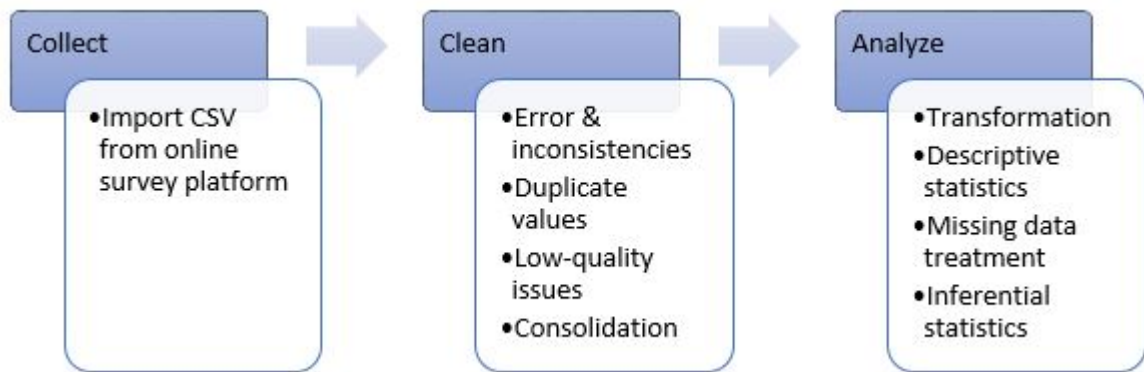
Figure 14: Survey's data analysis process

The next phase is the analysis of the data. Open-ended questions require a special analysis since the answers of every participant is different. The data requires transformation and verification to guaranty that the result does not change the responses, but at the same time allowing classification to have insights. Finally, questions 2, 6, 10, 13, 15, and 18 required transformations and tabulation in scales. The results of the dataset transformation serve as the base for the next steps.

The analysis continues with the use of descriptive statistics. The results are in Annex D and are a mix between the clean dataset with descriptive statistics and initial data analysis provided by SurveyMonkey. After the application of descriptive statistics, the data becomes information that includes percentages and the number of repetitions allowing the extraction of requirements.

The data permits a second analysis using inferential statistics. However, it is necessary to do missing data verification as pre-requisite to decide the best treatment. The results show that from 900 answers 21 responses are missing. Therefore, the missing data is 2,33%. Furthermore, the missing values are in questions: 6 (11 missing values), 10 (8 missing values), 14 (1 missing value), and 20 (1 missing

value). The levels of missing data are in the normal range. Therefore, listwise deletion control is enough before checking correlations. Finally, the analysis requires a correlation matrix including all the data to obtain an initial overview of connections and dependencies. Promising results are the baseline for a second exploration using linear regressions or a second chi-squared analysis.

The number of correlations is low for the number of variables. Therefore, since the missing data affect specific questions, the dataset gets an MI process to complete the missing values before repeating the correlation matrix. The idea is verifying correlations among variables that may not be possible to detect without using the complete dataset. However, the results of the analysis with MI data shows no significant difference. Therefore, *the results do not include MI data.*

3.5.3 Case Study

The data analysis of the case study considers the results monitoring the ICT artifact. The results of the interaction between the participants and the platform include the count of interaction and other features defined in the next chapters. Therefore, the data analysis of the case study uses descriptive statistics only.

The monitoring of the interactions should happen in the ICT artifact. Therefore, the collection of data happens in an automatic way; however, the process does not consider exporting the data to any repository. As a result, the first step of the data analysis is the collection of information from different sections of the artifact. The complications presented in the survey around cleaning the data are not present in this method. Therefore, the second part of the analysis is performing a descriptive statistic to obtain percentages and frequency.

The result is going to provide information for understanding which features of the artifact are the most used. Also, the selection of potential participant for the interview comes from the results of the interaction with the ICT artifact in the case study. The results are in chapter 6.

3.5.4 Interview

The amount of information resulting from an interview is considerable [Hannabuss, 1996]. The analysis of an interview makes a comparison of the responses by item [McIntosh and Morse, 2015]. After the comparison, it is possible to make a numerical transformation and perform a quantified analysis [McIntosh and Morse, 2015].

The first step for the analysis is by preparing the data. The preparation of the data includes a transcription word for word of the audio files to text [McIntosh and Morse, 2015]. However, the confidentiality of the responders is a priority. Therefore, data that can identify any subject is removed from the

transcription. Furthermore, text between brackets indicates the location of the anonymized text for transparency. The second step is content analysis. The data is sorting in similar categories and subcategories [McIntosh and Morse, 2015] [Rowley, 2012]. Therefore, the data classification follows the three sections described in this chapter in the interview section. Also, the order of the responses follows the order of the questions. This verification is necessary since during the interview the participant may address different topics, or the responses of certain questions complement others. As a result, it is necessary the modification of the audio transcriptions to allow the recognition of the interview categories and each question.

Finally, since the number of SSI is small. It is possible to compare participants and tabulate the categorical data. The analysis allows the presentation of results in percentages and frequencies. These results are in chapter 6 to provide a clear picture of the results since they support the third research sub-question.

4 Systems Requirements

In this chapter presents the identification and outline of the ICT artifact. The resulting artifact will tackle the main problem [Johannesson and Perjons, 2014]. In order to accomplish this task, it is necessary to explore even further the causes of the problem and propose a solution to the issues that start appearing.
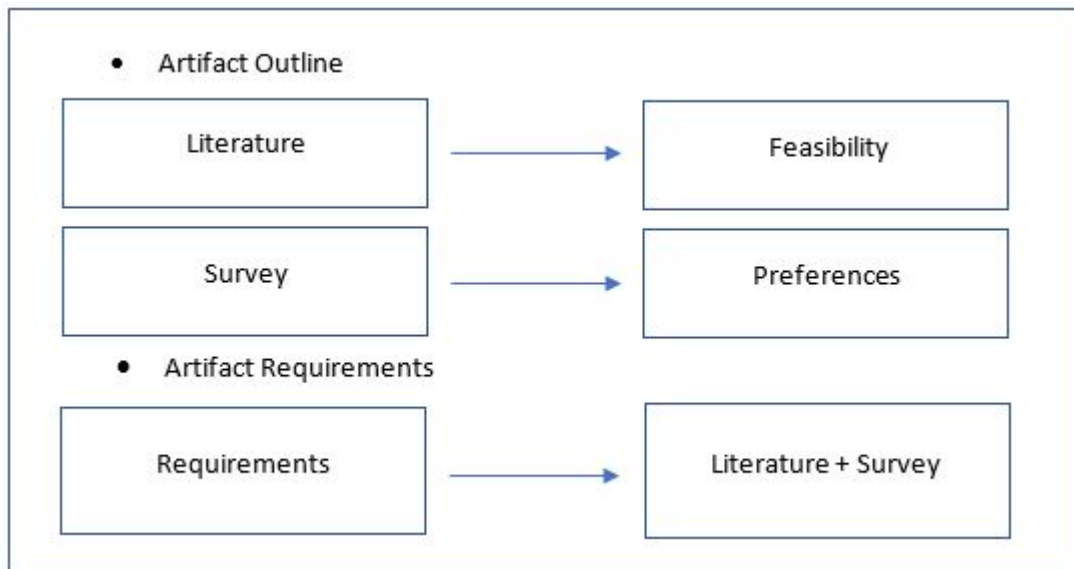
Figure 15: Process of artifact outline and requirements elicitation

The process to define the outline and requirements of the ICT artifact is in Figure 15. The outline of the artifact indicates what type of ICT artifact (i.e. architecture, device, application) match the preference of the target group and it is feasible at the same time. Finally, after defining the type of ICT artifact, the formulation of requirements follows. Chapter 2 presents the result of literature research: concepts, main principles, and stakeholder analysis. Therefore, these results become the starting points to elicit requirements. On the other hand, it is necessary to include the point of view and needs of the international student community into the requirements. Therefore, the student's perspective is going to be captured using a survey. The results of both methods shape the ICT artifact and allow the extraction of requirements.

The next section of this chapter introduces the survey and the results related to requirements' elaboration. On the other hand, the literature needed for the outline and the requirements are in each section.

4.1 Survey

The present section focuses on the survey administrated to the international students in Delft, it is development and results. This information offers the necessary support for the next sections.

4.1.1 Survey Development

The methodology in chapter 3 presents the purpose, general details, and the elaboration of the questionnaire. This section covers the development of the survey including relevant questions and its rationale.

The survey uses SurveyMonkey as an online platform. The selection of this platform is related to the functionalities that offer. Permit the creation of the questionnaire directly online, allows no-tracking of digital parameters, and provide a descriptive analysis of the results depending on the type of questions and its design. Therefore, SurveyMonkey allows a fast deploy, high confidentiality for the participants, and present partial results immediately.

The first step is the creation of the questionnaire. Annex C has the complete questionnaire including email communication. The third section of the survey starts with question 4 (Which of the following media sources do you use and how often?) and have as responses the most used applications for social media and messaging. This question aims to understand the type of applications that the participant uses and how often. Question 5 (Which are the preferred ways in which you receive information?) have six preselected responses that require ranking. The responses have a wide range of options from television to face-to-face interactions to understand how people receive information from other people. Question 6 (Which one do you trust the most?) is directly related to the previous question. The idea is understanding which way of communication is the most trusted among the participant to investigate its features. Question 7 (What are the main ways in which you share personal information?) have similar options that question 5 but excludes television. The result allows a clear understanding if there are differences between receiving and send information. Question 8 (What type of format do you use to share personal information on social platforms) have preselected options from text to videos. The results provide a direct requirement that the ICT artifact must support. Question 9 (How do you prefer hearing about events/activities near you?) have different options that require ranking. The results provide insides about the ways that people get to know activities. Activities and information have different connotations in the survey. Finally, Q10 (Which one do you trust the most?) is related to the previous question. This result is also a complement to understand which communication way is trusted and then understand its features.

The fifth section of the survey starts with question 18 (What are the types of activities that you would like to participate in your free time?) and have four preselected types of activities. The categories include sports, music, food, and visual arts. The results provide a starting point for understanding the interest of the participants and include them in the artifact. Question 19 and 20 are related to the preference of the participant when attending events and it is outside of the scope of the requirements. Question 21 (What kind of information would you like to share with your neighbors/peers?) provides a set of pre-selected responses. The result of this question provides a clear understanding of the type of information that participants prefer to share with others freely.

After the creation of the questionnaire, the service provider uses email lists to reach the participants and provide access to the questionnaire. Four email lists, one for each group of international students provides the based line of communications. The lists have the address of 16 Indian students, 15 Chinese students, 11 Greek students, and 15 students from other nationalities at the master level. The service provider allows sending email communications and a follow-up message after 7 days of no response or unfinished surveys. Finally, the survey responses are available right after each participant finishes the survey. SurveyMonkey presents a basic tabulation of the data and updates the results with each response. The survey remains open until at least all four groups reach a minimum of 10 participants completing the survey.

4.1.2 Survey Results

This section presents the results of the survey related to requirements for the ICT artifact. However, the result of all questions is in Annex D.

The survey has a target population of 3676 students. The number of students participating in the survey is 45. Therefore, *the confidence interval is 95% CI.* However, the number of responses is low in comparison with the total population which gives a *margin of error of 14,6%.*

The number of Indian students completing the questionnaire is 15 with a response rate of 93,8%. The number of Chinese students that complete the survey is 10 with a response rate of 66,7%. The total number of Greek student's response is 10 with a response rate of 91%. Finally, the number of students from other nationalities that complete the survey is 11 with a response rate of 73,3%. *The total response rate of the survey is 78,9%.*
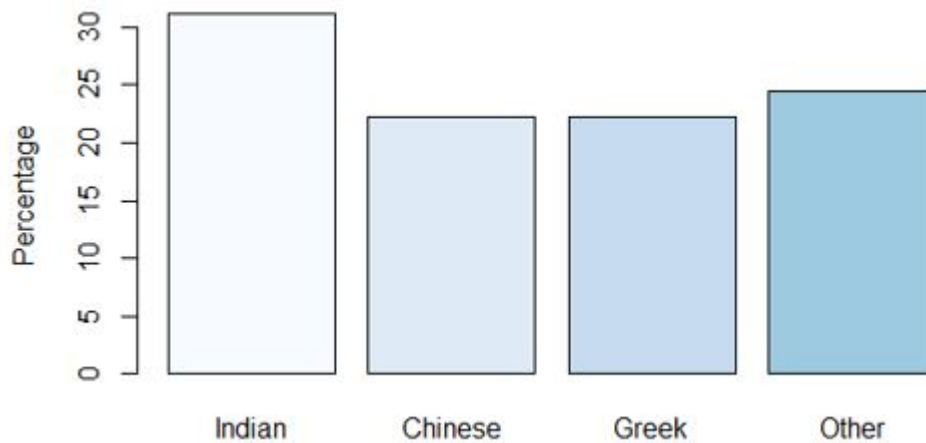
Figure 16: Survey Q2: Identify your nationality

The results of question 2 (Figure 16) provide information about the demographics of the survey. *Indian students represent 31,1%, Chinese and Greek have 22,2% each, and the rest of the nationalities represent 24,5%.* These values indicate more predominant participation of the three main nationalities with respect to the real demographics. The survey does not collect information about gender or age of students. However, the data related to the email address of the responders permit a good estimate. The number of male responders is 23 and female responders are 22. *The percentage is 49% female and 51% male participants.*

The survey addresses other topics like the type of accommodation, frequency of students in contact with another international outside of the academic environment, size of a support network, feeling of isolation, and willingness of improving social connections. These results are not part of the elicitation of requirements and it is possible to review them in Annex D.

The survey response of question 5 indicates that users prefer three digital ways to receive information: Social media, official websites, and messaging platforms. The first place is for social media with 33% of the users selecting it as their preferred way. The second place is for websites like newspapers with 29% of votes, and in third place messaging with 13%.
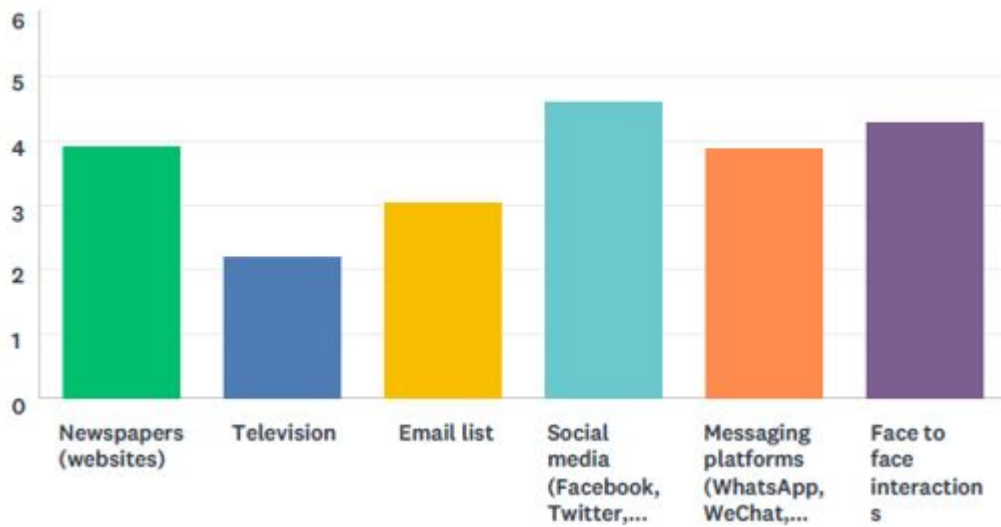
Figure 17: Survey Q5: Which are the preferred ways in which you receive information?

Figure 17 present the results of question 5 and Figure 18 the results of question 6. Question 6 shows the level of trust related to the channels to receive information. The results present dedicated websites as the most trusted option with 52,9% of students selecting this option. The second is face-to-face communications with 14% and emails with 11,8% of participants selecting these options.
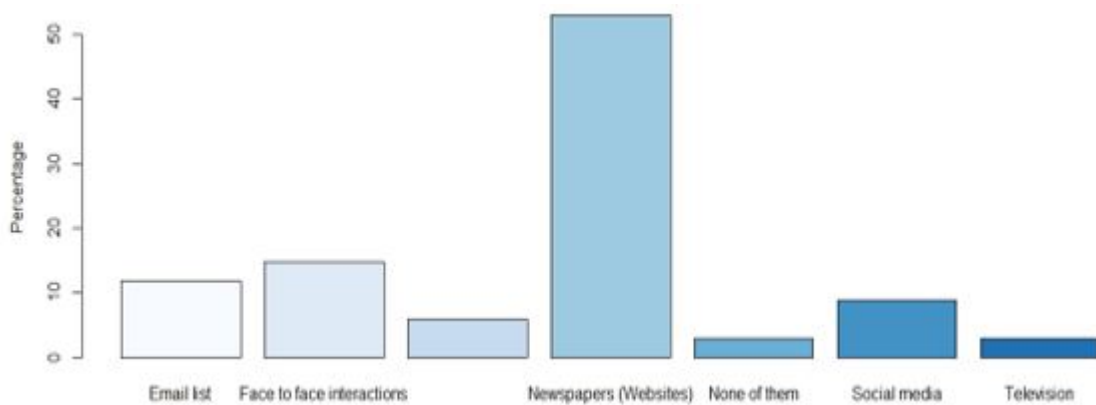
Figure 18: Survey Q6: Which one (preferred ways of receiving information) do you trust the most?

On the other hand, question 7 of the survey have the preferred ways that people use for sharing personal information. The results indicate that face-to-face

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communication is the best. However, digital channels like messaging platforms or social media have high acceptance with 76% and 49% respectively. The last two positions are for email and websites (blogs).
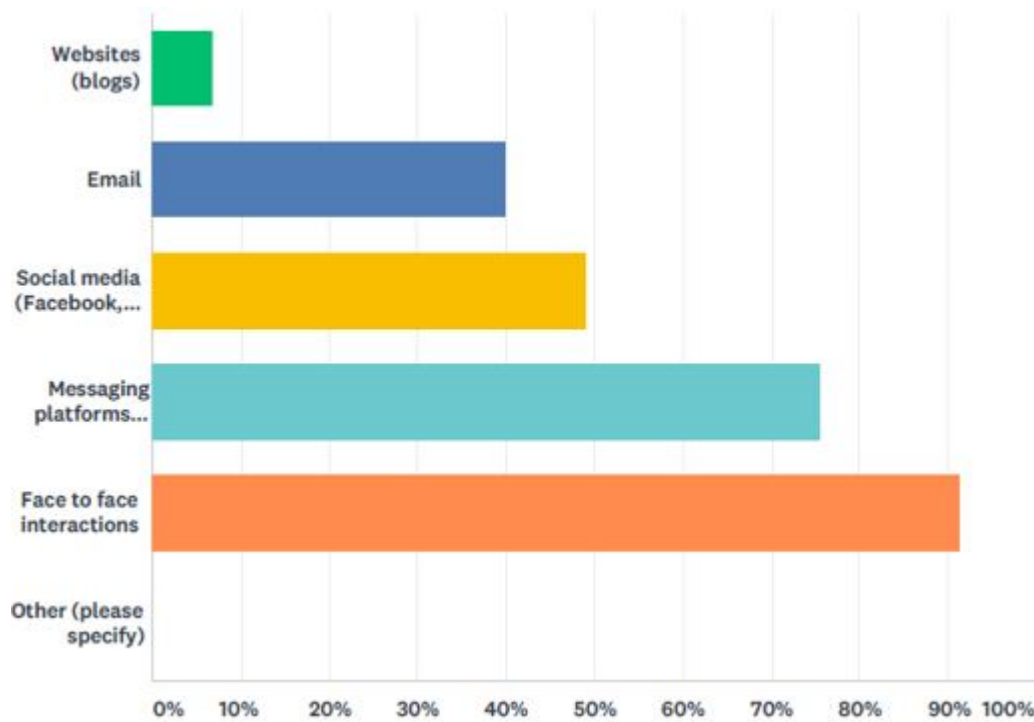
Figure 19: Survey Q7: What are the main ways in which you share personal information?

The results of question 8 of the survey show that people use text and pictures as the main formats for communication. 84% of responders use text and 82% uses pictures. Finally, 18% of users use videos or audio files for communication. Figures 19 and 20 present the results of questions 7 and 8.
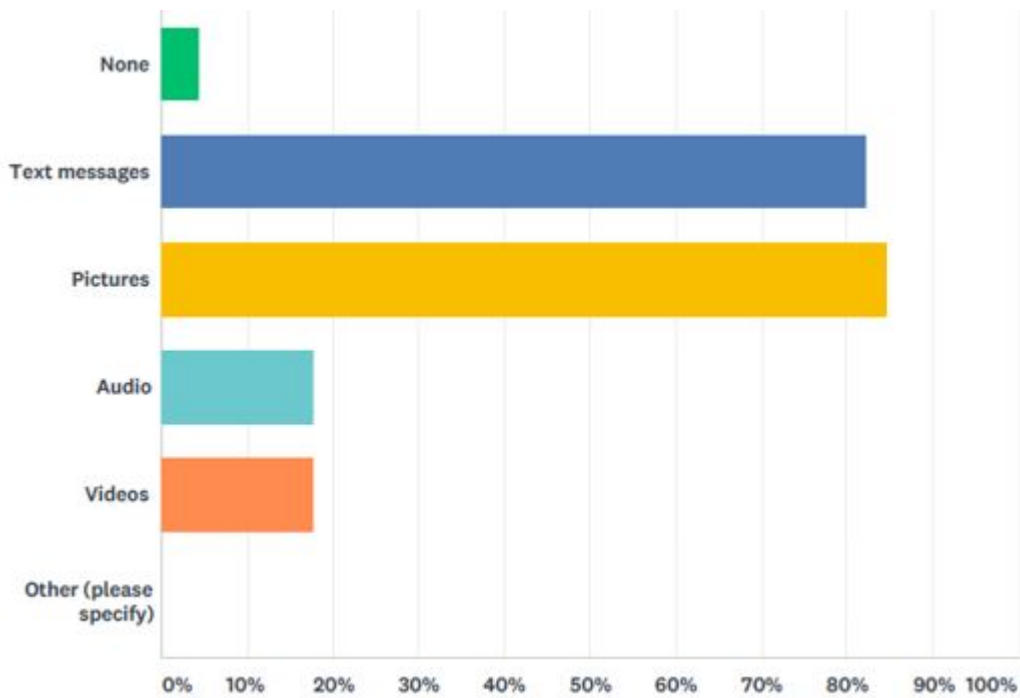
Figure 20: Survey Q8: What type of format do you use to share personal information on social platforms?

The answer to question 9 of the survey shows that international students prefer social media to receive information about events with 44% of votes. Another traditional method of publicity occupies the second and third position. Finally, websites have 13% of preference follow by email and text message with a 2% each.
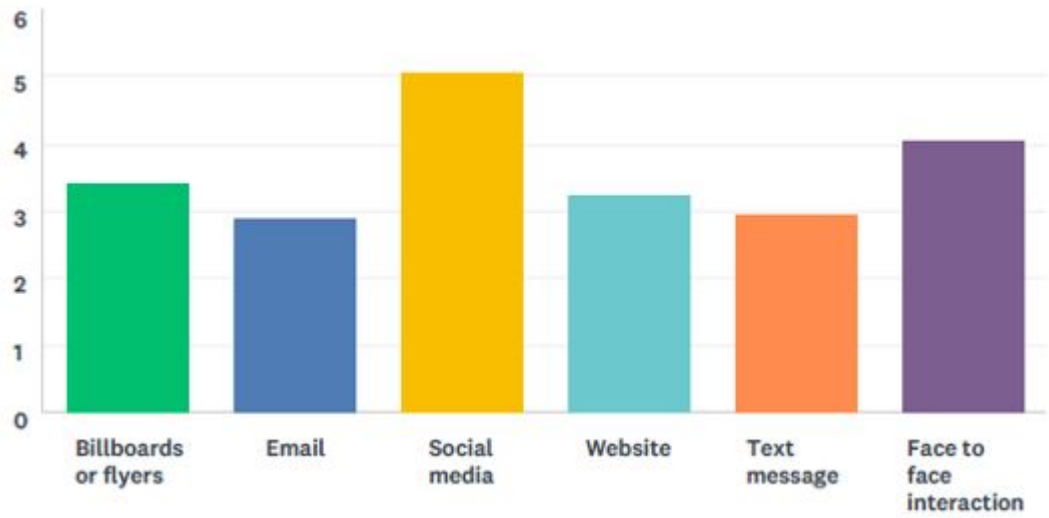
Figure 21: Survey Q9: How do you prefer hearing about events/activities near you?

Figure 21 and 22 present the results of question 9 and 10 respectively. The results of question 10 indicate that 29,7% of the participant trust the most on social media to receive information about events. In the second position is websites with 27% and in third position billboards and flyers still have high credibility with 21,6% of students selecting this option as the most trustful.
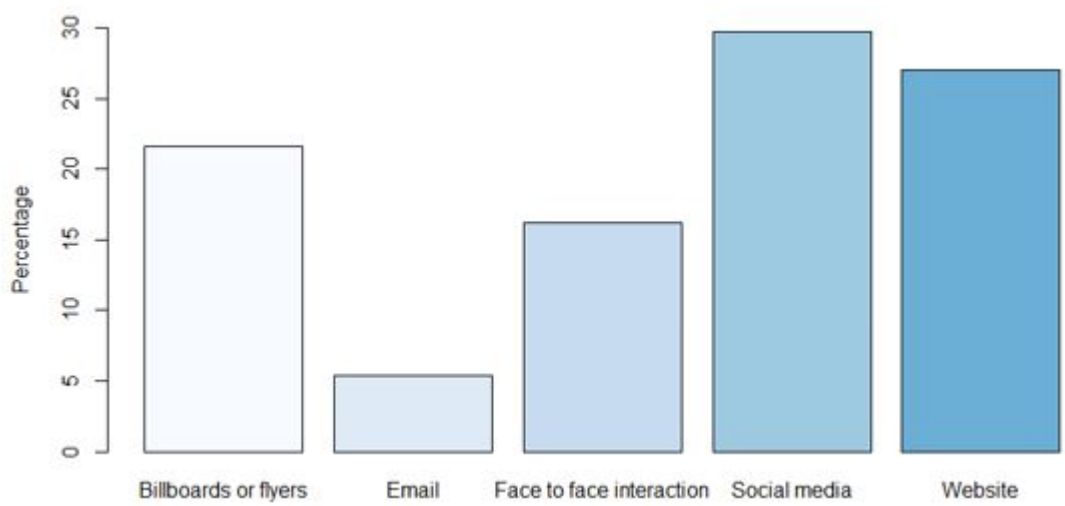
Figure 22: Survey Q10: Which one (preferred ways to hear about events) do you trust the most?

Question 18 of the survey address activities that the user may be interested to perform. The responses suggest that international students have an interest in cooking and eating activities with 80% interest. The other three categories are close together with 71% and 68% of interest. Music & concerts and movies & theater share the second positions while sports & dance activities have the third position. The results are in Figure 23.
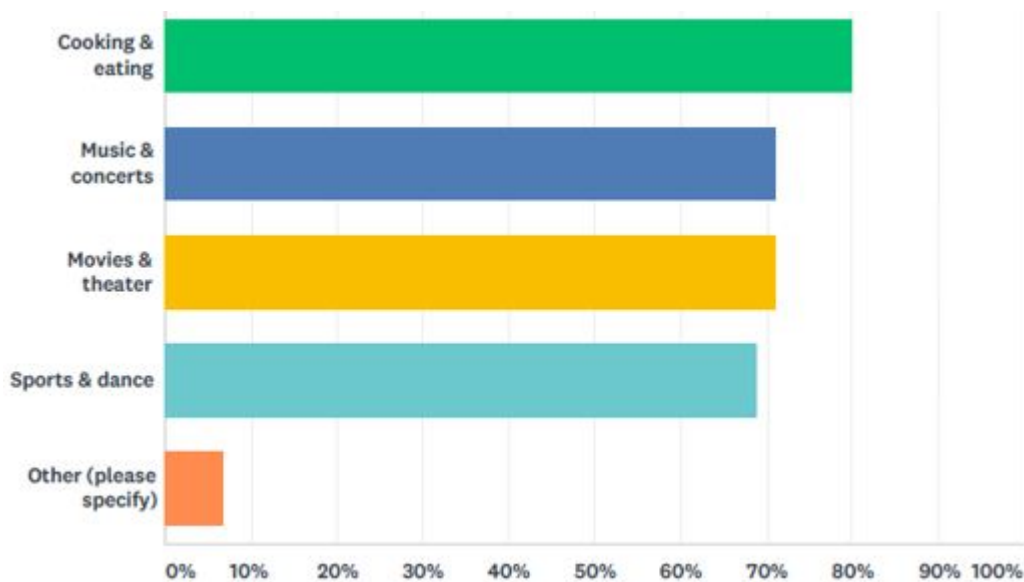
Figure 23: Survey Q18: What are the types of activities that you would like to participate in your free time?

The survey collects information directly related to the type of information that students are willing to share in question 21. Figure 24 has the results of this question. The data show that 84% of the participants are willing to share events (i.e. sports, games, parties). The second type of information is locations and landmarks with 71% of willingness while 'How to...' have a 62% in the third place. The rest of the categories are easy recipes, cultural information, and discounts or offers with 51% and 49% for the last two in a tie.
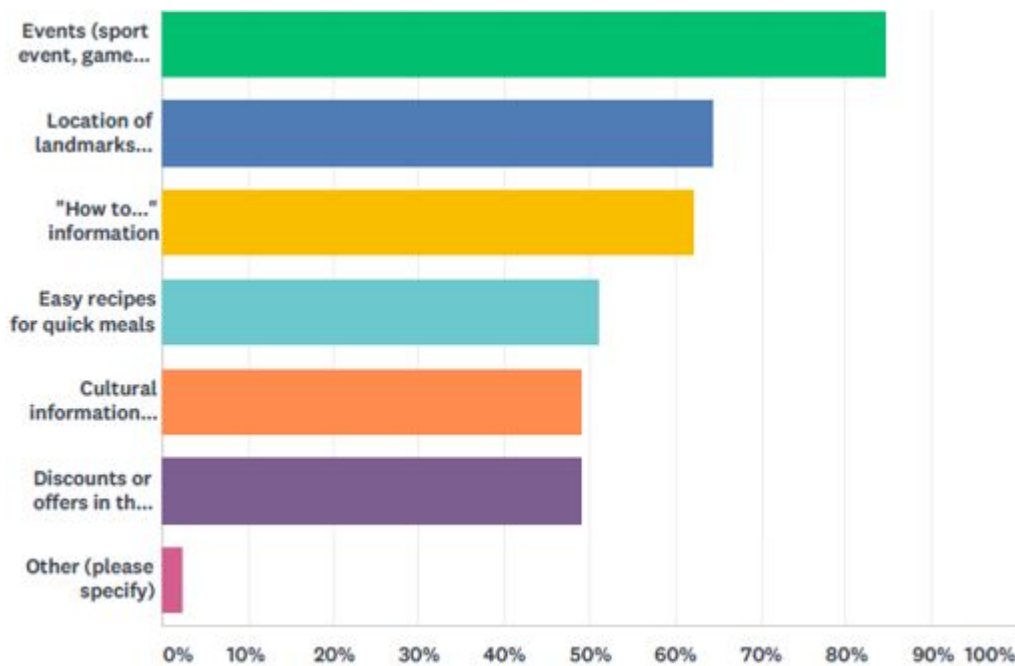
Figure 24: Survey Q21: What kind of information would you like to share with your neighbors/peers?

4.2 Artifact Outline

In order to have a proper artifact outline, it is necessary to review if an ICT artifact can be a good fit to create a community and address the four principles from the literature research (information, activities & space, multicultural approach, and key actors) to be successful in foster social interaction and connectedness among different groups. Also, it is necessary to introduce the preferences of the community expressed in the survey. Therefore, this chapter analyzes the feasibility of an ICT artifact to recreate community elements and contrasted with results from the survey. Then, it presents the feasibility of the artifact with respect to the main principles and survey's preferences. Finally, the results permit outlining the artifact which requires defining the type of ICT artifact and its description in general terms.

4.2.1 Elements of the Community

After the literature review, one of the problems identified is the lack of interaction and willingness. Therefore, it is necessary to design a solution that can stimulate international students to interact, share information, and in time develop a sense of community. McMillan and Chavis [1986] define four elements that define a

community and the ICT artifact should be able to incorporate them to improve the chances of fulfilling its goal: Membership, influence, integration & fulfillment, and shared emotional connection. Therefore, the artifact must be able to recreate the particularities of these elements.

First, membership is one of the elements that must be present. Therefore, a common symbol system must exit [McMillan and Chavis, 1986]. Language can be a symbol, however, in the case Delft international student community language can be a parting issue. Therefore, it is necessary to find a second symbol that represents all the groups. ICT has become universal in modern societies at a point where is almost unthinkable that people do not use any kind of ICT on a regular basis. At the same time, communications technologies as the Internet has not weakened nor transformed the community but enhanced their existing relationships [Hampton and Wellman, 2003]. On the other hand, the result of the survey conducted to Delft international students about the use of media sources and the frequency of use shows that the use of technology is present in all responders (See Annex C, page 137). *As a result, it is possible that an ICT solution can create membership and became a common symbol.*

Second, the sense of influence must be present in the community. Influence is a bidirectional relationship between the group/community and the individual [McMillan and Chavis, 1986] and related to the sense of matter. Moreover, people will contribute to a group if they believe that their efforts are needed in the group [Ren and Kraut, 2010]. In this sense, the proposed ICT solution must allow communication in a two-way fashion. Many online communities are based on the fundamentals of exchange information or engage in conversations. Furthermore, the users/members ask questions, exchange opinions and social support, and get to know each other [Ren and Kraut, 2010]. The result of the survey shows that the preferred way to receive information is social media, and for sharing information is messaging platforms after face to face interaction. Therefore, *using an ICT artifact to recreate influence through a two-way communication system is a viable solution.*

Third, integration and fulfillment of need are important for a sense of community belonging since they mean reinforcement [McMillan and Chavis, 1986]. Reinforcement is responsible for togetherness and provides the benefit of being part of the group [McMillan and Chavis, 1986]. The group of international students in Delft renovates itself over a 2-year period which means that it is always going to have newcomers. Newcomers will find beneficial to participate in community activities since in doing so, she/he will perceive gain from the community network [Shoji et al., 2010]. The use of an ICT application can provide a matching solution integration and fulfillment of need by allowing people to contribute with valuable information. Moreover, in a community scenario, the introduction of ICT

as a communication tool increase communication among the residents and a sense of familiarity [Hampton and Wellman, 2003]. The results of the survey (Question 21) reflect the broad spectrum of information that the participants are willing to share. Therefore, *an ICT artifact is a fit for sharing a broad range of information, recreating integration, and fulfillment of need.*

Fourth, shared an emotional connection is linked to shared histories, commonplace, time spending together, and similar experiences [McMillan and Chavis, 1986]. Therefore, the type of ICT solution must be able to recreate chances to connect with people that share common interests and focus on a specific location or group. Online services provide a new channel of communication that can increase the number of interactions among existing ties [Hampton and Wellman, 2003]. Therefore, an ICT artifact can recreate emotional connections among their users by allowing sharing information with known contacts and allowing the creation of events among users with the same interest. The result of the survey shows that participants trust social media and specific websites. *As a result, an ICT solution can provide an emotional connection based on trust and preferences of Delft international student community.*

Design research indicates that there are four types of artifacts: construct, model, method, or instantiation [Johannesson and Perjons, 2014]. In the case of IT systems, the choices are less since a construct is not possible. The results of this section require that the ICT artifact provides a sense of membership, two-way communications, allow sharing information and stimulate trust. Therefore, the type of ICT artifact can fulfill these functionalities is *an instantiation in the form of a device or application.* The next section provides more information to outline the ICT artifact.

4.2.2 Main Principles

The first review proves that an ICT artifact can replicate the elements of a community and provided the first direction in the outline of the artifact. The next step is a review of the main principles and their inclusion in the solution.

Information   There is a constant influx of newcomers into Delft and DUWO buildings stimulate by new acceptances to TU Delft. Initial communication and participation reduce the social distance between individuals, and normally newcomers are interested in initiate communication for the benefits [Shoji et al., 2010]. The use of an ICT artifact (i.e. social media, messaging platforms, websites) to establish first contacts is a good fit since the information exchanged can be easy and fast to communicate and understand.

ICT artifacts can display information from active and past members and provide different options to access the information. Allowing multiple voices from

different groups to be listened even after leaving Delft. The information collected from the survey indicates participant share text and pictures as favorite formats. An ICT solution can present several types of information thanks to integration with other systems using a layered modular architecture [Yoo et al., 2010]. Finally, *the versatility and modularity of an ICT platform can allow the content to be diverse and appealing to the multicultural reality of Delft international student community.*

Activities and Space Literature review point the lack of time and indifference as a barrier to participating in events proposed in traditional ways. However, allowing participants to co-create the events by having ownership can reverse the tendency. These events can have a positive impact on the collaborative spirit of the members and help them perceive their role in the community [Shoji et al., 2010] [Koh et al., 2007]. The survey addresses the topic barriers for participation, the results show that academic assignments are the main barrier since constrains the available time of the students. At the same time, limited physical space and cultural differences mark high as obstacles (See Annex C, page 147). Therefore, *it is important that ICT artifact allows students to co-create events according to their necessities or interest.*

Another aspect that can reduce the barriers for interaction and connectedness is the co-creation of space. ICT solutions are a good fit and can contribute to help people to interact outside their groups and increase the social capital in the neighborhood [Paulos and Goodman, 2004] [Hampton and Wellman, 2003]. As a result, since the creation of physical space is not possible for students, *the ICT artifact must allow international students living close to each other to share information about useful places in the neighborhood to interact.*

Multicultural Approach TU Delft is a world rank university that attracts talent from all over the world. Therefore, the international student community is diverse and as a result, heterogeneity is the norm with a multitude of different cultures are present. However, in heterogeneous networks willingness to share information is lower if the members are different, or in cases where the established connections are random [Larson, 2017]. This complex reality requires that *the ICT artifact creates a space where multiple visions and approaches can coexist and facilitate connections based on common interests. The ICT artifact can allow different digital spaces* under one platform depending on the interest of the users. The newcomers can choose to participate or contribute to an existing digital space or can create a new category.

Apart from allowing the expression of multiple voices an ICT platform can help to create an appropriate bonding space for multiculturality. Meetings in

free-space without a central control can allow participants to create social bonding outside of an existing social structure and develop specifically shared norms [von Krogh, 2011]. *The Internet and online platforms can be used as a free space where multiple perspectives can communicate in harmony.* Moreover, providing a safe place for expressing themselves would raise the awareness of other members and stimulate the curiosity for knowledge. The benefits are twofold: 1) The cultural differences should decrease, fixing one of the barriers for communication found in the survey (See Annex C, page 147), and 2) prevent community failures due to the lack of recognition of diverse and multiple interests of the actors in the community [Sacchetti and Campbell, 2015].

Key Actors   In the context of this research, key actors are international students that facilitate interaction and information sharing.

The situation in DUWO buildings resembles a multitude of familiar strangers. A familiar stranger is an individual usually observed but there is no interaction with her/him [Paulos and Goodman, 2004]. This scenario means that people recognize each other but choose not to engage. At the same time, Paulos and Goodman [2004] indicate that the same familiar strangers in an uncommon situation will not only stop ignoring each other but behave with extra familiarity. Therefore, an ICT solution can act as a proxy that triggers an out of the ordinary situation and allowing international students living in residential buildings to engage with each other.

Along with the familiar strangers, there are individuals that are part of several social networks and are easily recognizable among other members. These key individuals are known as sociometric stars [Chapin, 1950], and are important to stimulate the diffusion of information among members and lower the resistance to interact or start conversations. *ICT platforms also allow the exitance of well-known individuals or influencers.* Therefore, a platform that allows the rise of this key actors is a suitable fit as a solution.

The information presented in the previous section permit the identification of the type of ICT artifact as instantiation. However, this section provides a clearer identification. The ICT artifact should be an application that permits sharing information from different users in different digital spaces, create events, allow identification of landmarks, and permit the participants can be distinguished or rewarded. The selection of a device proposes more challenges than solutions. Therefore, an application that can use resources from existing hardware is more suitable. The type of application that can offer these functionalities is an ONLINE PLATFORM.

4.2.3 Online Platform

The information presented in this chapter justifies the selection of an online platform as the type of ICT artifact that can recreate the elements of a community and the capacity to include the main principles to foster interaction among heterogeneous groups and increment connectedness. The final step regarding the outline of the ICT artifact is reviewing how well this selection fits the reality of international students in Delft.

The results of the survey show that responders use different media to receive and share information. However, only the use of online platforms (YouTube) is universal by all the participants (See Annex C, page 137). This result provides support to the online platform as the ICT artifact.

The reduction of hardware, improvement in broadband communication, and the increment of power management have push novel capabilities in phones [Yoo et al., 2010]. The result is an almost constant use of smartphones and mobile capable applications in daily activities (i.e. entertainment, learning, social networking, driving) and places (i.e. schools, homes, cars) [Martin et al., 2018] [George et al., 2018] [Edgerly et al., 2018] [McCloskey et al., 2018]. On the other hand, responses from the participants about preferred communication ways and information show that participants use applications that run in mobile environments (Question 5, and 7). This means that *the solution must operate in mobile environments.* Online platforms have capitalized from technological improvements and are available for mobile environments covering this necessity.

The survey responses show that people have different barriers to establish communications (See Annex C, page 147). Therefore, the solution must allow not only sharing information but permit the users to create and schedule activities to increase the chances to interact with people that share the same interests. Nowadays, platforms use several channels and combinations of media to reach its users. Each channel is capable of customization depending on the preferences of the users [Shachaf, 2008]. Therefore, the needs of international students and the basic functionalities of an online platform are a good match.

The results of the survey show that an important segment of the responders has less than 4 people in their support network (See Annex C, page 147). The normal number of people in a support network must be higher than 4 [De Jong Gierveld et al., 2006]. Therefore, *the solution must help the users in the case support is needed.* Moreover, the solution must be capable to incorporate a range of options so the participants can feel at home and connected to a place of residence since this is directly related to human well-being [Williamson and Roberts, 2010]. An online platform can be a good match since the wide range of features that can be program. The responses from the survey may also show what kind of information participants are willing to share (See An-

nex C, page 152). An online platform can accommodate without problem this type of information but also can incorporate geolocation services. Shared information about physical places around the living place and information about the seasons cause a great effect on the participants [Williamson and Roberts, 2010].

Finally, the solution must be able to allow the user to actively participate. In this sense Nambisan and Nambisan [2013] propose some best practices that can be incorporated in the artifact to allow users to have a shared world-view: Provide a broad and historical perspective to create context and allow users to share their solutions, *provide web-based tools*, provide online and offline forums among actors, and connect different users with data to allow mashups. An online platform can incorporate all the principles presented.

The proposed solution based on the information collected from the literature and the responses of the sample group of Delft international student community is the creation of an online platform. The platform must connect the International student community in Delft. The online platform must be designed and tested to operate on a web-based environment to allow compatibility with different devices, operational systems (OS), and web-browsers. The platform must allow a sense of membership, two-way communications, incorporation of a positive narrative, and create benefits from its use. Finally, the platform must incorporate different communication channels, support different sharing format for send information and permit the creation of events and posting useful information.

4.3   Artifact Requirements

The platform's requirements should go in line with the problem that is going to solve [Johannesson and Perjons, 2014]. The purpose of the platform is improving social interaction and connectedness. However, it is necessary to breakdown this high-level requirement. During the outline of the ICT artifact, some functionalities of the online platform are presented. This information is the base to extract the requirements on a more concrete level.

On the other hand, it is also necessary to include information from previous research to elaborate a more complete list of requirements. Therefore, this section presents the knowledge base from previous approaches.

4.3.1   Knowledge Base

Previous research about community well-being, resilient communities, communal resources management, build environment creation, and health care addresses the problem of community engagement. Furthermore, some research addresses the role of ICT to improve current situations and provide some guidelines. Relevant information to elicit requirements is next.

Flexibility   The online platform must be able to *handle multiple sessions of activities* to provide different schedules and accommodate as many participants as possible [Burkhart-Kriesel et al., 2019]. Experiment with new forms of authentic participation that cannot only involve a small portion of a participant but all of them [Derr et al., 2018].

In order to have long-term participation, activities require connection with daily needs, and co-creation [Kitagawa, 2019]. The events put in place should be embedded in daily life activities, stimulate collaboration, repetitively, address various aspects, and serve the local population in a unique way and must be enjoyable [Kitagawa, 2019].

Information   There are several actions that can help to communicate the correct information. Burkhart-Kriesel et al. [2019] propose four actions to improve the community attractiveness: 1) promote the community strengths, 2) *create a welcoming atmosphere*, 3) develop comprehensive storytelling with the support of an application, and 4) enhance marketability.

It is not enough to have the information translated, it is necessary to really understand the differences in the communities to have the correct information available [MacDonnell et al., 2017]. The platform must use the correct language to address the participants [Derr et al., 2018].

In communities with a short number of members, these members tend to share information about their activities with their peers [Shoji et al., 2010].

Online communities are based on sharing information, however, too much information or off-topic information can damage the participation [Ren and Kraut, 2010]. In order to control these issues, some communities have *implemented moderation control techniques or user ratings*.

Knowledge of the Community   It requires a deep knowledge of the local community to understand how to influence its members to act [Bach et al., 2015]. Useful information can change in time with the composition of the community. Also, it is necessary to recognize the time and scale of the cultural changes that are going to be implemented [Derr et al., 2018]. Therefore, *the platform must be able to archive the information that is no longer relevant.*

Communication   Making an impact in the community requires a coherent narrative that can capture the concerns of those who are affected and propose solutions to the issues in a credible story [Goldstein et al., 2015]. Therefore, *the content of the platform must have a positive message and guide users to provide useful information towards others.*

Placemaking   Creative placemaking can elevate the identity of the place by enhancing its existence using a collection of visual, cultural, social, and environmental qualities that inspire the community to be engaged [Kelkar and Spinelli, 2016]. An online platform can *allow users to place geo-references* to create their own expressions (i.e. paths for relaxation, explore urban graffiti). It is possible to have an attractive space implementing features related to the physical space that awakens the curiosity of the people.

Governance   A sustainable virtual community requires four main principles: clear purpose, the definition of members' roles, leadership by community moderators, and online/offline events [Koh et al., 2007]. Therefore, *the platform should have access levels to create different roles* complementing the spirit of the bottom-up approach.

The application must foster communication and networking among different users [Comes, 2016]. There is also the necessity to *educate the participants* in the use of technology and encourage them to play active roles [Comes, 2016].

Governance must be able to shape and influence the system [Tiwana, 2013]. Therefore, it is necessary to monitor the activity of the platform first. Offline interaction is related to posting activity, and usefulness is linked to viewing activity [Koh et al., 2007]. Therefore, *the platform must be able to track the posting and viewing activity of the users.*

Community moderation tends to be less effective in cases where the community have a diverse interest since communications are diverse in content [Ren and Kraut, 2010]. On the other hand, personalized moderation implies *personalization of the user's content* in an online community. This type of control increases the satisfaction and interest of the users and reduce information overload, as a result, these controls improve participation [Ren and Kraut, 2010]. Therefore, implementing personalized moderation is a restriction for the free exchange of information.

Members of a virtual community are stimulated to remain active if they find information sharing and emotional ties [Suh et al., 2015]. The formation of cliques is based on own interest, purposes, and preferences [Suh et al., 2015], therefore, it is possible to retain all emotional ties in the cliques and fulfill the information exchange requirements. However, when the size of the clique increases, the desire to share information grows, but the emotional ties decrease [Suh et al., 2015]. Therefore, it is important to create a community inside the platform with cliques that retain the members, but at the same time, it is necessary to *manage the number of participants* in a clique to avoid members' oversize. This functionality is a restriction since suggest restricting the size of the groups.

Also, it is important to address the technical factors of the system as well, like

stability, speed, and capability of the software to stimulate discussion. Moreover, *the platform must achieve a high level of availability* and high IT infrastructure quality. If the physical attributes of the system are not in line with the needs of the user, the platform becomes an impediment [Koh et al., 2007].

Promoting citizen engagement and co-creation associated with an innovative environment requires defining strategies to fit the approach and innovation [Nambisan and Nambisan, 2013]. Therefore, *the solution requires a process to complement the artifact.*

4.3.2 Requirements

The information presented in previous sections of the document provides the base to create the requirements of the online platform including the outline of the platform. Figure 25 shows the hierarchical elaboration of requirements. The result is a list of 20 requirements. Table 2 is a complement to the list and it contributes with details of the requirements, indicating their status (i.e. functional, non-functional), background (i.e. from theory, from the survey), and if it is a restriction.

Foster interaction and connectedness

1 Recreate membership
- 1.1 Allow registration of members
- 1.2 Allow user's roles with access levels

2. Stimulate information sharing
- 2.1 Include useful information
- 2.2 Support multiple communication channels

3 Stimulate trust
- 3.1 Protect personal data
- 3.2 Present a clear interface
- 3.3 Implement a robust infrastructure
- 3.4 Incorporate narratives
- 3.5 Use positive message
- 3.6 Manage number of participants
- 3.7 Allow personalization of user's content

4 Support activities & space
- 4.1 Allow the creation of user's events
- 4.2 Support multiple digital spaces
- 4.3 Support location sharing

5 Implement a multicultural approach
- 5.1 Allow free expressions of users
- 5.2 Store data from members
- 5.3 allow different sharing formats

6 Support key actors
- 6.1 create a process to promote the artifact
- 6.2 Track posting & viewing activity

7 Support mobile environment
- 7.1 Implement web-based tools

Figure 25: Online platform requirements

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The requirements of the platform have 7 categories and are elaborate from the information presented previously including the results of the survey. However, some requirements are closely related. Therefore, in the process of creating a hierarchy, it is possible to see only the resulting requirements. The platform must:

- R1. Allow registration of members

- R2. Allow user's roles with access levels

- R3. Include useful information

- R4. Support multiple communication channels

- R5. Protect personal data

- R6. Present a clear interface

- R7. Implement a robust infrastructure

- R8. Incorporate narratives

- R9. Use a positive message

- R10. Manage the number of participants in events or groups

- R11. Allow personalization of user's content

- R12. Allow the creation of user's events

- R13. Support multiple digital spaces

- R14. Support location sharing

- R15. Allow free expressions of users

- R16. Store data from members

- R17. Allow different sharing formats (picture, text, video)

- R18. Create a process to promote the artifact

- R19. Track posting & viewing activity

- R20. Implement web-based tools

Table 2: Online platform requirements' details

Functional Requirements			Non-functional Requirements		
Req.	Literature	Survey	Req.	Literature	Survey
R1	Community [McMillan and Chavis, 1986]	Annex C, page 137	R2	Governance [Koh et al., 2007]	
R3	Community [McMillan and Chavis, 1986], online platform [De Jong Gierveld et al., 2006]	Annex C, page 152	R6	Information [Burkhart-Kriesel et al., 2019]	
R4	Community [McMillan and Chavis, 1986], information [Bach et al., 2015], online platform [Shachaf, 2008], social capital [Chu, 2009] [Mathwick and Klebba, 2003]	Annex C, page 138,139, 140, 143	R7*	Governance [Koh et al., 2007]	
R5	Communication [Goldstein et al., 2015], GDRP [Trunomi, 2019]	Annex C, page 139, 143	R9	Information [Burkhart-Kriesel et al., 2019]	
R8	Community [McMillan and Chavis, 1986], information [Burkhart-Kriesel et al., 2019], communication [Goldstein et al., 2015]		R10*	Governance [Suh et al., 2015]	
R11	Governance [Ren and Kraut, 2010]		R13	Flexibility [Burkhart-Kriesel et al., 2019][Kelkar and Spinelli, 2016], multicultural approach [Wali et al., 2017], information [Shoji et al., 2010]	
R12	Flexibility [Burkhart-Kriesel et al., 2019] [Kitagawa, 2019], Activity & Space [Kelkar and Spinelli, 2016] [MacDonnell et al., 2017] [Sacchetti and Campbell, 2015]	Annex C, page 152	R18	Governance [Comes, 2016]	
R14	Activity & Space [Paulos & Goodman, 2004] [Hampton et al., 2003]		R20*	Online platform [Nambisan and Nambisan, 2013]	Annex C, page 137
R15	Multicultural approach [von Krogh, 2011]				
R16	Knowledge of the community [Bach et al., 2015] [Derr et al., 2018]				
R17	Placemaking [Kelkar and Spinelli, 2016], Activities & Space [Goldstein et al., 2015][Sacchetti and Campbell, 2015]	Annex C, page 141,152			
R19	Governance [Koh et al., 2007], Information [Ren and Kraut, 2010]	Annex C, page 138, 140			
* Constraint					

Finally, after the elaboration of the requirements, it is necessary to present complementary information that provides support in the demonstration and evaluation of the artifact. In this case, the requirements of the online platform are a starting point to elaborate operational issues, the measure of effectiveness and measure of performance. Table 3 presents this information in connection with the

requirements.

Table 3: Operational issues and measure of requirements

Req.	Operational issue	Measure of effectiveness	Measure of performance
R1	Create a sign-up section	# of users	At least 20 users
R2	Create access levels	# of levels	At least 1 admin, 1 supervisor, 18 users
R3	Create categories with prese-lect topics	# of support topics	At least 1 support topic
R4	Implement diverse methods for send info	# of methods	At least 2 methods
R5	Implement security measures	# of irregular access	Less than 1 irregular access during operation
R6	Implement a simple outline and no distraction	# of paragraphs, # of colors	Less than 5 paragraphs, less than 5 colors
R7	Implement modular compo-nents	# of failures of modules	Less than 1 failures during op-eration
R8	Allow inputs with no restric-tion of characters	# of characters allowed	At least 1000 characters
R9	Include information about ben-efits and community	# of sections promoting collab-oration	At least 1 per digital space
R10	Perform a count of event assis-tance	# of registrations per event	Less than 10 per event
R11	Permit users to select the type of information	# of options	At least 3 options
R12	Implementing modules that support the event's creation	# of modules that create events	At least 1 module
R13	Create different sections for in-teractions	# of services	At least 3 services
R14	Interaction with external geo-references platforms	# of geo-reference platforms	At least 1 platform
R15	Allow a free range of topics	# of topics	At least 5
R16	Implementing databases	# of GB of storage	At least 500 GB during opera-tion
R17	Support different inputs	# of input formats	At least 3 (text, images, and video)
R18	Create a process to invite po-tential users	# of process	At least 1 process
R19	Implement counters for inputs and interactions	(# of posts, # of comments), and (# of views, # of likes)	At least 10 inputs and 20 ac-tivities
R20	Implement functionalities based on standards	# of web-based standards	At least 4 (IP/DNS/JAVA/HTML5)

5 Artifact Design and Development

Designing and development an artifact has as end-result an artifact that fulfills the system requirements and addresses the analyzed problem [Johannesson and Perjons, 2014]. Designing the artifact requires to identify the functions and structure of the solution that match the requirements. Also, designing the online platform requires technical information to support the design. Therefore, this chapter introduces some concepts to understand the components of a platform.

This section introduces the concepts of platforms and ecosystems. Then elaborates the different components of the platform based on the requirements. Finally, the last section elaborates on the development and practical implementation.

5.1 Platforms and Ecosystems

One of the first steps to design and develop the online platform is having a technical understanding of platforms. The platform is a product or service based on software that allows external parties to build complementary product or services [Tiwana, 2013]. Furthermore, a platform facilitates interactions between at least two distinct groups [De Reuver et al., 2018]. Finally, a digital product can become a platform if it has a layered modular architecture [Yoo et al., 2010]. On the other hand, an ecosystem is the collection of the platform and software services that interact to extend the functionality of the platform [Tiwana, 2013]. The ecosystem includes developers, end-users, and other intermediaries. The definitions match the artifact outline presented in the previous chapter.

The online platform connects master international students from different nationalities and different academic years. Also, international students can act as end-users and content generators. Therefore, the conditions suggest that more than one group is going to use the platform.

Requirements R7 and R13 aim for robust infrastructure and the implementation of multiple digital spaces. The layered modular architecture match R7 and support the connection with other services or modules. At the same time, R13 requires implementing different services to provide different digital spaces. These spaces can be designed as different modules providing different services. In the next section, the design of the platform's component takes place.

5.2 Platform Components

After defining the type of platform and its ecosystem, it is necessary to define the design options for the components of a platform. Tiwana [2013] indicates that the two main pillars of every platform are the architecture and its governance.

Therefore, previous the description of the modules, a brief explanation and defini-
tions about the architecture and the governance is in place. The design options for
the architecture and governance use requirements and literature as a guide. After
present the design for the platform's architecture and governance, this chapter
presents the design of the platform modules.

5.2.1 Architecture

A modular architecture can reduce complexity and give flexibility to the solution
by decomposing the product in loosely coupled components interconnected via
standard interfaces [Yoo et al., 2010]. As a result, the solution uses a modular
architecture with four layers typical of digital products.
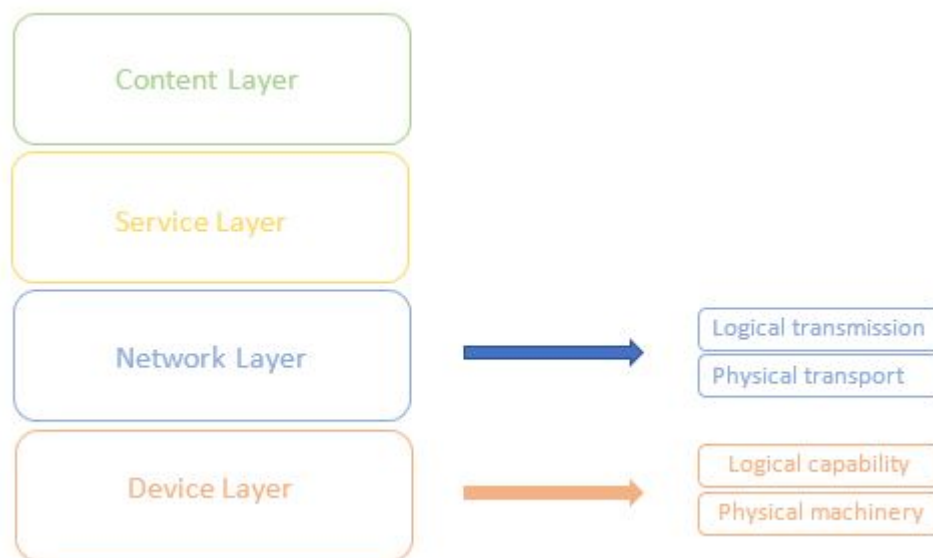
Figure 26: The modular layered architecture. Adapted from [Yoo et al., 2010]

Figure 26 shows the four layers of the modular architecture, the platform design
addresses all layers and sublayers. Defining these layers is a necessity not only for
requirements R7 and R13, but for requirements R4, R16, and R20. *These require-
ments aim for the implementation of multiple communication channels, storage for
data, and the implementation of the platform using web-based tools.* The decisions
about the platform's layers in this section of the design have an impact in the rest
of the requirements.

The first layer or device layer has two sublayers that are the physical machinery
and the logical capability. Implementing a web-based platform means that the so-
lution is agnostic of both since it will only consume the resources of the sublayers.

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In order to store data, and establish communication channels, the physical device should have processing/storage capacity and a suitable OS that access those resources. Therefore, the platform could run in a cloud environment or a traditional environment.

Second, the network layer also has two sublayers, the logical transmission and physical transport. In order to secure multiple communication channels, it is necessary to have a physical connection to the internet and run standard protocols TCP/IP.

Third, the service layer is an intermediary layer that connects the lower layer with the content. Therefore, following requirement 20, it is necessary that this layer uses standard protocols to warranty interconnection between layers and support web-based services and tools.

The last layer deals with data. Requirement 16 specify the platform must store data from its users for presentation. Therefore, this layer must also run under the standard to allow storage and presentation of different types of data.

Applications or software services are the complement of the platform and together form the ecosystem [De Reuver et al., 2018]. The applications are on the user side and have their own internal structure or microarchitecture. The microarchitecture influences the way the application connects to the platform [Tiwana, 2013].

Figure 27: Application Microarchitecture

Figure 27 presents the four elements of the application microarchitecture. The presentation logic element is the part of the application that receives inputs from

the user and displays the outputs of the application. The application logic has the main functionality of the application (i.e. video conference applications and the video streaming feature) [Tiwana, 2013]. Data access logic handles the exchange of data and the connections with databases. Finally, the data storage element is self-explanatory. Designing the microarchitecture requires the correct allocation of the four elements. Usually, these elements are distributed between the client and the server, and connected through the Internet [Tiwana, 2013]. Fulfilling requirements R20 and 16 means giving a great level of freedom to the users in terms of devices that can access the system. Therefore, the microarchitecture selected for the application is a cloud microarchitecture.
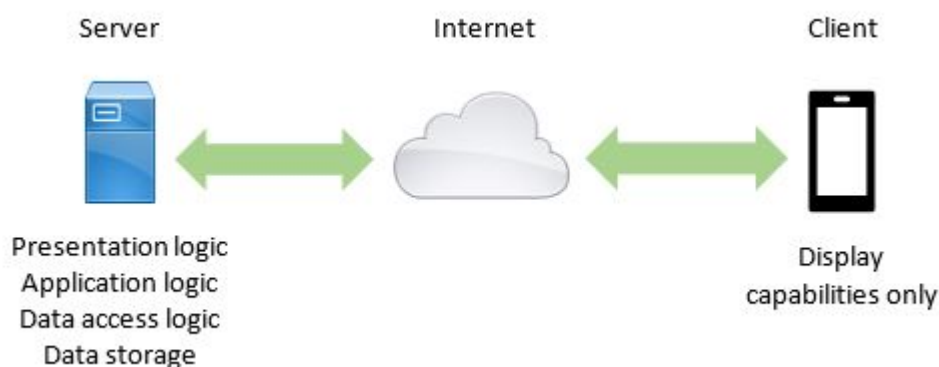
Figure 28: Cloud microarchitecture

The cloud microarchitecture put all four elements on the server-side, making the user device a *'dumb'* terminal [Tiwana, 2013]. The user side is a display that presents the inputs and output to the user. Therefore, the users have access to the platform from any device with basic processing/storage capabilities and any capable OS. Users require access to the Internet. Figure 28 shows the basic scheme of cloud microarchitecture.

5.2.2 Governance

The governance of a platform requires shape and influence the ecosystem but not direct it [Tiwana, 2013]. Therefore, the platform must display influence over the parties that cannot control. Architecture and governance behave like a mirror, the former reduce structural complexity and the later reduce behavioral complexity. There are four control mechanisms that platforms can use: gatekeeping, process control, control using metrics, and relational control [Tiwana, 2013]. First, gate-keeping deals with the criteria about who can access the platform. Second, process

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control deals with the degree of rewards or punishments that exits in the platform based on rules and procedures. Third, control using metrics is like the process control but based on metrics from the platform. Fourth, relational control is related to the use of norms and values in the platform to influence behavior.

Requirements R1, R15, and R19 aim for the capacity of register members, allow free expression from users, and track post and view activities from users. Therefore, the platform must allow the registration of international master students attending TU Delft only. Also, the platform must offer rewards to its members for posting activity by making public the monitoring activity like views or likes. The platform does not require the implementation of a metric control since there is no explicit parameter to reach. Finally, the platform must guide the users in the right direction without putting any rules on display or punishment.

5.2.3 Modules

The online platform requires a modular design to reduce the complexity generated by the different requirements of the system. A modular design resembles a Lego-like design [Tiwana, 2013] where different pieces cope with different requirements.

Table 4: Modules and requirements of the platform

Module	Submodule	Requirement
Backbone	Backend communication	R4, R7
	Database	R5, R7, R16
Frontend		R6, R7, R9, R14, R15*, R17
Authentication	Sign up	R1, R2, R5
	Accounts	R1, R2
	Sign in	R1, R2, R5
Membership	Notifications	R19
	Settings	R11
	Profile	R8
	Contribution	R19
Blog		R3, R4, R8, R13
Scheduler		R3, R4, R10*, R12, R13, R14
Forum		R3, R4, R8, R13
Chat		R3, R4, R13
Privacy	Cookie control	R5
	Information	R5
Contact form	Form	R4
	Privacy policy acceptance	R5
	Verification	R5
*partial fulfillment		

Table 4 has the main modules/submodules of the platform and the requirements of the system. Requirements do not match one-to-one to modules/submodules.

Furthermore, fulfill some requirements demand the functionality of more than one module/submodule at the same time. In some cases, technical limitations or trade-offs with other requirements do not permit total fulfillment of some requirements. Finally, *the first two modules: backbone, and frontend are the main platform and the other modules operate like applications.* Therefore, configuring/updating one of the modules does not disrupt the operation of other modules. However, the authentication service is the base for accessing certain functionalities of the platform. As a result, interrupting this service causes failure to access certain services of the platform. The rest of this section introduces all modules/submodules and their connections with the requirements.

Backbone   The requirements related to this module of the platform are *R4, R5, R7, and R16. The requirements look for multiple communication channels, protect personal data, a modular architecture, store data from the users.* Requirement R5 introduces a new variable to the main module of the platform. The protection of data means that this module must be ready to include security measures or allow connection with other modules to create the necessary protection. Therefore, the platform must be able to create the correct ecosystem to fulfill those requirements. Also, stored data in the must be available to other modules via internal communications.

Table 5: Requirements for backbone module

Module	Submodule	Requirement
Backbone	Backend communication	R4, R7
	Database	R5, R7, R16

The backbone module is the core of the platform and works with the frontend module hand to hand to allow the interaction of different modules and the users. *The main purpose of this module is allowing the communication between different modules and access the information in the database enabling modularity (R7).* Therefore, the backbone has two submodules: 1) backend communication, and 2) database. *The backbone runs universal protocols and oversee connections in (between applications) and out (between end users) of the platform (R4).* The backbone module running HTML5 enables other applications to run in the browsers of mobile devices [De Reuver et al., 2018]. Therefore, this module runs in the four layers of the architecture (device, network, service, and content) to have access to the device and network layers resources and allow integration with other modules using standard protocols of the service and content layers. On the other hand, the second module is responsible for the database and its connections with other modules. *The database will store information about the users and preference of the system (R16).* Furthermore, *data must be secure and centralized to avoid that*

other applications of the platform collect information independently (R5). Finally, this module must manage the data in order to comply with GDPR directives like delete information at the request of the user [Trunomi, 2019].

Frontend Requirements *R6, R7, R9, R14, R15, and R17 suggest the platform must support show a clear and attractive interface, interact with other modules, including a positive message, support georeferencing, present different information to the users, and support different information formats.* Therefore, the frontend module must present the outputs of all other modules in a single united presentation. A display module that supports the interaction between the user's inputs and the application outputs provides a perfect fit to standardize the way the users see the information in different devices (Laptops, tablets, smartphones). Furthermore, having a module that handles visualization of all other modules permits the creation of a uniform layout to stimulate interaction. Art (visual expressions) in a microscale serve as a catalyst for engaging people in different topics [Kelkar and Spinelli, 2016].

Table 6: Requirements for frontend module

Module	Requirement
Frontend	R6, R7, R9, R14, R15*, R17

The frontend has no submodules and is in charge to support the interaction between users and different modules of the platform. *The frontend must present a minimalistic look to present only the most important information, restricting the number of colors to avoid distractions and provide different layouts to create a visually appealing look (R6).* There must be a connection between the frontend and the backbone to access other modules (R7). Also, *the frontend must support text, pictures, or videos (R17) to display positive messages using visual expressions for maximum impact (R9).* The frontend must be able to display georeferencing information from external platforms (R14) or links to these sites. At the same time, the module must be able to present information independently of the screen size of the user's device. The module should be able to detect the type of device and resize the content or modify the order of the elements without losing valuable information. Finally, *the combination of all these features must be able to stimulate the user to post diverse information in a free manner (R15).* In groups, enforcing functional norms is possible only if the norms are for the interest of the members [Kitts, 2006]. The information available on the platform and other user's content should guide users of the system to post diverse information. Therefore, fulfill requirement 15 is a combined task of all other features and a choice of the user, as a result, it is partially accomplished.

Authentication Requirements *R1, R2, and R5 aim for the register members, provide different access levels and protect personal data.* In heterogeneous groups to have a functional community and integration, it is necessary for boundaries to create distances between members and non-members [McMillan and Chavis, 1986]. Therefore, the platform requires a module that authenticates users and control access to certain sections of the platform. Also, implementing registration enables a secure environment to handle the data that users share in the platform and gives control over accessing the content.

Table 7: Requirements for authentication module

Module	Submodule	Requirement
Authentication	Sign up	R1, R2, R5
	Accounts	R1, R2
	Sign in	R1, R2, R5

The authentication module has three submodules: 1) Sign up, 2) accounts and 3) sign in. Each of the modules oversees the accomplishment of one of the main goals of the module. *The sign-up submodule must collect general information of the visitors in case they desire to become members (R1).* The basic information required to become a member is a valid email account and a password to secure their own data. The accounts submodule creates a profile/account after the visitors submit the information. *The profile of the user has the main attributes associated with the user and permit the selection of different roles and allowing access to different features (R2).* Moreover, the user can add more information depending on their own interests. Finally, *the sign-in submodule verifies the account email and the password to allow access to member-only sections of the platform (R5).*

Membership Requirements *R8, R11, and R19 aim for incorporate narratives to communicate information, permit users to select the type of information that they receive to avoid overload, and track incentives for the users (post and views).* Therefore, the platform requires the implementation of communication among the members with no restrictions in terms of format and length of the messages. Moreover, it is necessary that members can express their personality if wanted. On the other hand, the platform must include functionalities that permit take actions in the case that the user's behavior goes against the platform's norms [Rivera et al., 2017]. Allowing users to personalize their preferences help to maintain self-control about the information posted. Finally, motivating the members of an online community requires tangible (money) or intangible (public recognition) means, selecting one or the other depends on the nature of the community [Antikainen and Vaataja, 2015]. In this case, the platform requires intangible means as rewards since the platform seeks for societal improvement. However, to

be able to provide public recognition, not only the mechanisms must be in place, but it is also necessary to track and display the recognition of the members.

Table 8: Requirements for membership module

Module	Submodule	Requirement
Membership	Notifications	R19
	Settings	R11
	Profile	R8
	Contribution	R19

The membership module has four submodules: 1) contribution, 2) profile, 3) notification and 4) settings. First, *the notifications submodule provides a recognition system, allowing users to review likes or responses to their activities (R19).* Second, *the settings submodule controls notifications that members receive and personalize the input content based on their interest (R11).* Third, *the profile submodule allows the personalization of the member's profile, expanding the information and the ways that a user can include narratives (RR8).* Finally, *the contribution submodule allows participants to react directly to other members activities (R19).*

Blog Requirements *R3, R4, R8, and R13 look for the incorporation of useful information, multiple communication channels, narratives, and multiple digital spaces.* A platform can create usefulness to the members by providing a functional interactive design [Rivera et al., 2017]. Also, the platform requires that users post information that is useful to others. Therefore, it is necessary for a combination of interactivity and proper information. An interactive design delivers sophisticated communication tools for user interaction. Narratives are storytelling about lived experiences [Bamber, 2016] which requires that the communications channels support the publication of diverse content and forms. Finally, the chances to interact with other users is higher when there are multiple services. In this case, *the blog work as one of four digital spaces associated with a service (R13).*

Table 9: Requirements for blog module

Module	Requirement
Blog	R3, R4, R8, R13

The main purpose of the blog module is *allowing users to create meaningful content that conveys a story to other members (R3).* Furthermore, members of the platform can interact with these stories to enhance contributions. Therefore, *the module allows members to create their own content without restrictions or predefine standards (open topics) (R8).* Also, the blog must allow the use of text, images,

and other digital resources to create attractive posts that match the identity of the creator and can be useful to others. Moreover, the information created in the blog is not only available to the members but general visitors to increase visualization of the content. Finally, *the module should allow other members to interact with the content and the creator via direct responses or reactions (R4).*

Scheduler *Requirements R3, R4, R10, R12, R13, and R14 aim to incorporate useful information, multiple communication channels, manage the number of participants in events, allow participants to create their own events, including multiple digital spaces, and support location sharing.* Therefore, some requirements are the same from previous modules R3, R4, and R13 and its justification are the same. On the other hand, a platform wanting to achieve a connection to broad socio-cultural issues must address its activity in terms of geographical reach, information, and activities [Rivera et al., 2017]. Also, people still require physical connections among them, as well as digital connections [Hampton and Wellman, 2003]. Finally, managing the number of members attending online/offline events allows delivering a positive experience.

Table 10: Requirements for scheduler module

Module	Requirement
Scheduler	R3, R4, R10*, R12, R13, R14

The scheduler module allows members of the platform to create and promote their own events to interact online or offline (R12). Therefore, this module must *allow the selection of an upcoming date and linked to a physical space in case that is necessary (R14).* Moreover, the platform should permit to the owner of the event create a description of the event using text, pictures or hyperlinks to improve the attractiveness of the occasion. Finally, *the scheduler must include a tracking section répondez s'il vous plaît (RSVP) to manage the assistance (R10).* The information requested by this module must be minimum but enough to get in contact with the attendees. The complete fulfillment of requirement 10 is not possible since participants can show at events without using the RSVP service.

Forum *Requirements R3, R4, R8, and R13 look for including useful information, multiple communication channels, narratives, and multiple digital spaces.* The list of requirements is the same as the blog. Therefore, some key points are in this module that makes the difference between the forum and the blog. The forum module needs the incorporation of a quick way to communicate with others, the creation of a repository of useful and trivial information. Rivera et al. [2017] conduct a study of design and user interface of different platforms, one of the basic

functions is the capacity to post offers and reply to the offerings. Therefore, this communication exchange must be quick and simple. Attempts to improve social behavior and provide benefits to the community like in preparedness scenarios begin by understanding what the daily activities of the communities are, their interest, and needs [Kitagawa, 2019].

Table 11: Requirements for forum module

Module	Requirement
Forum	R3, R4, R8, R13

The forum module provides an easy and fast communication channel between members to share diverse information (R3). Therefore, *the implementation of the forum must allow sharing free expression of daily activities or valuable information arranged in categories (R8). The forum must allow interaction among the members to get responses or comments and improve the information in the platform (R4).* At the same time, *the forum must allow a search section to find information based on the interest of the members and follow this information if desired (R3).* The module must allow the integration of multiple formats in the messages to permit customization and include useful information or reference to external sites. Finally, *this module is one of the digital spaces created for the interaction of users (R13).*

Chat Requirements *R3, R4, and R13 look for introducing useful information, multiple communication channels and multiple digital spaces.* Therefore, the requirements are close to previous modules. In this case, the information presented focus on the unique attributes of the module.

Table 12: Requirements for chat module

Module	Requirement
Chat	R3, R4, R13

The chat module has as a goal exchange information between members in real-time to improve their interaction (R3 and R4). Therefore, the module must allow the communication of short messages. The module must be capable to recreate basic functionalities of other chat application, but the information must be available only during the duration of the session. *This is the last module that provides a different digital space for user's interaction (R13).*

Privacy *Requirement R5 aim for the protection of personal data.* Applications that have good privacy and security protection mechanisms in place experience more interest and enthusiastic interactions from their users [Fang et al., 2017].

Improving the community requires education by communicating theories and the use of technology [Comes, 2016]. Therefore, the platform must protect the data, but at the same time, complain about regulations and provide information about the information that collects and inform the users if needed.

Table 13: Requirements for privacy module

Privacy	Cookie control	R5
	Information	R5

The privacy module has 2 submodules: 1) cookie control, and 2) information. *The first module informs about the collection of data and collects consents. Also, this module works with the database to eliminate data from the platform by the user's request (R5).* The second module communicates users about privacy policies and technical features before submission of information. *Privacy of the members starts by not collecting information that is not necessary for operation (R5).* However, the collection of information (i.e. required for operation, or given voluntarily) is in comply with GDPR guides.

Contact Form Requirements R4 and R5 look for implementing multiple communication channels and protect personal data. This module is a complement to the communication channels that provide communication between users. The module provides communication between users and the manager(s) of the platform. At the same time, this communication channel is open to no members. Therefore, the information provided in this module must follow the necessary regulations.

Table 14: Requirements for contact form module

Module	Submodule	Requirement
Contact form	Form	R4
	Privacy policy acceptance	R5
	Verification	R5

The module has three submodules: 1) form, 2) privacy policy acceptance, and 3) verification. *The first submodule allows communication between users and the owners or maintainers of the site (R4).* Also, the communications must allow free topics like a request of information, the creation of a new digital space or category, or report any problems. *The second submodules collect the consent to use any personal data for contact purposes (R5).* Finally, the last submodule implements *verification to avoid the generation of spam and to improve the level of trust about the use of technology (R5).*

5.3 Development and Practical Implementation

The modules of the platform and their main functions provide a guide for practical implementation. The development of the platform deals with the technical construction of the platform. On the other hand, the practical implementation deals with the process of putting the platform online and restrictions the system inherit due to practical or social issues. Therefore, this part of the document presents both sides in a complementary form.

5.3.1 Platform and Ecosystem

The technical solution requires coding the platform's backbone and later the applications or modules that provide different functionalities. Another solution is the use of open-source or proprietary modules to speed the deployment of the application. Since the development of the platform from scratch is not part of this research, *the platform and applications/modules use a proprietary solution.* The solution selected is WIX based on the main features of the solution that include customizable main structure, application market, and mobile optimization [WIX, 2019].

In terms of connectivity, the platform requires access to a broadband connection and IP requirements to allow the service to be visible on the Internet. However, the same nature of putting the platform online create security concerns. Therefore, the implementation uses the connectivity (2 Gbps of Internet connection) and security solution provided by WIX.

The implementation of the platform requires capturing information and metrics about the behavior of the participants. Offline interaction is significantly related to posting activity, and usefulness to viewing activity [Koh et al., 2007]. Therefore, the platform provides two types of information: 1) general use of the platform, and 2) information about individual preferences. The first metric can provide information about the number of visits to side, and the number of contributions in the platform (i.e. number of posts, blogs, and events). The second can provide information about individual posting and networking activity (i.e. following activity, views, and likes).

5.3.2 Architecture

Implementing the platform requires following the design choices in every layer of the architecture and the microarchitecture. WIX cloud service provides the solution for the four layers and is compatible with the design choices. The service provided by WIX support protocols and standards (HTML5, SSL, SSH, Java, DNS) and provide APIs for integration with other applications. However, the service provided by WIX uses a proprietary code which restricts access to the

source code. On the other hand, WIX certifies the integration and compatibility of the application reducing the time of implementation. In case that an application or service is not available, it is possible to create code to find workarounds or establish connections with third parties' applications [WIX, 2019]. Also, a public domain (**delftcommunity.nl**) linked to DNS services points to the cloud provider to permits access from the Internet. These choices also are compatible with the microarchitecture defined in the previous section as cloud.

5.3.3 Governance

Closing the platform at the user level limits the potential of the platform [Ondrus et al., 2015]. However, allowing an open registration permits that third parties also access the system. Therefore, the simplest solution is confirming registration previous approval of the site's management team. This option is important at early stages to guarantee that users are members of the target group.

The design requires the creation of incentives to the members of the platform. However, the recognition cannot become a race for first places; therefore, the platform has the capacity to recognize useful participation or contribution with a non-rival nature incentive [Kitts, 2006], in this case, a *'like'*. This solution works as rating system since is based on reputation and promote trust [Slee, 2013] and incentive good behavior [Jøsang et al., 2007]. On the other hand, there is no formal punishment since the assumption is that not interesting topics will be inconsequential to the community.

Finally, the platform requires the implementation of a certain level of access to allow reviewing of activities or limit access to other functions. As a result, members can have four levels of access: 1) normal access, 2) writer, 3) forum moderator, and 4) admin. Table 15 shows the different access levels of platform users.

Table 15: Access levels of the platform

Level	Member	Chat	Blog	Event	Forum
Normal access	Full	Write	None	None	Write
Writer	Full	Write	Write	None	Write
Forum moderator	Full	Write	Write/Modify	None	Write/Modify
Administrator	Full	Write	Write/Modify	Write/Modify	Write/Modify

The platform addresses the content control by creating categories to suggest the type of information that is interesting for all the groups included in this study. However, public content is more complicated to control once the information is display. A simple solution is restricting people's capacity to post information using the access levels implemented in the platform. Therefore, in the blog module,

any interested user must request access allowing the moderator to pay attention to the new blog. The same concept applies to events where the creation of new unsupervised events can create potential issues (i.e. creation of fake events). In case that any content does not follow the values of the community, users or members can use the communication form to contact the managerial group for a review.

5.3.4 Modules

The modules implementation is a process that involved not only the creation and configuration of the application, it also requires the design of the frontend of the platform. Annex E has the design and implementation of the platform in detail.

Backbone and Frontend Implementing the backbone and frontend modules requires to initialize the main service of the service provider WIX. The main service takes several minutes to initialize and configures a basic backend communication and the frontend. The basic configuration gets ready the APIs for connections with other application, establish communication with the processing and storage services, starts protocols for email, transfer documents, communication with domains and a database.

The basic configuration establishes connectivity to the Internet and assigns resources for the publication of the platform. Therefore, it is necessary to configure the domain to put the platform online. The platform uses the domain delftcommunity.nl. The final step is the configuration of the frontend, the layout and physical appearance of the platform.

Figure 29: Home page of the platform

The frontend requires the configuration of two different visualizations, the first one for regular browsers and the second for mobile devices. The presentation of the platform to the users uses 9 pages which allow different services and digital spaces. Table 16 presents the main structure of the pages, Annex D presents the full connection between the webpages and the modules in the design section.

Table 16: Frontend main structure

Page	Subpage	Access	Visualization
Home		Public	Always
Information		Public	Always
Blog		Member	Always
Members	My account My draft Notification Settings Forum posts Blog likes Followers Blog comments Blog posts	Member	Always
Events		Member	Always
Forum		Member	Always
Chat		Member	Always
Privacy policy		Public	On-demand
Cookie policy		Public	On-demand
Access	Sign-up Sign-in	Public	On-demand

Authentication   The three submodules require the configuration of the two pages to deploy the functionalities. The first subpage is the Sign-up, this page is accessible on-demand and requires two fields to introduce data. The second subpage is the sign-in, this page accessible on-demand requires two fields for authentication and must match the information provided in the sign-up. In case of authentication issues (i.e. missing password, account confirmation), these pages require connection to the backend communication submodule to sending communications to the users experiencing issues. The first part of the email address works as the username of the member account. The account submodule creates the member account with these three parameters. The user can change or add data using My account page in later instances.

After the sign up a manual confirmation from the platform's administrator is in place before creating the account. After the confirmation, the platform sends an email invitation to the account of the new member confirming that her/his access is ready.

The sign-up process exposes the email address of the users that become members and present a username based on this email account. In some cases, free expression requires a certain level of privacy. Therefore, requirement R15 is partially fulfilled since most email accounts have some level of identification over its user.

Membership   The membership module requires close integration with the main platform since data about the members' activity depends on this module. The configuration of this module requires 9 pages in terms of presentation. These pages are always visible but only after successful authentication. Moreover, each of the four submodules uses different pages to accomplish their functions, a graphical representation is available in Annex D.

The profile submodule uses two pages: 1) Profile, and 2) My account. The Profile page has a connection to the account generated in the authentication module and permits the user presenting information about themselves to other members. This page allows the incorporation of text, images, and videos. On the other hand, My account permits the modification of the initial information provided in the sign-up process. Information subject to modification is the username, first name, last name, and include more email addresses. However, changing the initial email account is not possible since communications and privacy acceptance requires a validated account.

The contribution submodule uses three pages: 1) My drafts, 2) Forum posts and 3) Blog post. The information presented on these pages is the collection of the contributions made by the user in the blog and forum sections. My draft page is an automatic feature of the WIX module to save text, pictures, and other formats before the information is available for reading. The main purpose of this submodule is the identification of contributions with their creator to allow traceability.
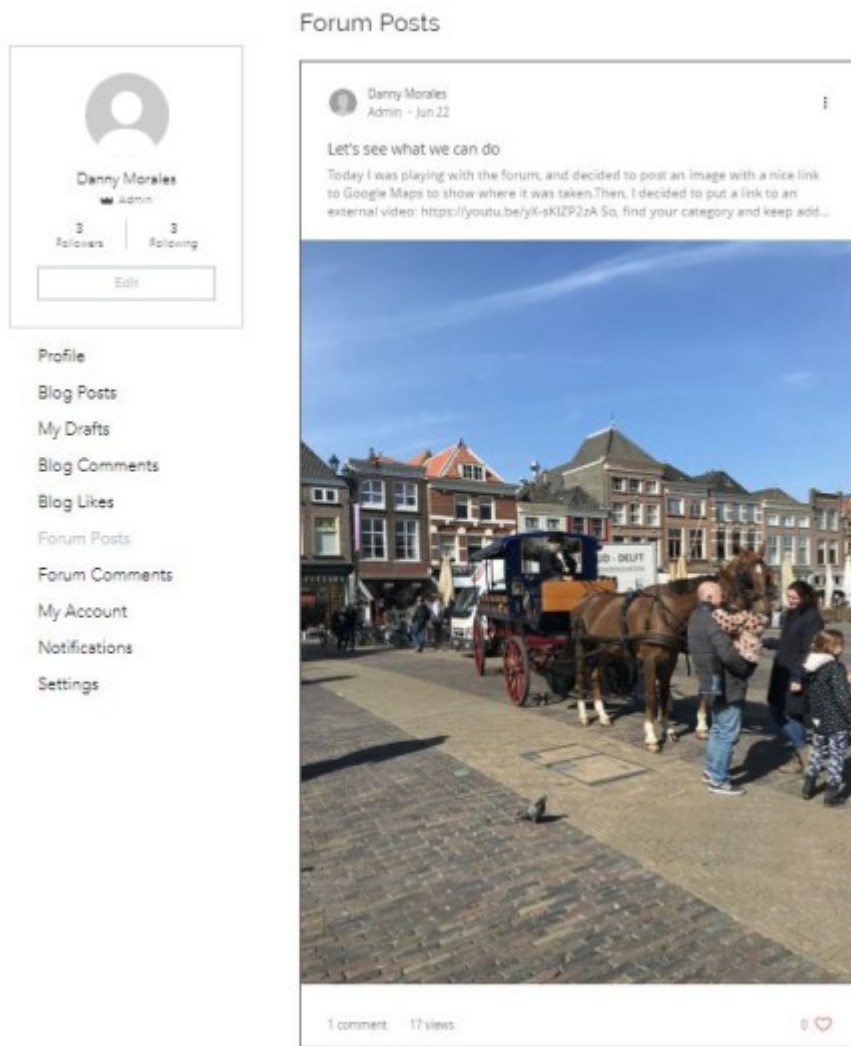
Figure 30: Forum posts page

The next submodule, notification, use five pages: 1) Notifications, 2) Forum comments, 3) Blog likes, 4) Blog comments, and 5) Followers. The first page, notifications, present all the reactions from other members based on user contributions. Forum comments, blog likes, and blog comments show the responses that the user made to the reactions or responses. This feature allows the interaction between members and classifies the interactions for easy access. Finally, the Followers page presents information about members that decide to follow the user. This feature is for positive stimulus and does not affect visualizations or restriction of any kind. Also, the following feature of the submodule stimulates the creation of strong networks inside the community which can create trust and reciprocity

[Kelkar and Spinelli, 2016].

Finally, settings submodule uses one page and requires the integration of the submodule with the platform, forum, blog, and chat modules. The settings page permits the configuration of email notification when different events happen in the system. Configuring the integration between the module and the backend to enable email communications is simple and requires the email addresses collected by the authentication module. The rest of the modules require *'pushing'* information to initiate the notification process. The email notification uses predefined text and the default configuration send a notification for every activity that affects the user. The levels of notification are on/off and track likes, comments, updates, and messages.

Blog   The implementation of this module permits sharing posts of the blog with traditional social media but block access from third parties to the members' data. Achieving this level of operation with social media demands the configuration of boundary resources. Boundary resources are the software tools that act as interfaces to define the relationship between the platform and apps [Ghazawneh and Henfridsson, 2013]. In this case, the configuration of the boundary resources of the module allows the creation of a link for sharing the blog. This implementation choice response to the fact that the blog is visible to the general public, but the privacy of the users takes precedence. Finally, the blog allows the incorporation of pictures and links to permit the creation of stories and rich content.
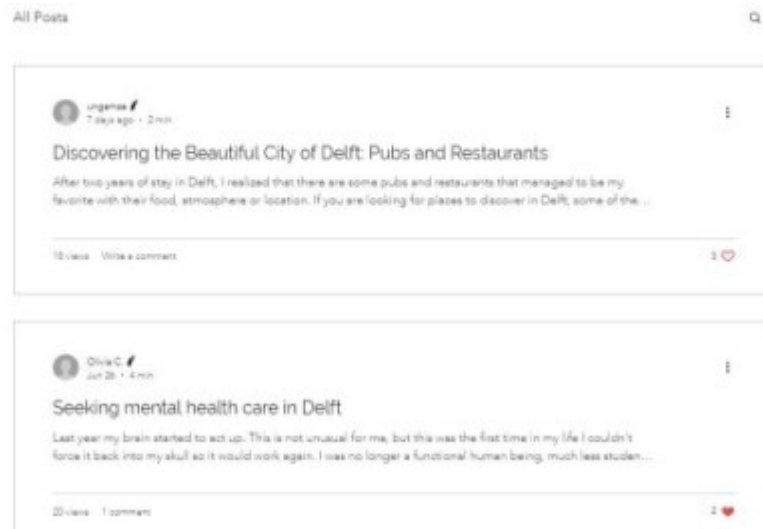
Figure 31: Blog page

Scheduler   The scheduler has a calendar, RSVP manager, and email communication. However, the module must respect the access level defined in the governance. Creation of events must be easy but at the same time, not all members must be able to create and share events. Therefore, to prevent misuse of the solution, it is necessary to use the features of the authentication module to restrict access. The members interested in creating an event must require access to the platform manager. The necessary levels for creating an event is in Table 15.
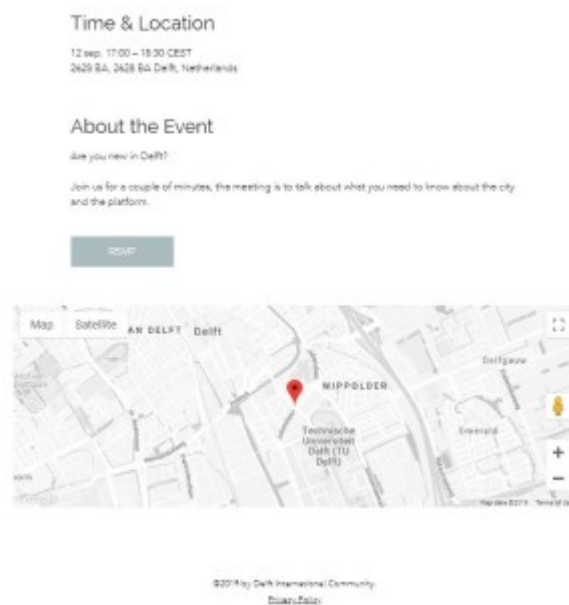
Figure 32: Scheduler page

The decision of asking a certain access level makes this feature less attractive to use. The RSVP section manages the number of people assisting to events but cannot prevent that non-register members show to a popular event. Therefore, having a module that assistance the control of attendees of an event is not enough to fulfill R10.

Forum The implementation of the forum uses access levels defined in table 15 for control who can see and use the service. Configuring the forum needs an initial set of categories. The options proposed in the forum are based on the results of the survey (see Annex B question 21). The main four categories represent the more voted options of the survey and the last category allows general topics. The creation of categories helps the user to identify topics fast. The forum also has a search function to complement the classification. The forum allows the use of text, pictures, links, and code to create simple or refine post with connection to other sides. In the pages of the forum is a bottom to create a new post and in the lower part of every post, a comment section is available. The connection with the membership module allows the collection of responses to the posts (likes, views, comments) which are shown along with the post and in the membership sections.
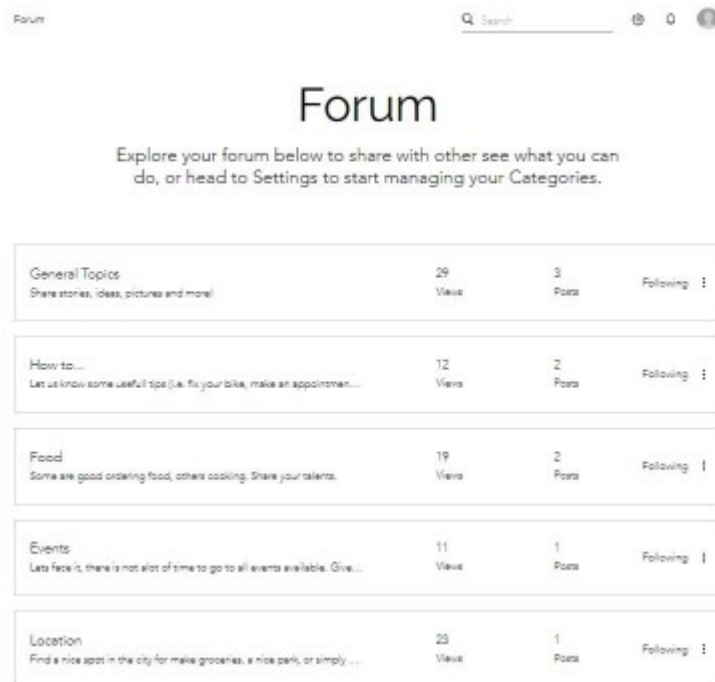
Figure 33: Forum page

Chat   The solution for implementing the chat is the use of a third-party application into the platform. The application selected belongs to Rumble and requires creating the necessary code to allow the application RumbleTalk to interact with the platform. However, this type of integration restricts the use of the chat in terms of active users and access to different functionalities. The first drawback is the need to perform a login to the chat using guest usernames which limit the number of active members to less than 10 at the same time. Also, it is not possible to use all the functionalities of the application.
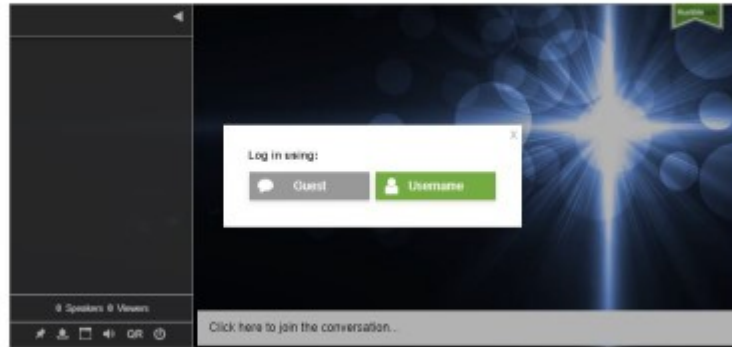
95

Figure 34: Chat page

The limitation generated from the integration between the application and the platform limit the efficacy of the module. However, the implementation does not affect the realization of the requirements associated with this module. The chat allows short, fast and easy exchange of information among the participants. Finally, the implementation is capable to display information in the chat only for the time that session is active. Furthermore, recording of data is not possible in the chat which guarantees the confidentiality for the users.

Privacy The platform does not collect sensitive information from the users. However, in cases when the collection of data happens, it is necessary to first inform the user about the collection of data and second record the consent from the participant. The privacy module addresses these issues in cases where automatic data recording is happening. The platform stored and registers information and activities respectively. Collected data allows the operation of the platform and become KPIs based on the measure of requirements defined in Table 3.

This kind of application requires coding the module to inform the user of the platform the use of cookies in the code. The module uses JavaScript to detect a new visit and deploy a page on demand (cookie policy) that inform the user about how the collection of data happens in the platform and permits selecting different consent levels. Finally, the module sent the information to a third-party reporter [Cookiebot, 2019] to avoid opening the platform's database to third parties. The

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code anonymized the information collected in a way that is not possible to trace the source IP address of the users but still provide useful insides.

Contact Form   The first submodule uses a formulary to allow any visitor to write text messages. The required information is the name, email address and selects the verification choice to activate the third submodule.

The privacy policy submodule uses a hyperlink to present in detail the platform's policy about the collection of data. The submodule is present in every formulary or page that collects data from the users. Therefore, the module requires the integration of the authentication module to present the information in the sign-up and sign-in pages.

The last submodule implemented is verification, the nature of the contact form and the location in the home page expose the module for misuse. Therefore, the mechanism reCAPTCHA which protects websites from spam and abuse [Google, 2019] brings to the platform control over automatic use of the form. Activating the mechanism reCAPTCHA v2 requires coding the necessary scripts in the home page and the boundary resources for share information with third parties.

5.3.5   Process

The last step in the implementation of the platform is not technical. *Requirement 18 looks for the creation of a process to promote the artifact.* Also, the platform works in a social environment which means that the people are the most important factor and the reason for creating the system. Therefore, achieving the union between the online platform and the international master community requires a process to promote initiatives in the community. *This section presents good practices related to actors, involvement strategies, activities in the platform and a general process for implementation (R18).*

Actors   Bischoff et al. [2017] have four steps to include the necessary actors: 1) locate engage individuals that are already interested in the problem, 2) find community champions, 3) locate the community partners, and 4) champions and partners have regular meetings.

The first step proposes to incorporate engaged individuals. Program meetings to raise awareness about the issues and find available resources and strengths [Bischoff et al., 2017] is a solution. However, in this case, the platform implementation does not uses engage actors since the purpose of the platform is to stimulate engagement in its users.

Second, champions influence the culture of the groups [Bischoff et al., 2017] [Kitagawa, 2019], and generate trust among the community [Kitagawa, 2019]. Therefore, after the technical implementation of the platform-specific users receive

access to post information on the blog. These users contribute with narratives into the blogs to stimulate the interest of other members.

Third, the process needs partners since champions are usually a small group of people (3 or 5). Therefore, the involvement of more members of the community that support the solution is important [Bischoff et al., 2017]. In this case, the invitation to participate in the platform follow the information presented in the methodology of the case study.

Finally, the meetings serve to share knowledge/responsibilities, and ownership to tackle community problems [Bischoff et al., 2017]. However, the scope and time limitation of this research make these steps not suitable for implementation.

Involvement Strategies   Bischoff at al. [2017] propose two main good practices for improving the success of the implementation. The first is to make sure that all relevant stakeholders are involved in the solutions. The second is controlling activities performed by volunteers via supervision.

The relevant stakeholder is the international student segment. Therefore, the platform needs the participation of users from the main four groups defined for this research. On the other hand, the volunteers are equal to community champions. Their activities include posting in the main blog. Therefore, the supervision of these actors includes confirming their willingness to create content and allow them permission to write the posts. However, since one of the purposes is the verification of the type of content that people share with others, there are no direct influence or control about the topics posted in the blogs.

Supporting Activities   Pascua et al. [2017] suggest two principles that the activities happening in the platform must accomplish. First, the activities must present a strong social network goal. Second, the activities must stimulate the principle of reciprocity to create a cycle that allows new participants to take the post later.

In order to accomplish these two principles, the process uses two strategies. First, instructions and categories of the platform guide the members' activities (i.e. posts, creation of content and/or events) to be useful to the community and potential new users. Also, the activities performed by the community champions serve as an example of what people can expect in other sections of the platform. Second, during the invitation of the initial participants the only guidance deliver to the potential members is that it is possible to share any kind of information, ask questions, or respond to questions from other members. This guidance opens the door to have an exchange of information between members and create a sense of reciprocity.

Implementation Process The first step involves having all relevant stakeholders involved in the process. The stakeholder's analysis found that the key player is the international student group. After having the target group in mind, the process requires engaged individuals. In this case, contacted people are the previous participant of the survey that accepted future contact about the research. These group of individuals have some knowledge about the problem but is not clear if they count as engaged individuals. Therefore, the invitation to use the platform include them but not limited to this initial group. The second group of invitation includes international students that the researcher has contact and finally, the third group of people includes international students referred from previous participants.

The email invitation includes a brief introduction of the research, a short explanation of what the platform can do, and the mail link to access the platform (`www.delftcommunity.nl`). The email notification reaches 60 individuals. The number of participants selected goes in line with the minimum number of students required for this phase of the study that is 20 people and assuming a lower participation rate than the survey 40%.

The next part of the process is finding community champions. These champions need to have good writing skill and the willingness to share information with others. Therefore, the two champions selected have connections with the researcher. However, the participants accept voluntary to post information and the topics chosen by themselves. Champions post information first to have data in the platform before the rest of the participants uses the platform.

The next step is locating community partners. In the case of this research, community partners are second-year students that have experience and can contribute to the potential questions, or information request in the platform. The invitation includes these participants and first-year students as well.

Finally, the platform has a section to explain the use of the platform and a preselected category that encourage sharing information with the goal of support others and general topics extracted from the survey. Therefore, the last part of the process is in the hands of the platform itself. The structure aims for participants with more experience to reply to questions from other participants and in turn, the cycle continues.

The whole process must be an open-ended participatory project to build a local network, reciprocity, and identification [Sacchetti and Campbell, 2015]. However, time restrictions force to address a complete process in design but makes impossible achieve the implementation of all the steps or a continuous process.

6   Artifact Demonstration and Evaluation

After developing the artifact, understanding if the product fulfills the purpose of its implementation requires demonstration and evaluation. Demonstrate the online platform requires choosing the right scenario and determine the way the platform is going to operate in that scenario. Moreover, it is necessary to describe the operation of the artifact. On the other hand, evaluate the artifact requires selecting the type of evaluation and the necessary method to collect the results. The online platform uses a real case scenario with an ex-post/naturalistic evaluation and the collection of data uses interviews and automatic scripts in the platform.

6.1   Demonstrate the Artifact

After finishing the process of development, the online platform needs to show its functionalities in a specific case. Ideally, demonstrating the artifact can probe it can solve some aspects of the problem description [Johannesson and Perjons, 2014]. Also, demonstrating the artifact can help to present the idea to the intended audience in a convincing way [Johannesson and Perjons, 2014]. Furthermore, to demonstrate an artifact there are some scenarios like fictitious cases, well-documented cases based on literature, or real-life cases. *The online platform design and implementation consider a real-life case from the start.* Therefore, after the completion of the development phase, the platform is fully operational to start the case study. The target scenario focus on residential buildings in sectors near TU Delft (Wippolder, Voorhof, and City Center) where DUWO have most of their buildings offers [DUWO, 2018]. Targeting international students in a specific area has the intention to limit the information into a more local context. The number of international students invited to the demonstration is 60 between the four main groups.

Based on the operational level of the online platform and the real case scenario, the case study use interviews to collect information about the platform's use and recording data from the platform directly. The demonstration of the platform requires a brief understanding of what the users are going to do. Therefore, this section shows a brief introduction to the main services of the platform. The platform offers to the members and users 6 services: 1) access, 2) blog, 3) forum, 4) events, 5) chat, and 6) members.

First, the access service is the base to allow authentication to other functionalities of the platform. A visitor of the platform can become a member using the log-in link place in the top of every page. After the submission of the data, the process of confirmation starts, a communication arrives at the platform manager and the manual confirmation allow or not a registration to the platform. If the manual confirmation is positive the user receives an invitation mail to participate

in the platform. The second step is to select the log-in page and introduce the email address and password.

Second, the blog service allows share information not only to members but visitors. After registration, all members receive a permit to post in the blog. The blog does not have any category giving freedom to the members to post information. In the blog section, a member can click the button *'Create a Post'* and it is possible to include text, pictures, and hyperlinks. All posts allow comments or reactions (i.e. likes) to promote interaction between the members.

Third, the forum has pre-defined categories (i.e. How to..., food, events, location, and general topics) to suggest the members about the kind of information that would stimulate the exchange of information (See Annex C, page 152). Members can post a new topic after selecting a category using the button *'Create New Post'*. It is possible to comment or react to an existing post after selecting the post. Members can exchange valuable, useful information with other members or simply open a new post asking questions to the community.

Fourth, the event service has an interface that permits creating a new event. The details include descriptions, time, location, and include geolocation references to have a map. The RSVP permit joining the event and for the creators of the vent collecting information of users that are interested in the event.

Fifth, the chat service is a fully functional chat room. However, due to implementation restrictions, the chat has a limited number of concurrent members. Members can join the chat room selecting the *'Guest'* option in the login screen. Members can choose to use their own username and join the conversation(s) happening in real-time. The chat service allows members to share information freely and in real-time since there are no restrictions over the topic(s) happening in the chat room.

Finally, the members service allows the creation of a basic social network. The page shows the profile of other members in the platform and permits the option to follow these members. Following members activates email notifications that provide information about new interactions with the platform. The information visible from other members is basic since the purpose of the platform is not the replication of traditional social networks but follow others based on the information provided in the system.

6.2   Artifact Evaluation

The evaluation of the platform uses an ex-post strategy. This strategy requires deploying the platform, which in this case is in real conditions. This strategy is suitable for summative evaluations [Johannesson and Perjons, 2014]. Therefore, is a good match since our goal is to understand the effects of the platform over the users. On the other hand, naturalistic evaluations have high external validity since

are their set up is in real scenarios. Therefore, the naturalistic evaluation makes a match with the purpose of the research.

The selection of an ex-post/naturalistic evaluation for the online platform requires a clear definition in terms of resources. This research has limitations in terms of time (duration and time of the year); therefore, the evaluation of the platform runs for two weeks. The platform's demonstration takes place in the month of July, which impacts the number of available international students. Therefore, the evaluation of the artifact using interview aims to have at least 25% of active users in the city of Delft to perform a face-to-face interview.

The two evaluations require different approaches. The collection of data is automatic, and the users have information about the collection of data as an integral part of using the platform. The information collected from the cookies reveals information about the user's location and type of device used for accessing the system. The information collected via the interaction of the users in the platform includes the number of visits, comments, views, likes, and followers. This information is visible at all moments in the system except for the number of visitors which is a statistic accessible only the platform administrator. All the statistics presented in this research are from the first two weeks of operation. *The collection of data provides the necessary information to check the measure of effectiveness elaborated in the requirements and determine which requirements are effective or not.* Also, it is possible to understand the interaction of every user with the systems and the data provides a starting point to see the interaction between users and the selection of participants for the interview.

On the other hand, the interview requires coordination to get access to the participants and allocating enough time. Therefore, after the two weeks of operation, the selection of candidates starts. The interview has a set of questions (See Annex G) that address the three topics listed in the methodology. The candidates selected have different levels of interaction with the systems, from passive to active users. The first step is to contact them and request their voluntary participation in the interview. The invitation reaches 12 participants and 6 responded affirmatively to the request. The next step is to coordinate as many interviews as possible within three days to have 2 interviews per day. Also, it is necessary to complete this part of the research before international students leave the city due to the end of the academic year. *The result of the interview allows understanding the motives and reasons that make participants interact with the platform and verify if the platform accomplishes its purpose.*

6.3   Artifact Results

This section presents the result of the case study and interview. The case study focuses on the interaction between the participants and the platform. On the

other hand, the results from the interview present responses of a group of selected participants based on their interactions with the platform.

6.3.1 Case Study

The use of the platform generates and collects different information about the interaction of the students with the platform. Some general data about the users, services, and formats shared by the participants give a better understanding of how users interact with the platform and validate certain requirements. *The number of visitors during the two weeks period was 40 and the number of members in the same period is 26.* The percentage of mobile visitors is 10% with only 4 students accessing the platform from their phones.

International students interact with four services of the platform. Depending on the service, users or members can interact with the content or create new ones. It is possible to rank the services based on interactions. *The first place is for the forum with 99 interaction, following the blog with 40 interactions, the event service with 1 interaction and the chat with no interactions.* Interactions are the number of 'views' and 'likes' that other users can provide to the inputs. On the other hand, the members or users can create posts or comments, these two options are inputs. *The result of the inputs has a similar ranking with the forum in the first position with 24 inputs following the blog with 3 inputs and in the last position the event and chat with no inputs.* Table 17 show the ranking of services based on inputs and interactions.

Table 17: Ranking of services

Position	Service	Interactions	Inputs
1	Forum	99	24
2	Blog	40	3
3	Event	1	0
4	Chat	0	N/A

The blog service register 2 blogs and 1 comment. These blogs include no pictures and 1 link inside the content. On the other hand, the forum registers 8 posts and 16 comments. The content of the posts or comments includes 2 pictures and 4 links.

The case study collects a detail interaction of the students with the blog and forum services. Annex F have numbers of views, interactions, likes, pictures, and links per individual blog including the topic of the post. In general, the blogs have in average 19 views per post while the forum has 12 views. The posts of the blog address 2 topics: Health care, and restaurants & pubs. On the other hand, *the post in the forum address 7 topics distributed in 5 categories*: Housing, tourism,

bicycles, health care, restaurants & pubs, beers, and sports. Table 18 has the ranking of topics based on the number of views including both services.

Table 18: Ranking of topics based on views

Position	Topic	Views	Comments
1	Sports	35	9
2	Health care	28	1
3	Restaurants & pubs	24	0
4	Tourism	17	1
5	Drinks	14	3
6	Housing	11	3
7	Bicycles	4	0

The platform has different digital spaces to create interaction among users. The most used services are the blog and the forum. However, there are functionalities included in the main services that complement the information posted by international students. One of the functionalities is the option to react to the information of other users. The content in the forum and blog have 2 and 4 likes respectively. The functionality of allowing hyperlinks enable connection of the original content with other pages, there is a total of 5 links in the content redirecting users outside the platform. The platform has the option of following content or users, the data collected by the platform indicate that the option of following other users create a small cluster of 3 participants. Finally, *the events section has a valid registration to an event via the RSVP functionality in the service.*

The interaction with the platform results in different users acting in different roles. *The role of moderator has 2 students* that participate in the blog. *The students writing in the blog or forum is 8* (excluding students in other roles), and the number of *other users is 15*. The researcher remained in the role of administrator.

The number of communication channels implemented to establish communications is 5 (blog, post, email, electronic form, and instant message). The operation of the platform had no breaches in terms of security or information losses. Also, during the demonstration of the platform, no malfunctions occur. The interfaces use a minimum number of colors with 3 as average and the number of paragraphs in the 4 modules is under 2 paragraphs (instructions). The platform shows no restriction in terms of characters with the longest input having 948 words. The contributions in the blog (2) have positive connotations and in the forum (8) as well. The main atmosphere of the inputs is providing information freely or in reply to somebody else questions. The users can choose to receive information about the platform, receive information from the blog or forum, and receiving information from the interaction of other users. Finally, Table 19 shows the measure of

performance and the results of all requirements.

Table 19: Results for all requirements

Req.	Measure of performance	Results
R1	At least 20 users	26 users
R2	At least 1 admin, 1 supervisor, 18 users	1 admin,2 moderators,8 writers,15 users
R3	At least 1 support topic	3 topics (health, bikes, housing)
R4	At least 2 methods	5 methods (blog, post, email, electronic form, messaging)
R5	Less than 1 irregular access during operation	None
R6	Less than 5 paragraphs, less than 5 colors	2 paragraphs, 3 colors (average)
R7	Less than 1 failures during operation	None
R8	At least 1000 characters	948 max. (not proved)
R9	At least 1 per digital space	Blog 2, forum 8
R10	At least 10 per event	1 registration
R11	At least 3 options	3 levels (from the platform, from the services, from other users)
R12	At least 1 module	1 module
R13	At least 3 services	4 (3 used)
R14	At least 1 platform	1 platform (Google Maps)
R15	At least 5	7 topics
R16	At least 500 GB during operation	500 GB (contract)
R17	At least 3 (text, images, and video)	Blog 2, forum 3
R18	At least 1 process	1 process
R19	At least 10 inputs and 20 activities	inputs: 24,3,0, N/A interaction: 99, 40, 1, 0
R20	At least 4 (IP/DNS/JAVA/HTML5)	At least 20

6.3.2 Interview

The interview address three main topics: requirements, information, and functionality.

Requirements The evaluation of the platform uses not only data but input from users of the platform. A group of international students responds questions about requirements of the platform. The interview's question 1 asks about the support of the platform to share stories and find information. All the responses were positive, the users find the interface user-friendly, flexible, and intuitive. Interviewee number 2 mention: *"The platform offer[s] me like the flexibility to start to write about places or topics that I was interested, so I had no limitations"*. Interviewee number 4 also express: *"When I see other people share just a question or somebody say that there some event going on, that is what encourage me actually,*

looking at other people sharing, so the fact that there is everything else in the open and people are just talking . . . that is most inviting for me also to share". Which implies that users not only find the platform technically appropriate to share information, but the display of the information also incentivizes sharing information. On the other hand, interviewees indicate that introducing categories to organize information improve the location of information. Interviewee number 2 mention: *"I found different options especially the topics of food, or the topics of places, or activities to develop here in Delft, was really useful, was really easy to access to this information, was really easy to explore the platform".*

Question 2 of the interviews ask participants about the usefulness about having information about locations in the platform. Almost all responses indicate that locations are useful. However, one interviewee mentions that the information was not useful. Interview number 4 indicates: *"I didn't find it useful just interesting for me to know . . . the question section is more useful . . . ".* Therefore, in this case, the connotation of the response does not imply a negative response to information about the location. Participants indicate that this type of information is good for new students and that its use improves if includes hyperlinks to external sites as a complement. Interviewee 2 indicate: *"For us as students that we arrive like in a new city, eh, for me is useful but probably for new students that arrive like a first month will be really useful".* On the other hand, interviewee number 1 said: *"It was super useful because there was a link provided . . . by clicking that link I just found the close-by hospitals".*

The next question in the interview address the relevance/identification of the posts for the participant. All participants responded that the information on the platform was relevant or helpful. Some of the reasons that make participants identify with the information are matching necessities, locality, and timing. Interviewee number 1 said: *"It was very relevant because it was just the moment that I was looking for something like that".* Interviewee 3 indicates not only the matching need but the usefulness: *"I found it personally interesting cause I was also searching for a place to run . . . in the website he actually posted a map and ok you can go through here, and actually tested that this morning".* Finally, interviewee 4 responds: *"It is most relevant because first of all . . . when I open the platform I know that it's about what interaction with other people . . . then because there is all center to where I am, so everything is connected to me".*

Question number 4 addresses the implementation of social network features (i.e. likes, comments) and if these have an impact on the willingness of people to interact in the platform. The responses are mixed, 60% of the participant responded affirmative and the rest did not find these features appealing. Participants that indicate that they will be more willing to interact associated likes with usefulness and a feeling of helping others. Interviewee 1 indicates: *"I think yes, I*

would be willing to share more things and interact more because that means people are actually using the platform and what I wrote was really beneficial". Interviewee number 3 indicates: *"Definitely, yeah, of course ... I think the platform is arranged in such a way that you get notifications when you get a reply or a post regarding something that you posted that is how I follow the rest of the conversation ... this entire platform is meant to help other people ... if someone would ask me: OK, you say that you prefer your own bike but why can't I use the other ones? ... I am more than happy to help them out"*. On the other hand, participants that indicate that it will not change their willingness indicate that those features are not interesting to them as much as the relevance of the content. Interviewee 5 indicates: *"I also want another level of advice ... relevant and timely"*. Also, one suggestion is changing the label to change the mindset of the participants. Interviewee 6 indicate: *"... But maybe, I would be more willing to contribute if people found my posts or comments "useful" or "helpful". It's a subtle mental difference"*.

Information   The interview addresses information with three questions. Question 5 asks the participants about the motivations behind their contributions. Each participant contributes to different topics; however, most of the responses are related to experiences that they have/had and how important the information is for them. Interviewee 1 indicates: *"In the blog is usually something informative ... I just wanted to share my experiences with others ... I feel comfortable writing about ... I like writing just tips for restaurants ... It can be useful for students"*. Interviewee 2 said: *"I know like, I have been in different countries, and I know that sometimes is difficult to find like activities, like ok, usually the main activity that people find is like lets go to a bar, but no[t] all people would like to join in this kind of activities, so once I find this alternative to register different activities, that trigger[s] me"*. Also, some participants notice that their selection of the topic and the information posted is in line with their knowledge and a desire for help. Interviewee 4 said: *"The question was about the housing situation and with respect to the municipality, and very very recently I have to corresponding the municipality regarding my own housing issue, so it was kind of exactly very fresh in my mind, so the question was very relevant to the information that is very solid in my mind right now so I can give out some substantial information there ... The others didn't affect me personally, this one did, so this is why I choose this"*. Finally, interviewee 5 indicate: *"Because that is what it is important ... it will depend of the situation like if I broke my bike, I want to post something about where to fix my bike"*.

Question 6 of the interview try to find the type of information that international students think that is important, but it was not in the platform. The responses in-

dicate that external information like workshops, the housing situation, and events outside of the city can be a nice complement. Interviewee 2 said: *"I really like a workshop like a conference, like topics that probably is outside the university . . . like, ah, in the city. That would be nice because then we can join with Dutch people or with another activities in the city"*. Interviewee 3 responded: *"Housing situation here in Delft, which it has been a problem for a lot of people . . . I could have been nice to see some warnings or something like that"*. Finally, interviewee 4 said: *"I just wonder once if, because this is very center to delft, is there some way that we can also ask about some or we can see something about other cases around delft"*.

The last question about information looks for the participants to identify the most engaging topic posted on the platform. The responses are varied including health insurance, sports, and events. Interviewee 2 indicated: *"I think I read something about the health insurance, that probably could be useful . . . that caught my attention because I said like, oh, [I] didn't know this one. . . if it is common topics, probably, I won't read. . . but this one was an experience that, how she deal with the insurance, how to do with the process"*. Also, interview 3 said: *"Running route . . . I was surprised that we were actually sort of having a conversation . . . I was honestly well, pleasingly surprised"*. Interviewee 4 provide information about how she/he perceives the city: *"Events, so somebody posting about some event that is happening because that is one thing that I fell I'm really lacking is to go out here in Delft. I really really want to find other things but It just seems dead but then when I'm look at the platform ok, there are something going on, I just don't know them [events] . . . it allows me to go out there and actually interact to the people rather than thinking there nothing going on here and nobody is here"*.

Functionality   The interview addresses topics related to the platform's functionality. The last two questions of the interview try to understand why some features are more visited than others, and possible new features that can stimulate more participation. Question 8 asks about the selection of different parts of the platform. Participants indicate that they choose the forum since is easy to use. The forum allows participants to reach people, share knowledge and find information (i.e. ask questions). On the other hand, the lack of use of specific sections of the platform is related to lack of interest (blog) or lack of participants (i.e. chat). The event section is not address directly in the answers; however, in different parts of the interviews it clear that students did not use it or understood this part. Interviewee 1 said: *"I didn't have the needs, so my purpose was to write the blog to inform people, and also, I want it to check the forum . . . I found what I was looking for"*. Interviewee 3 indicated: *"I saw that the forums on the platform were the ones are where being the most used, so I got drawn to that part . . . I decided*

to contribute ... I can put my grain of sand on it ... I found something that could be useful. I saw them but the blog I've never being drawn into blogs ... a little bit boring ... I prefer to go to direct sources of information like someone asks a question that may be related with what I want to know. I see the chat room as a very useful in the case that you can't find information you are looking for easily ... the chat room is a more immediate way to get us information". Finally, interviewee 5 responded: *"It was easy to use, I just want it to reach people and forum is usually an easy way to reach ... and also just have a question".*

The last question of this section asks openly to international students about functionalities that they wish the platform could have. Some users do not mention any extra component. However, others mention that it would be interesting to have videos, temporary chat rooms, and a rolling fee for events. Interviewee 2 said: *"If there is more visualization like videos would be nice if people start to comment about the videos".* Also, interviewee 4 indicated: *"If there is something ... some topic, or something that is bothering someone, then maybe they can have like a debate with people or ask their opinions on it. I want to open it for some period of time, not forever".* Interviewee 5 commented: *"Events, what is coming up ... like a rolling fee ... like to the dates ... very specific to Delft".*

After question 9, a follow-up question tries to understand if the international students are willing to use the platform to post and find information during their living time in Delft. The responses were all positive except two. Moreover, the reasons are the suggestions offered by other social media sites based on tracking previous interactions, and the number of users. Interviewee 1 said: *"I would considered because actually there is no such a website that serves the functions that this platform does. This platform it just serves for these specific purposes for the student community in Delft".* Interviewee 4 said: *"No, I will still go to Facebook because it gets notifications and ... it tracks my interest ... so it keeps giving me suggestions that I want to see".* Finally, interviewee 5 said: *"Yeah, if it has information that I found very helpful for example where do I buy a bike ... especially when I landed ... if I'm getting a lot of useful information then for sure I'll go back".*

7 Discussion

This chapter presents some discussions about the results introduced throughout the research in order to answers the research questions. The analysis includes information resulting from literature review, surveys, platform testing, and interviews. Also, this section addresses limitations and the direction of further research.

7.1 General Topics

The survey includes questions that try to understand the possible motives for the lack of interactions. One of the questions asks about the presence of international students in a support network. The hypothesis was that Indian, Chinese and Greek students have support networks from their own nationality. The results show a weak relation r = 0.413. However, the p-value for these two factors is p = 0.09505 which confirms the null-hypothesis. This means that problems due to the lack of social interaction are not specific of nationality but is common for all international students. Further analysis between nationalities and the size of the support network using a cross-correlation table and chi-square analysis show a p-value of p = 0.02213 which is enough to discard the null-hypothesis that in this case means that exits a relation between nationality and the number of students in the support network. The results show that the Chinese community has a 100% of its participants over 4 people in their support network, followed by the rest of internationals with 72%, Indians with 64% and Greeks with 40%. Which means that the more highly connected group is the Chinese community followed by the rest of nationalities, Indian and Greeks. *Therefore, this information can be related to the perceived willingness to interact with other groups.* It is possible that students with a strong support network do not need the pressure to interact with others.

The result of the survey point to the use of mobile applications or services on a daily basis. Therefore, the platform allows access to the service using mobile or desktop devices. However, the number of users accessing the system via mobile devices is only 10% which do not justify the creation of mobile apps. Furthermore, this could imply that the behavior of international students about sharing useful information is a programmed activity.

The research presents four main principles from which the requirements and development of the platform are based. These principles are information, activities & space, multicultural approach, and key actors. First, information is address in the survey and the lack of information is one of the obstacles for interaction. The results of question 1 in the interviews confirm that the platform is supportive, intuitive and user-friendly for adding information. *Therefore, this principle is one of the most relevant for the creation of a community between international*

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students and properly added to the platform. The second principle is activities &
space. Space is related to a location, and the implementation of locations is di-
rectly present in the forum. The results of question 2 of the interview indicate that
this part of the principle is useful and interesting. *Therefore, space is a relevant
principle in terms of community creation.* The third principle, the multicultural
approach, was not part of any question of the survey. However, the design of this
principle starts from the moment of the selection of the main international groups
in the study. The implementation of this principle can be seen in the informa-
tion used in the forum coming from the results of all communities, and in the
authentication service and frontend as well. *Therefore, a multicultural approach is
relevant for the creation of a community between international students in Delft.*
The final principle is key actors. These actors from the perspective of the platform
are second-year students that can collaborate with the platform posting informa-
tion or answering questions that could appear in different sections of the platform.
Therefore, this principle is relevant and closely related to an effective process.

7.2   Research Questions

This section of the discussion focuses on the results associated with the research
questions formulated previously.

- The first sub-question is: *What are the main requirements for an IT artifact
  to stimulate information sharing?*

The requirements of the platform have two sources: 1) literature review, and
2) survey directed to international students in Delft. In this case, some require-
ments are necessary to the creation of the platform, and others are directly related
to the stimulate information sharing. As a result, some of the requirements do
not have an evaluation during the platform demonstration since this involve not
a naturalistic scenario but an artificial evaluation for internal validity. However,
having a fully functional platform in a real scenario and the decision to using a pro-
prietary service for the construction of the platform implies that the components
of the platform are working properly. Furthermore, the results after the test of
the platform confirm reaching the minimum measure of performance. *Therefore,
the operation of the platform validates the requirements linked to registration of
members (R1), protection of personal data (R5), robust infrastructure (R7), Allow
personalization of content (R11), support location sharing (R14), store data from
members (R16), and implementing web-based tools (R20).*
The rest of the requirements have a direct connection with the stimulation of
information sharing. The next requirement: allows user's roles with access level
(R2) tries to provide a define a role among the users of the platform. The creation
of roles provides a way to supervise the information shared in the platform or

events. However, all users must be able to share at any moment in any of the digital spaces/services. *Therefore, create roles do not provide any advantages in terms of information sharing. Furthermore, it may be an obstacle if a user decides to create an entry and discover that she/he does not have the necessary access rights.*

Include useful information (R3) required using the responses of the survey to understand what type of information is interesting for the students. The result provides several topics like events, locations, and a section 'How to' with high interest. The platform implements these categories in the forum. The results show that the category 'How to' has useful inputs (i.e. bikes). However, other categories and the blog have useful information as well. The interviews confirm that users are more willing to share information that they consider useful to others and engage in ongoing topics for the same reason. Furthermore, the number of views around this type of information is the highest. *Therefore, include useful information in the platform stimulate interaction and encourage new postings.*

Support multiple communication channels (R4) require the implementation of different ways to send and receive information. The platform uses email, blogs, posts, electronic forms, and instant messages. The results of the platform's use indicate that some of the communication channels are only operational. However, some communication channels associated with the forum service have a positive impact. The number of posts in the forum is the highest, followed by blogs. Furthermore, the interviewees found useful that an email reaches them when someone replies to their post. As a result, the exchange of information keeps ongoing. *Therefore, having multiple communication channels by itself does not seem to have major impact. However, multiple communication channels working together support information sharing.*

Present a clear interface (R6) is associated to show only the necessary information and reduce distractions to the user. The platform interface proves to be clear and able to communicate the correct message since interviewees indicate that the interface is user-friendly, intuitive, and able to communicate the goal of being supportive with others. On the other hand, some interviewees indicate that some of the features of the platform were unknown. This could be related to the limited section that presents the different capabilities of the platform. *Therefore, a clear interface is important for the interaction of the users with the platform. However, in this case there is no sign that indicates that this requirement stimulates information sharing.*

Incorporate narratives (R8) involve telling a story with the purpose of having an impact and motivate people. The platform permits that the communications have enough space to share stories. The blog is the space more suitable to have narratives. However, the results show that the blog is not the most view section

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of the platform and the number of interactions with the content is limited in comparison with the forum. Some interviewees indicated that the blog is not as interesting as the forum or does not meet their necessities quite as well as the forum. *Therefore, the use of narratives does not seem to have a major influence on information sharing.*

Use a positive message (R9) requires presenting information that focuses on the benefits of participating in a community. The platform has positive messages in different sections and pages. One of the messages is the idea of bringing support and interaction between members. Interviewee 3 indicate: *"this entire platform is mean to help other people"* which implies that this type of positive message creates an impact on the users. Also, most interviewees indicate that their reason form sharing information is to provide useful information. *Therefore, a positive message promoting support and its benefits have an impact on information sharing.*

Managing the number of participants in events or groups (R10) requires implementing a count and control over the attendants. The results of the platform show only one registration. *Therefore, the lack of interaction does not provide enough information to validate this requirement.*

Allow the creation of user's events (R12) means that the platform requires a feature to accomplish this requirement. The results of the survey indicate that most participants are interesting in know about events. Interviewees mentioned that the platform could make a difference if the members ended up meeting in real life. However, the results of the monitoring indicate the creation of no new events and only one person register to an existing event. *Therefore, the lack of interaction does not provide enough information to validate this requirement.*

Support multiple digital spaces (R13) imply the creation of different services for users to interact with the platform and with between each other. The platform implements 4 main spaces: blog, forum, scheduler, and chat. Only 3 are associated with information sharing since the scheduler is more event-related. The purpose of each service is different, but it is possible to see that the inputs and interactions favor the forum over the blog, and the chat has no input or interactions. *Therefore, multiple digital spaces have a positive impact on information sharing. However, the number of digital spaces should be in line with the number of participants. Otherwise, some of the digital spaces would have no participants creating a negative image and disinterest.*

Allow free expressions of users (R15) aim to the creation of different topics that others find interesting and engaging. The results of the platform test show that students generate 7 different topics by their own and all have views, and most have interactions. *Therefore, allowing users to have the freedom to choose their own content stimulate information sharing.*

Allowing different sharing formats (R17) imply allowing users to put informa-

tion in the form of text, pictures, videos, hyperlinks. The results show that not all the messages have extra formats apart from the text. However, the interviewees find relevant and useful the information that have images or hyperlinks as complements. *Therefore, allowing different formats does not stimulate information sharing directly, but increase the quality of the information and the interest of the participants.*

Create a process to promote the artifact (R18) aim to bring people to the platform. The process addresses initial users that create initial content, and make sure that the platform has people with more experience to be able to contribute with the necessary information to questions. This is a relevant topic since some interviewees indicate that they are more willing to share information if they feel knowledgeable and comfortable about the topics in the platform. At the same time, other students indicate that they will use the platform if there are more participants. *Therefore, a process that aims to bring novice and experienced users to the platform stimulate information sharing.*

Finally, tracking posting and viewing activity (R19) require that the platform present the activities around the user's posts. The response to this kind of interactions was mixed. Some students indicate that this kind of feature does not encourage them to share more information. On the other hand, other students associate this information with valuable and useful contributions stimulating future posts. One of the interviewees suggests changing the concept of 'like' for 'useful' or 'helpful'. *Therefore, providing extra information about the value of user's contributions stimulate information sharing.*

- The second sub-question is: *What type of information shared using the IT artifact change the perceived level of connectedness among their users?*

The results of the survey show that students are willing to share information about events, locations, 'How to', food, and cultural information. The platform implements the top four responses and adds a general category to allow users of the forum to put their own content. On the other hand, the blog does not put any pre-selected topic. The results of the platform test show that the forum has only one post referring events, or location. In contrast, categories like 'How to', food, and generally have 2 posts each. The blog section has other two posts that match location and 'How to' information. Therefore, the most used type of information is 'How to', followed by location, general, food, and at the end events. This order also matches the number of views per topics. As a result, the topics with more view are health care and sports.

These two topics have *the main characteristics that international students are looking for usefulness, relevance, and interest.* Literature indicates that exchanging social support, opinions and asking questions allow users to know each other

[Ren and Kraut, 2010]. Inclusion is the result of individuals engaging in task or activities that contribute to the group [Singletary Walker et al., 2019]. Members of a virtual community remain active if they find information sharing, emotional ties [Suh et al., 2015] and the feeling that the community needs their contributions [Ren and Kraut, 2010]. There is a relation between a personal involvement in her/his community and her/his wellbeing [Sacchetti and Campbell, 2015]. Also, care to stimulate trust among members [von Krogh, 2011]. Finally, high-quality interaction among the members of the community creates a shared emotional connection [McMillan and Chavis, 1986]. *Therefore, based on literature it is safe to indicate that sharing useful, relevant and interesting information help members of the platform to improve their perception of connectedness and belonging to the community.*

- The third sub-question is: *What functionalities of the IT artifact are necessary to stimulate communication apart from the shared information?*

The platform demonstration pays attention to the demonstration of 5 modules of the platform that permit interaction with the students (membership, blog, scheduler, forum, and chat).

The membership module has meaningful interaction from the students. It is possible that the reason is the saturation of social media that international students have. As a result, it could be of no interest to spend time on this kind of functions. *Therefore, the membership module in terms of the use of profiling the users makes no difference for increase communication of the students.*

The scheduler is another module that has almost no interaction. Some users indicate that this feature was not understood and this may be the reason for no interaction. However, some users indicate that this feature must be present to help students to know each other outside academic activities, others indicate that social media like Facebook is better suited for this task. *Therefore, it is not enough information to validate the impact of the scheduler stimulating communication.*

The chat has not to register interaction, one of the reasons could be the lack of enough users to allow interactions in real-time. Another possibility is the lack of a topic in the chat. One of the interviewees indicate that it would be more appealing to have a place to share opinion for a limited period, this topic must be relevant and current. *Therefore, a chat room is not enough, but a chat room with a topic defined during a certain time may stimulate the exchange of information.*

The forum works perfectly for fast exchange of useful information between members. This module in combination with the blog is the most used functionalities of the platform. Most of the interaction happens in the forum following the blog. However, some participants find the blog not useful or time-consuming to engage. *Therefore, the blog must be used as an invitation to share experience and*

not overlap with the content of the forum to have a better impact. Also, these two functions are important to stimulate communication. Apart from the main modules, the platform introduces some functionalities in its normal operation. The use of comments is a fast and easy way to communicate with other users on the platform. *The result shows that comments stimulate participation and exchange of information effectively.* The personalization of notifications and the introduction of categories prove to be useful for the users. Interviewee 4 indicate that personalization is not common in other platforms. Also, it was noted that choosing the type of notification allow the users visiting the site when needed and respond any questions. *Therefore, notifications and personalization stimulate the willingness to communicate in the platform. Finally, external connectivity with other sites using hyperlink had been mention and prove effective to stimulate interaction among users.*

- After the analysis of the sub-questions it is possible to have an answer to the main research question: *How can information-sharing apply in an ICT artifact foster connectedness between individuals from different nationalities in Delft's international student community?*

Information sharing can foster connectedness between international students from different nationalities in the city of Delft using an online platform. The information in this platform must be useful, relevant, and interesting with the purpose of support other members. Also, the platform must have multiple communication channels working together to reach users and facilitate information exchange. This communication channels must be implemented in different modules with specific functionalities. However, the number of modules should grow according to the number of users to avoid low use and desertion. The platform should have information that transmit a positive message to stimulate students to connect into the platform and share information. Furthermore, the platform must allow the users to share information using different format like text, videos, pictures, and permit communication with external sites using hyperlinks in forums or blogs that permit fast responses and have recognition for the information. Finally, the platform must have a process to reach experience students that can provide the necessary information.

7.3 Limitations and Future Research

One of the most important limitations of this research is the time and the season of its execution. The time allows to perform the survey, elucidate requirements, construct the platform, perform the test in a real scenario and perform interviews to the participants is only four months. This is partly due to the restriction of the

master's program but also due to the need of international students to conduct the research. The interviews could no longer happen after the first weeks of July since it is the start of summer break and most of the students leave the city. This time constrains have its most impact on the number of participants and the time that the platform is online. *Therefore, it is advisable to continue this research in a different season and if possible, extend the demonstration of the platform.*

The number of participants in the survey is only 45 which gave a margin of error of 14,6%. This means that some of the requirements originate in survey results may be different or change with a larger sample. Also, the percentage of students from the four groups address in the survey and the real distribution is not a match. It is possible that some results also present distortions with respect to a bigger sample. *Therefore, it is necessary to expand the number of participants in the survey in future research.*

The result of the survey suggests different information that international students find interesting or willing to share. Information about cooking & eating act, music & concerts, movies & concerts, and sports & dance receive high marks. However, the platform only registers information about food and sports. This mismatch could be caused in part for the choice of use close-end questions with pre-defined categories. The results of the interview suggest options like workshops and housing-related information as more suitable. However, these categories are not in the survey. *As a result, the categories presented in the survey based on literature research may not be completely applicable to the context of this research. Therefore, the use open-ended questions in future research is a better option to reveal better results instead of pre-defined categories.*

Some of the modules of the platform have no interaction (scheduler and chat) which means that some requirements and functionalities related to these modules could not be validated. It is possible that the implementation of the platform does not provide enough clarity or information to the users about all its functionalities. Also, it is possible that the number of students was not enough to reach critical mass for all services. It is important to make this distinction since interviewee 2 mention as an extra comment that: *"the same people that is participating there [platform] can create events that people can join physically that would be really nice"*, which point that at least the schedule could be useful or redesigned to present information from other sources or social media. *Therefore, it is recommended that before ruling out some of the requirements or functionalities that future research address these two limitations and a redesign of modules.*

The survey conducted at the beginning of the research introduces several questions to understand the causes leading international students to not interact or maintain regular connections with other students from the same nationality. The result of Q15 (Annex C, page 138) of *the survey indicates that academic assign-*

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ments are the major cause followed by financial pressure. It is probable that these two causes are related since the intuition for international students (EU students' fees are lower than the rest of international students but still higher than local fees) is higher than Dutch students (TU Delft, 2019). Therefore, the pressure to finish their studies takes precedence leading to prioritizing academic activities over leisure activities. Moreover, these causes are outside of the scope of this research. However, the problem analysis indicates that the lack of interaction also affects TU Delft and the municipality of Delft. *Therefore, further research should include the results of this research and develop means to institutionalize solutions at the university and the municipality regarding the first two obstacles.*

8 Conclusions

This is the last chapter of the thesis and is going to present the conclusions of the research based on the results and the information presented in the discussion.

- The results of this research can be suitable for similar situations and considering the suitable city size. In this case other small student cities with international populations.

- The artifact that suits better the task of stimulating social interaction in a heterogeneous group of international students is a web-based platform. The behavior of international students proves that it is not necessary for the implementation of a mobile application as long as the site supports mobile browsers.

- After the use of the platform in a real scenario the requirements that stimulate information sharing in a platform are: 1) Present a clear interface, 2) use a positive message, 3) support multiple digital spaces, 4) allow free expressions of users, 5) allowing different sharing formats, and 6) tracking posting and viewing activity.

- The inclusion of narratives in the platform does not make a significant impact in the context of this study.

- The information shared using the platform must be useful, relevant and interesting with the intention of providing help to other members to increase the perception of connectedness and community. In the case of international students in Delft, this information must relate to practical information and connected with the local reality of the city like housing, health insurance, and sports.

- The functionalities that the platform must have to stimulate communication are: 1) rewards for the users in terms of notification about usefulness of the information, 2) external connectivity with other sites or platforms using hyperlink, 3) digital spaces like chats with a well-defined topic and a determined time, and 4) a blog and forum functionalities with no overlapping content or topics to improve interaction.

- An online platform can foster connectedness between different groups of international students including relevant and interesting information that benefits other students. The platform should have communication channels that support interaction among users and properly present all its functionalities. Also, the platform must allow the exchange of data with other sites.

- The platform requires more exposure among international students from all nationalities to be attractive, reach critical mass and positioning itself as an alternative to traditional social media in the city of Delft.

- An integral solution requires the implementation of the findings in this research along with the integration of TU Delft and the Municipality of Delft since the factors that interfere with social interaction are related to these two institutions.

- Problems related to saturation of services for TU Delft like counseling are linked to the lack of community sense with international students. TU Delft should consider implementing new internal policies to address economic factors and balance student life for international students not only at the beginning of the academic year but during the whole year and set goals for the next five or ten years. Allowing that solutions like the one in this research fill the gap.

- The municipality of Delft should also include programs for international students and a communication interface that allow connection to other sites o platform to permit a clear communication about the benefits of the city.

- The result of this research can be different depending on the season of the demonstration and evaluation of the artifact. Therefore, it is advisable to continue this research for a longer period and in a different season.

- Other universities with similar problems could start programs or services to stimulate participation and create a community spirit to improve the livelihood of students and create positive relations with alumni.

9   Annex A: Scientific Paper

The space corresponding to Annex A belongs to the scientific paper resulting from this research. The document is in the online repository of TU Delft repository in its digital version.

10 Annex B: Literature Research - Research Gap

The results of the literature research corresponding to the main research gaps are present in Table 20. The context of the research, area of application, time reference of the study, and main contributions of the authors are detailed. The context and area of application vary depending on the researcher interest or field. Also, the application section provides an idea of the physical environment in which the research took place.

Table 20: Comparison of community resilience and contributions

Author	Context	Area of Application	Time	Application	Main Contribution
[Kitagawa, 2019]	Engage communities in the practice of everyday-life preparedness	Disaster risk reduction	Create a long run practice and culture of disaster risk reduction	Three different communities in Japan (Sendai City, Kakogawa City, and Kuroshio Town)	Identification of two success factors: key actors and active involvement
[McDermott, 2018]	Model of resilience based on human system-of-systems to include social dimensions	Disaster risk reduction	Long term development of human outcomes	Tested in three different contexts, community resilience, organizational skill retention, and political corruption	Development of a 6 processes framework to encourage systems thinking and modeling
[Bach et al., 2015]	Understanding the key elements that permit successful community resilience	Disaster risk reduction	Long term engagement to strengthen communities before, during and after a disaster	Analysis of 7 cases in different countries: Australia, New Zealand, Germany, the United Kingdom, the United States, Sweden, and Canada	Identification of 6 recurrent topics: Invest in infrastructure, increase public participation, learn together and create trust, leadership practice in line with community structure, a collaboration between jurisdictional boundaries, and improve governance
[Comes, 2016]	Determine the potential to create a remote support network between communities to share competencies and experiences	Disaster risk reduction	Long term planning and adaptation to self-organize, withstand, and recover from a crisis	Emergency response scenarios with the ad-hoc connection of professional responders, communities, volunteers, and local authorities	Identification of three gaps on information systems: temporality, plurality and polyvocality, and engagement
[Burkhart-Kriesel et al., 2019]	Analyze how engagement foster social interaction, breakdown barriers, and help members to identify attractive aspects of the community	Improve community well-being and create a sense of belonging	Long run practice to attract new members to move into the community and retain them.	Marketing Hometown America program on two communities (the City of Litchfield, and York County)	Programs should have a long-time perspective, flexibility, use timing to achieve progress, leader selection, including different perspectives, and acknowledge the progress
[Derr et al., 2018]	Integration of children and young perspective into resilience planning for cities	Quality of life improvement	Long term planning strategies including different perspectives	Analysis conducted in 3 cities: Boulder, Mexico City, and Thessaloniki	Identification of young voices provide new perspectives to resilience planning and the need for political will and resources to incorporate them into the main framework
[Wali et al., 2017]	Achieving sustainable and adaptative manage of natural resources using human well-being and environmental conservation	Environmental conservation	Focus on long-term management for protecting areas in Amazonian-Andes communities	Develop plans for improving quality of life and well-being linked to managing resources in three regions (Putumayo river basin, Tapiche Blanco, and Cordillera Escalera)	Including local voices and different perspectives based on strengths and norms can improve community resilience and improve well-being

Reference	Description	Category	Time scale	Case	Findings
[Pascua et al., 2017]	Cultural ecosystem services provide insights about human-environmental relations for sustainable interaction with natural resources considering the physical place of the community	Natural resource management	Long term management programs for natural resources	The analysis was conducted in two communities in the islands of Hawai'i and Kaua'i.	Creation of a new framework with 4 categories: Knowledge, spiritual landscapes, social interactions, and, physical and mental wellbeing
[Kelkar and Spinelli, 2016]	Identification of challenges and solutions to create viable and vibrant communities using community engagement through art and culture	Built-environment creation	Locally-driven solutions for long term creation of communities	Creation of public spaces in neighborhoods	Uses design thinking approach and research methodology obtaining 6 stages: Explore, discover, dive-in, extract, organize, and assess
[Goldstein et al., 2015]	Analyzing the impact of narratives to engage communities and allow the understanding of urban systems and transformative change	Built-environment creation, and quality of life improvement	The time scale of the narratives is not addressed in the document; however, the narrative should be added to the length of the process	Three cases: cautionary tales in Santa Ana neighborhood, multicultural narratives for integrating the Los Angeles River, and learning network for wildfire management	Argues for the inclusion of interpretative planning research in resilience design to achieve the goals of the projects
[Sacchetti and Campbell, 2015]	Analyze the differences between an interest-based approach, and a relation-based approach to create public spaces in a community	Built-environment creation, and quality of life improvement	Medium term planning in both cases due to financial restrictions only	Analysis conducted using 2 cases: using arts to create social inclusion (Scotland) and increase the social inclusion of people with health issues (Scotland)	Social enterprises have the potential to create community ownership and the importance of a variety of spaces (physical and relational)
[Bischoff et al., 2017]	A process to engage the community to support health care procedures under the supervision of experts	Health care improvement	Long term training and engagement of community members	Two different communities were selected based on population and distance to a major city	Determination of 5 principles to implement community mental healthcare: coordinate local resources, expand community capacity, have a portfolio of approaches, delivery of interventions in unconventional settings, and ensure that practices are family centered
[MacDonnell et al., 2017]	Immigrant women suffer from discrimination which decreases their mental wellbeing. Activism can improve their engagement and improve their mental state	Health care improvement	Long term planning, and promoting activism	The grand Toronto area focusing in 50 communities	The inclusion of 5 policy and program recommendations: health promotion, strengthening community action, create supportive environments, develop a healthy public policy, and develop personal skills

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11   Annex C: Survey

The first survey was conducted using SurveyMonkey as the online platform. The survey was created in the platform. The delivery method was using email distribution lists and automatic remainders in case of not responding. The platform allows personalized messages to the participants to improve the response rate. Finally, the platform allows the collection of the responses and an initial data analysis of the responses.

The present Annex includes the survey instrument that is the questionnaire itself. The survey codebook that allows the reconstruction of the survey in other platforms and it can be process by any XML tool. Finally, the email communication messages text is going to be included. This text has the initial invitation and explanation of the survey.

11.1   Survey instrument

The first part has a welcome section to the survey and provides an email address for questions.

Promoting Social Interaction Between International Students

Welcome,

The purpose of this study is to collect information about how much the international community in Delft shares experiences among each other. Thanks for participating!

Questions about the study can be made directly to the email address:
D.E.MoralesBriones@student.tudelft.nl

11.1.1   Section 1

After the introduction, it is necessary to comply with the GDPR requirements and the consent from the participants in a clear way to avoid any inconveniences [TU Delft, 2019].

Promoting Social Interaction Between International Students

As in any questionnaire used for research purposes, some basic consents are needed. The next few statements require your affirmative answer.

* 1.
I have read and understood the study information dated May 2019. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

I consent voluntarily to be a participant in this study and understand that I can withdraw from the study at any time, without having to give a reason.
I understand that taking part in the study involves responding to the question provided by this online questionnaire/survey.

I understand that the data provided will be used for academic purposes only. Please be assured that the data are confidential, and the results of any research or analysis using the data will be presented in a way that individual respondents cannot be identified.

I give permission for the data provided in this questionnaire to be archived in 4TU so it can be used for future research and learning. The archived data will comply with the principles of confidentiality previously mentioned.

☐ Yes

11.1.2 Section 2

The second section contains the sensitive questions, like nationality and accommodation from participants.

The questionnaire is composed of four sections. Some segments are longer than others and some questions required an answer before moving to the next stage.

* 2.
Please, identify your nationality

[   ]

3.
Which type of accommodation do you have?

○ Self-contained unit (Live alone)

○ Non-self-contained unit (Live with roommates)

11.1.3   Section 3

The third category looks for information about participant's social media and usage to determine possible functionalities of the IT development and KPIs.

* 4.

Which of the following media sources do you use and how often?
(Select all that apply)

	Don't use it daily	Once or twice a day	Between 3 and 6 times a day	Between 7 and 10 times a day	More than 10 times a day	N/A
Facebook	○	○	○	○	○	○
YouTube	○	○	○	○	○	○
Facebook Messenger	○	○	○	○	○	○
WhatsApp	○	○	○	○	○	○
Instagram	○	○	○	○	○	○
Twitter	○	○	○	○	○	○
LinkedIn	○	○	○	○	○	○
WeChat	○	○	○	○	○	○

Other (please specify)

* 5.

Information is considered any news, facts, or knowledge interesting to you.

Which are the preferred ways in which you receive information?
(Rank all that apply)

☰ ⇕ Newspapers (websites)		☐ N/A
☰ ⇕ Television		☐ N/A
☰ ⇕ Email list		☐ N/A
☰ ⇕ Social media (Facebook, Twitter, YouTube, etc.)		☐ N/A
☰ ⇕ Messaging platforms (WhatsApp, WeChat, Messenger, etc.)		☐ N/A
☰ ⇕ Face to face interactions		☐ N/A

6.
If you selected more than one option in Q5, which one do you trust the most?

[   ]

* 7.
What are the main ways in which you share personal information?
(Select all that apply)

☐ Websites (blogs)

☐ Email

☐ Social media (Facebook, Twitter, YouTube, etc.)

☐ Messaging platforms (WhatsApp, WeChat, Messenger, etc.)

☐ Face to face interactions

☐ Other (please specify)

[   ]

8.

What type of format do you use to share personal information on social platforms'
(Select all that apply)

- [ ] None
- [ ] Text messages
- [ ] Pictures
- [ ] Audio
- [ ] Videos
- [ ] Other (please specify)

[   ]

* 9.

How do you prefer hearing about events/activities (i.e. football tournaments, concerts, parties) near you?
(Rank all that apply.)

☰ ⬍ Billboards or flyers		☐ N/A
☰ ⬍ Email		☐ N/A
☰ ⬍ Social media		☐ N/A
☰ ⬍ Website		☐ N/A
☰ ⬍ Text message		☐ N/A
☰ ⬍ Face to face interaction		☐ N/A

10.

If you choose more than one option in Q9, which one do you trust the most?

[   ]

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11.1.4 Section 4

The fourth section will collect information about the social network of the participants, interaction with other international students on a daily basis, and isolation.

* 11.
How often do you spend time with people from other nationalities outside the academic environment?

○ Every day

○ A few times a week

○ About once a week

○ A few times a month

○ Once a month

○ Less than once a month

12.
How do you define your social network excluding academic circles?

○ Very extensive (the minority of my social network is based on class members)

○ Extensive (a small segment of my social network is based on class members)

○ Neither extensive nor restricted (half of my social network is based on class members)

○ Restricted (a good segment of my social network is based on class members)

○ Very restricted (the majority of my social network is based on class members)

13.
Within the current academic year, how often do you feel isolated?

☐ Always

☐ Usually

☐ Sometimes

☐ Rarely

☐ Never

14.

Would you be willing to increase your number of social connections?

○ Very likely

○ Likely

○ Neither likely nor unlikely

○ Unlikely

○ Very unlikely

* **16.**

A support network is a group of people close to you. This group is composed of people that we see regularly and provide support when needed.

How many people are in your support network?

○ 1 to 3 people

○ 4 to 6 people

○ more than 6 people

17. Does your support network include people from other nationalities?

○ Yes

○ No

11.1.5 Section 5

The last section looks for information that potential users would be willing to share with their neighbors.

* 18.
What are the types of activities that you would like to participate in your free time?
(Select all that apply)

☐ Sports & dance

☐ Music & concerts

☐ Cooking & eating

☐ Movies & theater

☐ Other (please specify)

19.
What is the usual time in the day that you would like to attend the events?
(Select all that apply)

☐ Weekdays in the morning

☐ Weekdays in the afternoon

☐ Weekdays in the night

☐ Weekends in the morning

☐ Weekends in the afternoon

☐ Weekends in the night

20.
Would your attendance to the activities improve if they are close to your residency place?

○ Yes

○ No

* 21.

Other international students living near you may have similar experiences o
needs. Sharing information can help people to feel accepted or find solutions.

What kind of information would you like to share with your neighbors/peers?
(Select all that apply)

☐ Location of landmarks (tourist places, parks, etc.) and useful places (supermarkets,
repair shops, etc.)

☐ "How to..." information

☐ Cultural information about your own country (carnival, día de los muertos, etc.)

☐ Easy recipes for quick meals

☐ Discounts or offers in the neighborhod

☐ Events (sport event, game nights, parties, concerts, etc.)

☐ Other (please specify)

22.

Do you have any comments/feedback about the survey or the research? Please let
us know.
(Feel free to skip this question)

23. Are you interested in the results of this study? Provide us your email address
for future contact with relevant information.
(Feel free to skip this question)

11.2 Email communication text

The present document has the opening statement included in the invitation email
for participation in the online survey (questionnaire). The invitation email is

automatically created in the online platform SurveyMonkey. The email carrying the opening statement is complemented with a button that activates a link to access the survey and collecting the responses from the participants.

The invitation email title is: *"We want to hear your voice and opinion"*. The source email corresponds to the researcher institutional account via private servers of the online platform. Finally, the invitation mail follows all the requirements to avoid being categorized as spam.

Figure 35: Email communication text

12 Annex D: Survey Results

The survey detailed in Annex B has 23 questions separated into different sections. However, some of the questions presented in the survey do not require analysis. Question 1 is the informed consent that all participants require to accept to proceed with the questionnaire. Question 22 and 23 allow the participants to provide general comments about the survey or provide an email address to receive information about the research. Therefore, this Annex only provides results on the remaining 20 questions that have useful information for the study.

12.1 Question 2

The result of question 2 is a list of nationalities, the original list includes more than 10 different nationalities. However, the study requires an analysis of only 4 groups that can be seen in Figure 36. The group with more responses is the Indian community with 14 responses or 31,11% of the total. The second and third groups are the Chinese and the Greek communities with 10 responses each or 22,22% per nationality. The last group is the sum of all remaining nationalities with 11 responses or 24,44% of the total. The total number of responses to this question is 45 with no missing values.
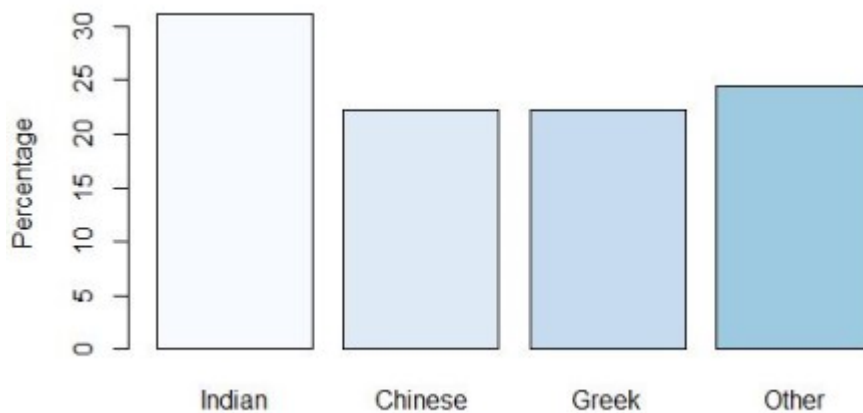
Figure 36: Responses to Q2 of the survey: Identify your nationality

12.2 Question 3

The result of question 3 is a two-level variable with information about the type of accommodation that the participants have. The responses indicate that 28 participants live in sharing spaces with roommates or 62,22% of the total. On

the other hand, 17 participants live alone or 37,78% of the total, the results can be seen in Figure 37. This question was responded by 45 people with no missing values.
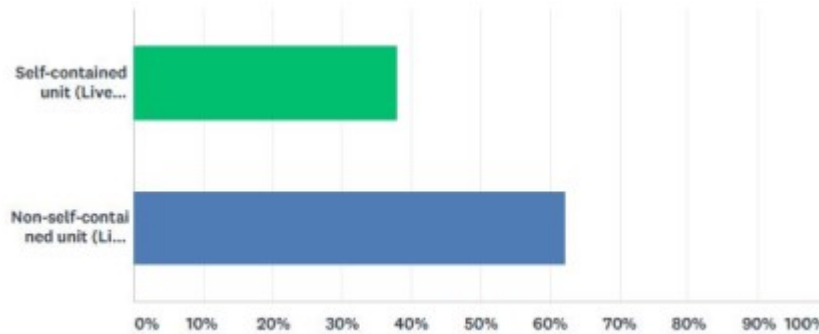
Figure 37: Responses to Q3 of the survey: Which type of accommodation do you have?

12.3 Question 4

The result of question 4 indicates which social media is used by the participants and how often. The question uses a list of 8 social media from the 15 most popular social media of 2019 [Digital Information World, 2019]. Each platform has 5 levels of use frequency or an N/A option to indicate that is not used. Moreover, this question allows the participants to add any social media that they use, and it was not pre-selected in the list.

The universal platform among the participants is YouTube with a 100% use rate. The second most used platform is WhatsApp with 97,78% of use. The third position is for Facebook with 95,56% of use. There is a tie in the fourth position with a 91,11% of use between Facebook Messenger, Instagram, and LinkedIn. The fifth position is for Twitter with a 71,11% of use and the last position is for WeChat with a 64,44% of use. Figure 38 presents the results per platform.
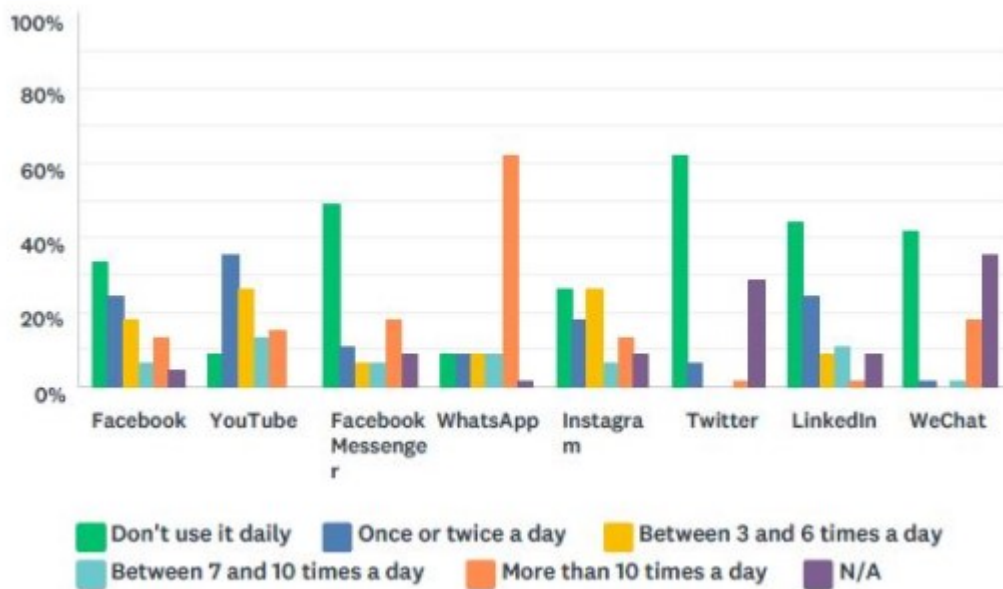
Figure 38: Responses to Q4 of the survey: Which of the following media sources do you use and how often?

In terms of usage frequency, the results are different. The most frequently used platform is WhatsApp with 62,22% of its users picking up the application more than 10 times a day. The second position has a tie between Facebook Messenger and WeChat with 17,78% of participants using the application more than 10 times. The third position is YouTube with 15,56%. The fourth position has a tie between Facebook and Instagram with 13,33% of heavy use. Finally, in the last position, Twitter and LinkedIn can be found with 2,22% of use more than 10 times a day.

On the other hand, social media with less frequently use – *'Don't use it daily'* – is Twitter with 62,22% of its users. Facebook Messenger is the second less frequently used with 48,89%. The third position is for LinkedIn with 44,44% of users not picking it up daily. WeChat has the fourth position with a 42,22% followed by Facebook with a 33,33%. Instagram is the sixth less frequently used platform with 26,67% of participants not using it daily. Finally, YouTube and WhatsApp are tied in the last position with only 8,89% of its users not picking up with the applications daily.

Question 4 has a response of 45 participants with no missing values. At the same time, two participants indicated that they use other platforms, Line and Telegram. Both extra options are messaging platforms used determinate regions or known for their encryptions and confidentiality.

12.4 Question 5

The result of question 5 is a ranked list with six different ways of communication. The pre-selected options can be ranked from 1 to 6. It is also possible to select the option *N/A* in case the participant does not use that form of communication to receive information. The question has a response from 45 participants and no missing values.

Face to face interactions is the universal way to receive information with a 100% rate of use. The second most common preferred way to receive information is social media with 97,78% of use. The third way of communication is messaging services with 93,33% of the participant using these services. The fourth preferred way to receive information is newspapers or dedicated webpages with an 88,89% of use. The fifth position is for email lists with an 86,67%, and in last position, it is television with a 57,78% of use.
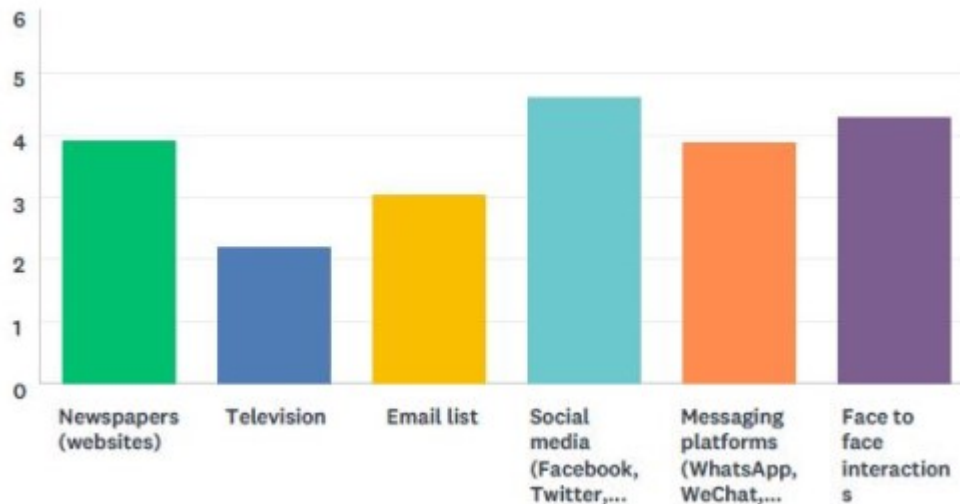
Figure 39: Responses to Q5 of the survey: Which are the preferred ways in which you receive information?

Figure 39 shows the results of the ranking, in the first place we can find social media with an overall score of 4,61 or 33,33% of its users voting as their favorite way to receive information. In a second place, there is face to face interactions with a score of 4,29 or 20% of participants voting as their preferred way and 20% as their second favorite. In third place are newspapers or dedicated websites with a 28,89% as favorite, but only an 8,89% as the second favorite. The fourth place with a minimum difference is for messaging platforms with a 3,88 overall score or 13,33% of users ranking it as their favorite. In fifth and sixth position are

email list and television with 2,22% of their users choosing them as their favorite. However, email has a 13,33% versus 6,67% of television responses choosing them as the second favorite.

12.5   Question 6

The result of question 6 is a list of options based on the pre-selected choices of question 5. The original options in the previous question have six options, however, this is an open question that allows the participants to express themselves. Therefore, we have seven level responses that can be seen in Figure 40. The communication way most trusted is newspapers or dedicated websites with 52,94% of responders' confidence. The second most trust option is face to face interactions with 14,07% of confidence. In third place with 11,76% of trust is email list option. Social media has the fourth position with 8,82% of trust among the participants. In fifth place with 5,88% of participant choosing it as trustworthy are messaging platforms. In the last place, we can find television with 2,94% of trust among the participants. The extra response also has a 2,94% of the participant's votes, however, the response is *'None of them'*. The total number of responses to this question is 34 with 11 missing values.
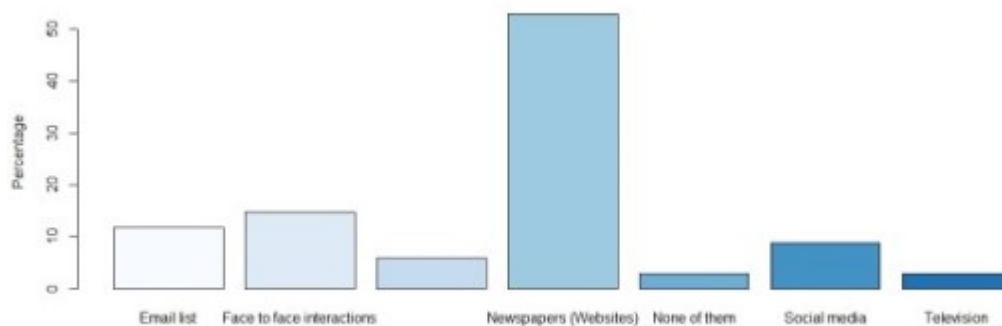
Figure 40: Responses to Q6 of the survey: Which one (preferred ways of receiving information) do you trust the most?

12.6   Question 7

The result of question 7 is a list with pre-selected ways to share personal information, the list has five choices and is related to previous questions. The responses indicate that 91,11% of the participants share information through face to face

interactions. The second most selected option is messaging platforms with 75,56% of the participants choosing it. In the third position is social media with 48,89% of participants selected it. The fourth position is email with 40% of participant selecting it as a media to share information. Finally, websites or blogs with 6,67% of participants selecting it. The results can be seen in Figure 41. This question was responded by 45 people with no missing values.
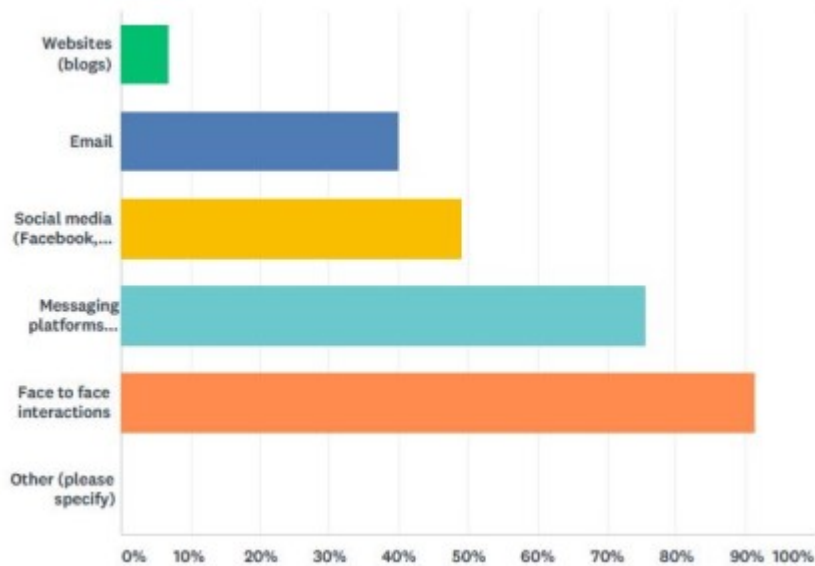
Figure 41: Responses to Q7 of the survey: What are the main ways in which you share personal information?

12.7   Question 8

The result of question 8 is a list with five pre-selected formats to share information and the number of votes. The responses show that 84,44% of the participants share information through pictures. Close, in the second position is text with 82,22% of participants' votes. The third position has a tie between audio and videos with 17,78% of responses. Finally, the last option is none with 4,44% of participants results. All the results can be seen in Figure 42. This question was responded by 45 people with no missing values.
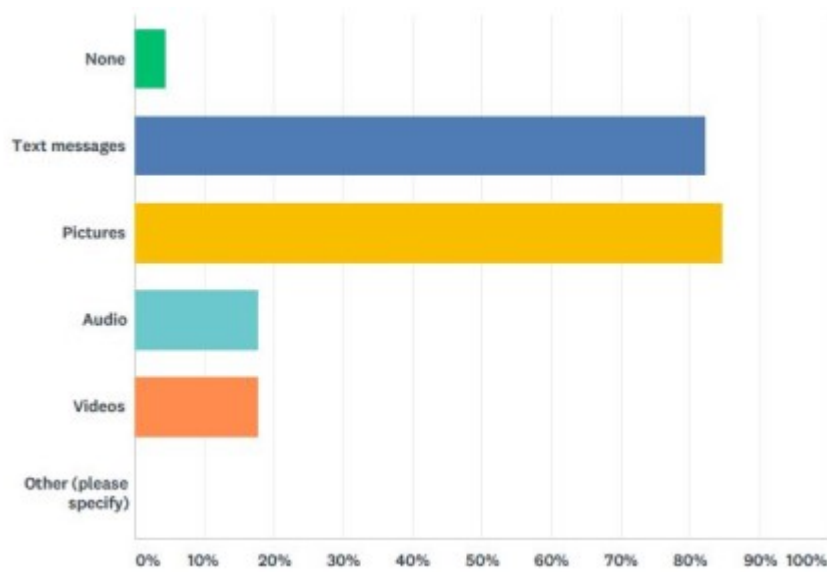
Figure 42: Responses to Q8 of the survey: What type of format do you use to share personal information on social platforms?

12.8 Question 9

The result of question 9 is a ranked list with six different ways of communication. The pre-selected options can be ranked from 1 to 6. Like in question 5, it is also possible to select the option *N/A* in case that the participant does not use that form of communication to hear about events and activities. The question has a response from 45 participants and no missing values.

Social media is the universal way to hear about events with a 100% rate of use. In the second position, there is a tie between dedicated websites and face to face interaction with 97,78% of use. The third way of communication is billboards/flyers with 93,33% of the participant using these ways. The fourth preferred way to hear about activities is text message with an 88,89% of use. The fifth position is for email lists with an 82,22%, and in last position.

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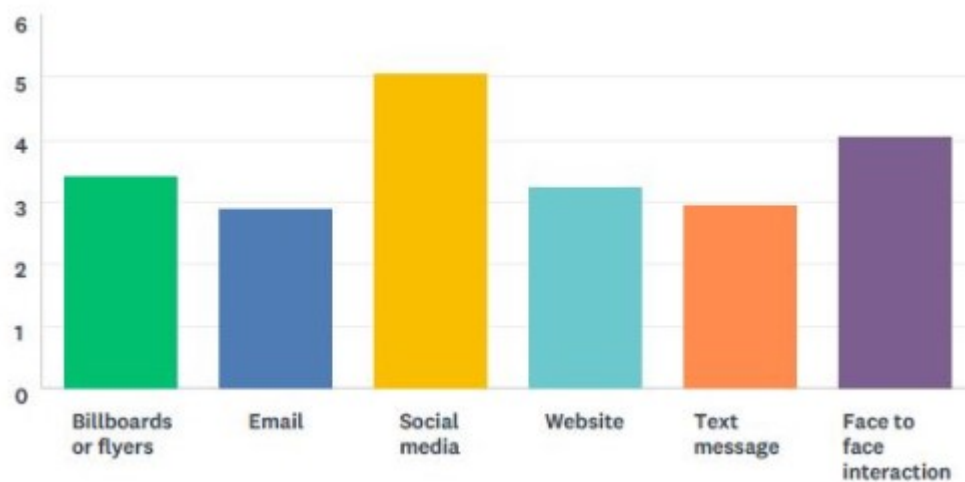
Figure 43: Responses to Q9 of the survey: How do you prefer hearing about events/activities near you?

Figure 43 shows the results of the ranking, in the first place we can find social media with an overall score of 5,07 or 44,44% of its users voting as their preferred way to receive notification about events. In a second place, there is face to face interactions with a score of 4,05 or 22,22%. In third place are billboards/flyers with a 15,56% as favorite. The fourth place with a 3,25 overall score or 13,33% of users ranking it as their favorite is website. In fifth and sixth position are text message and email list with 2,95 and 2,89 or 2,22% for both as a favorite way. However, text message has 15,56% of its users ranking as the second favorite against only 11,11% of email lists.

12.9 Question 10

The result of question 10 is a list of options based on the pre-selected choices of question 9. The original options in the previous question have six options, however, this is an open question that allows the participants to express themselves. Therefore, we have only five level responses that can be seen in Figure 44. The most trusted communication way for events and activities is social media with 29,72% of responders' confidence. The second most trust option is websites with 27,02% of confidence. In third place with 21,62% of trust are billboards/flyers. Face to face interaction has the fourth position with 16,21% of trust among the participants. In the last place with 5,40% of participant choosing it as trustworthy is email. The total number of responses to this question is 45 with 0 missing values.

142
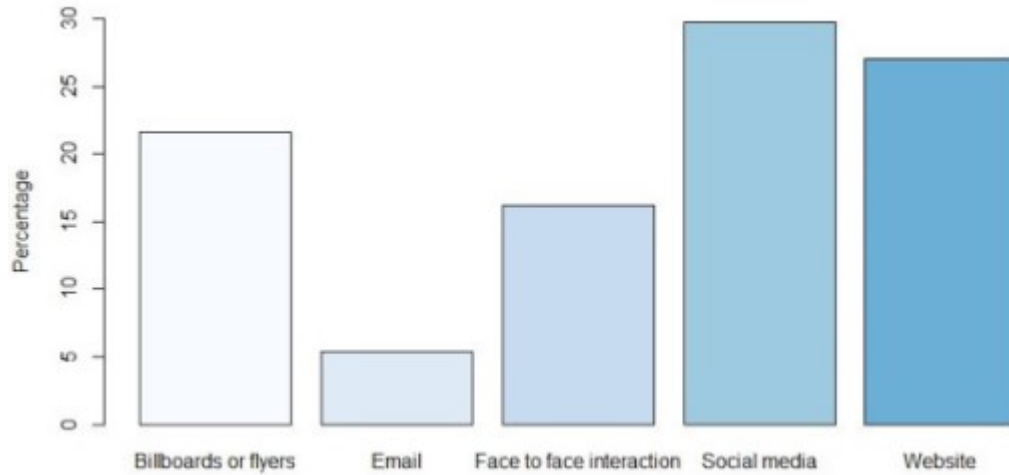
Figure 44: Responses to Q10 of the survey: Which one (preferred ways to hear about events) do you trust the most?

12.10   Question 11

The result of question 11 is a six-level variable with information about how often the participants engage with people from other nationalities. 26,67% of the participants spent time every day with people from other nationalities. The responses indicate that 40% of participants share time a few times a week. About once a week receive a 4,44% of responses from the participants. A few times a month, on the other hand, receive 13,33% of votes. Once a month also receive 4,44% of votes. Finally, less than once a month is selected 11,11% of the time, the results can be seen in Figure 45. This question was responded by 45 people with no missing values.
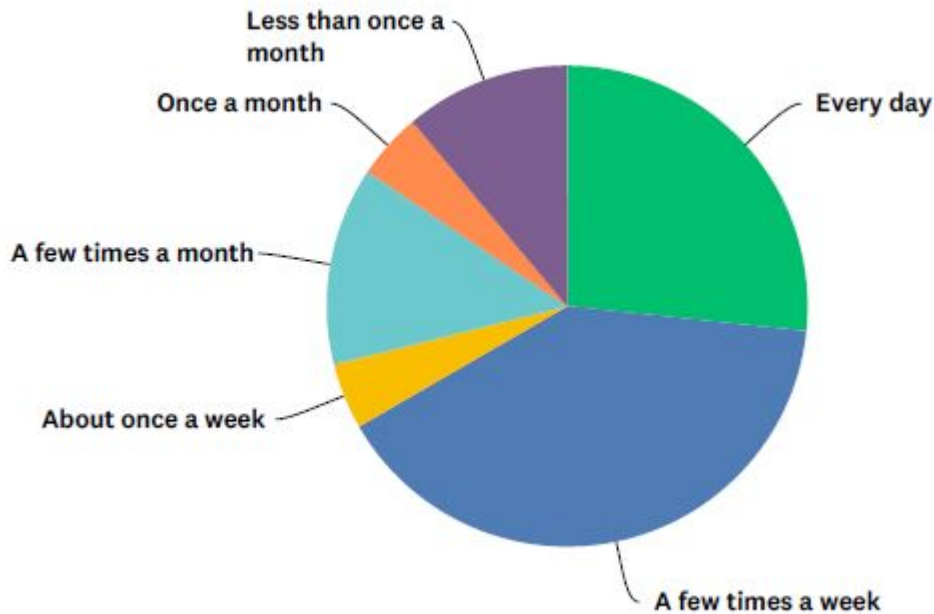
Figure 45: Responses to Q11 of the survey: How often do you spend time with people from other nationalities outside the academic environment?

12.11 Question 12

The result of question 12 is a five-level variable with information about how connected a participant is. 11,11% of the participants report a very extensive network. The responses indicate that 24,44% of participants have an extensive social network. Neither extensive nor restricted receive a 37,78% of responses from the participants. Restricted, on the other hand, receive 20% of votes. Finally, very restricted receive 6,67% of votes, the results can be seen in Figure 46. This question was responded by 45 people with no missing values.
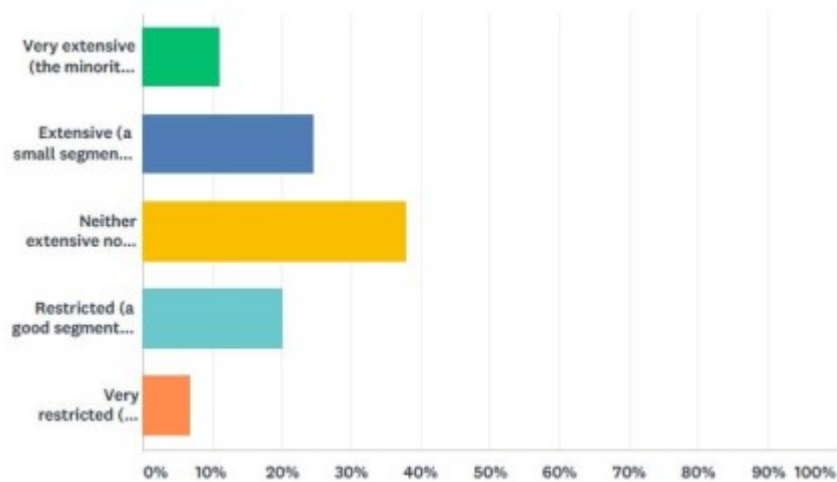
Figure 46: Responses to Q12 of the survey: How do you define your social network excluding academic circles?

12.12 Question 13

The result of question 13 is a five-level variable with pre-selected levels of frequency for feelings of isolation. The results can be seen in Figure 47, and the option always has 2,22% of responses. The option usually has 6,67% of the participants. The third option, sometimes, has 53,33% of votes. On the other hand, the option rarely has 33,33% of responses. Finally, the option never has 6,67% of votes. The total number of responses to this question is 45 with no missing values.
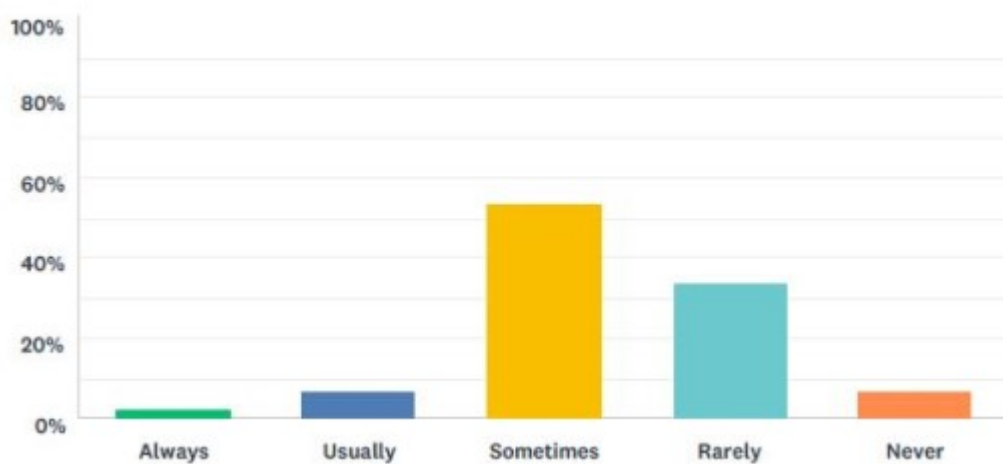
Figure 47: Responses to Q13 of the survey: Within the current academic year, how often do you feel isolated?

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12.13   Question 14

The result of question 14 is a five-level variable with information about the willingness to increase social connections. The responses indicate that 13,64% of the participants express the option very likely. 52,27% of the responders choose likely as their answer. Neither likely nor unlikely receive a 22,73% of responses. On the other hand, 11,36% of the participants choose unlikely as the answer. Finally, no responses are registered for very unlikely, these results can be seen in Figure 48. This question was responded by 44 people with 1 missing value.
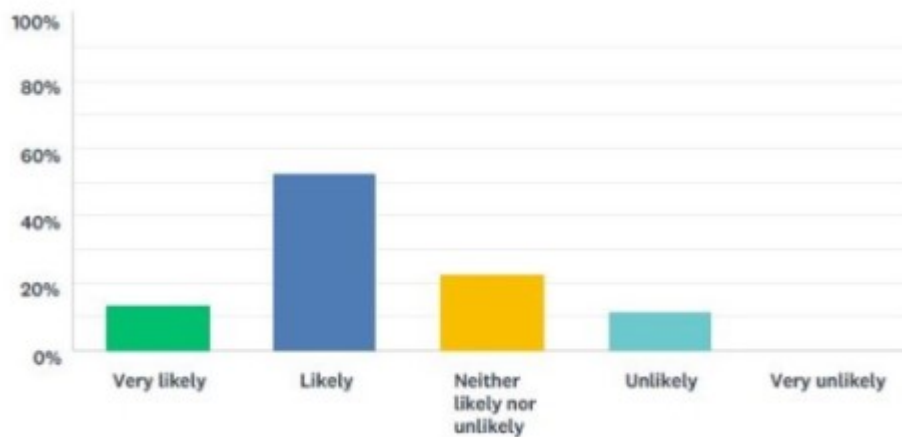
Figure 48: Responses to Q14 of the survey: Would you be willing to increase your number of social connections?

12.14   Question 15

The result of question 15 is a list with five pre-selected reasons that could hamper the chances of interact with other people. The question allows the participants to propose different reasons not listed by the researcher. The responses show that 80% of the participants find academic assignments the biggest obstacle. In the second place, financial pressure with a 42,22% is the second more troublesome factor. Participants vote cultural differences as the third option with a 37,78% of votes. In the fourth position with 33,33% of the participant is for limited physical space. Finally, the last option is few information about events registers 24,44% of votes. All the results can be seen in Figure 49. Moreover, the results show that 15,56% of participant choose different reasons. The other reasons can be categorized into three reasons: Prefer not to interact, language, and more urgent matters. This question has 45 responses with no missing values.

146
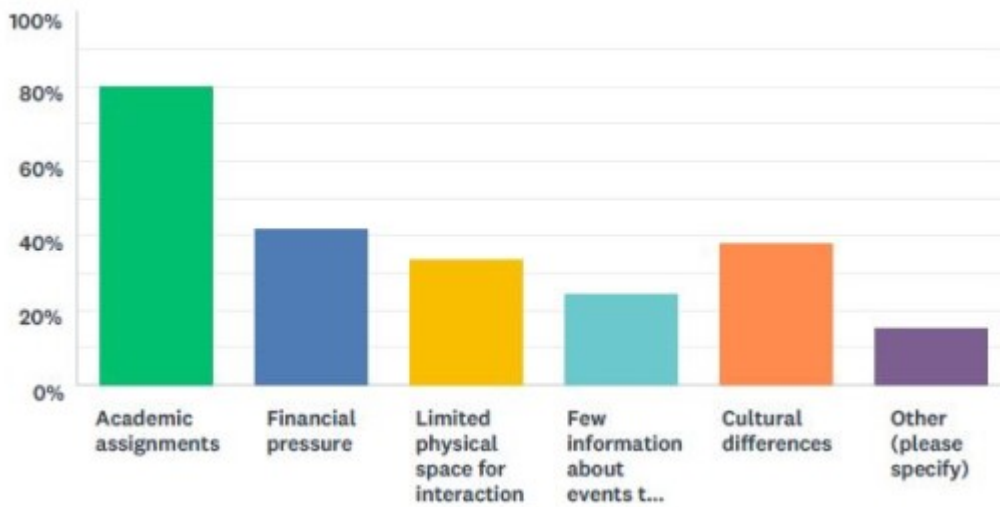
Figure 49: Responses to Q15 of the survey: Which are the main factors that you think could limit your interactions with people in your free time?

12.15 Question 16

The result of question 16 is a three-level variable with information about the size of a support network. The responses indicate that 31,11% of the participants have a support network between 1 and 3 people. Option 4 to 6 people is selected by 53,33% of the participants. Finally, the option more than 6 people have a 15,56% of participants selection, these results can be seen in Figure 50. This question was responded by 45 people with no missing values.
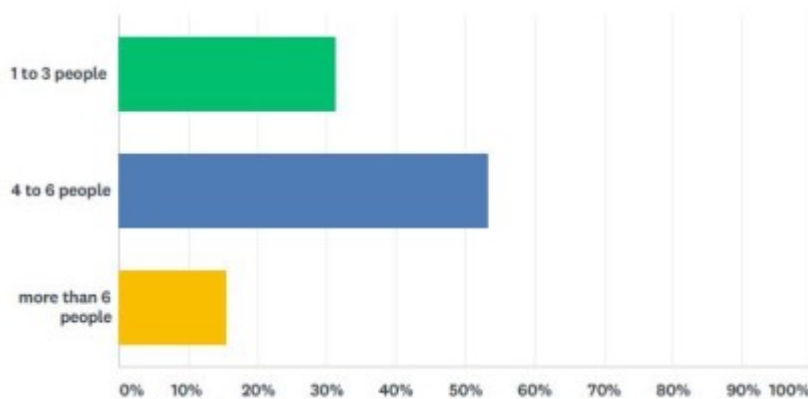
Figure 50: Responses to Q16 of the survey: How many people are in your support network?

12.16 Question 17

The result of question 17 is a two-level variable with information about the inclusion of people from other nationalities in a support network. The responses indicate that 25 participants have people from other nationalities in their support network or 55,56% of the total. On the other hand, 20 participants only rely on their own nationality or 44,44% of the total, the results can be seen in Figure 51. This question was responded by 45 people with no missing values.
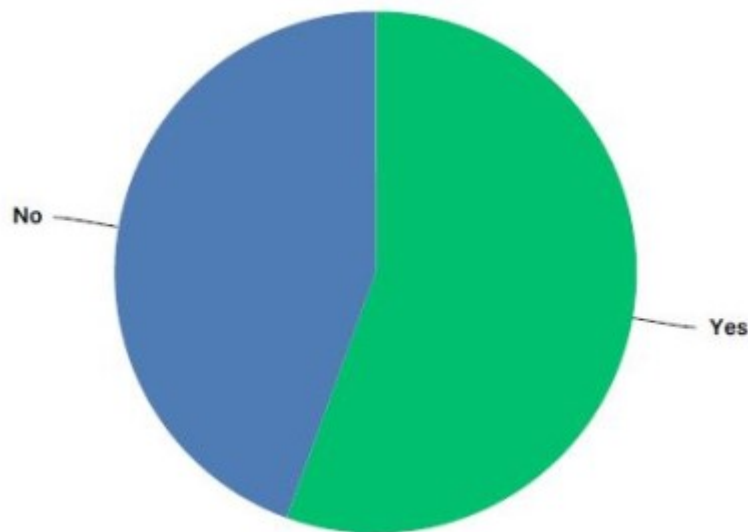
Figure 51: Responses to Q17 of the survey: Does your support network include people from other nationalities?

12.17 Question 18

The result of question 18 is a list of four pre-selected activity categories for leisure. The question allows participants to use the options *'Other'* to include any activities that the researcher have not included. The responses show that 80% of the participants are interested in cooking & eating activities. In second place we have a tie between music & concerts activities and movies & theater with a 71,11% of responses. The third position has 17,78% of votes corresponding to sports & dance activities. Finally, the other option has 6,67% of votes. All the results can be seen in Figure 52 and the proposed activities are: a book club, photography, and sightseeing & drinking. This question was responded by 45 people with no missing values.
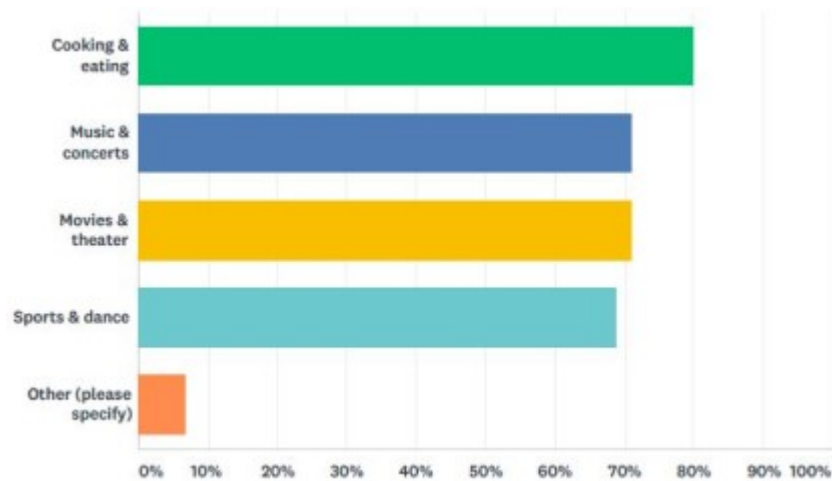
Figure 52: Responses to Q18 of the survey: What are the types of activities that you would like to participate in your free time?

12.18 Question 19

The result of question 19 is a list of six pre-selected time slots. The responses show that 88,64% of the participants are interested to attend events weekends in the night. The second most preferred option is weekends in the afternoon with 84,09%. The third position with a 68,18% of votes is for weekdays in the night. The fourth position with 25% of responses is weekends in the morning. Finally, with 9,09% of positive responses weekdays in the afternoon is the last option selected. There are no responses for the option weekdays in the morning, all results can be seen in Figure 53. This question was responded by 44 people with 1 missing value.
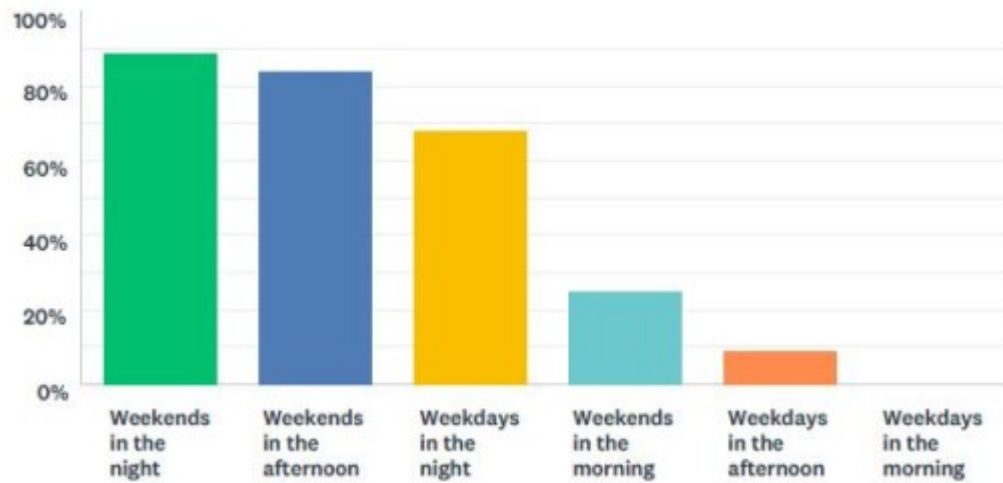
Figure 53: Responses to Q19 of the survey: What is the usual time in the day that you would like to attend the events?

12.19 Question 20

The result of question 20 is a two-level variable with information about willingness to attend events and proximity. The responses indicate that 41 participants are more willing to attend an event if it is close, or 93,18% of the total. On the other hand, 3 participants indicated that the proximity of events does not improve her/his attendance, 6,82% of the total. The results can be seen in Figure 54. This question was responded by 44 people with 1 missing value.
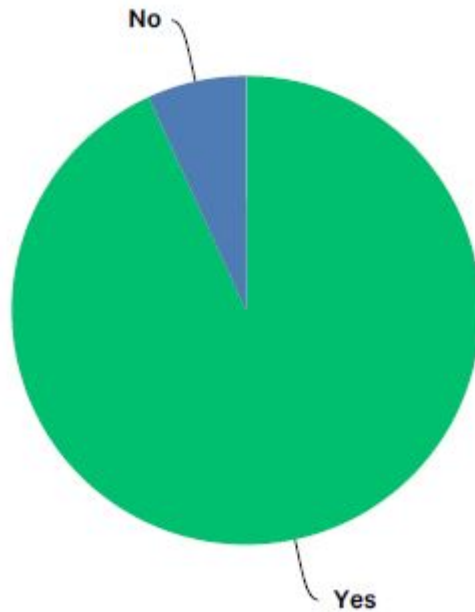
Figure 54: Responses to Q20 of the survey: Would your attendance to the activities improve if they are close to your residency place?

12.20 Question 21

The result of question 21 is a list of six pre-selected types of information to share among pairs. The question allows participants to use the options *'Other'* to include any type of information that the researcher has not included. The responses show that 84,44% of the participants are interested in share information about events. In second place we have the location of landmarks and useful places with 71,11% of responses. The third position has 62,22% of votes corresponding to *'How to...'* information. The next result, easy recipes for quick meals receive 51,11% of the participant's vote. Finally, in the last position, there are a tie between cultural information, and discounts or offers in the neighborhood with 48,89% of positive responses. All the results can be seen in Figure 55. The option *'Other'* receives a 2,22% of votes and the type of information is about recent life events, tv series, or news. This question was responded by 45 people with no missing values.
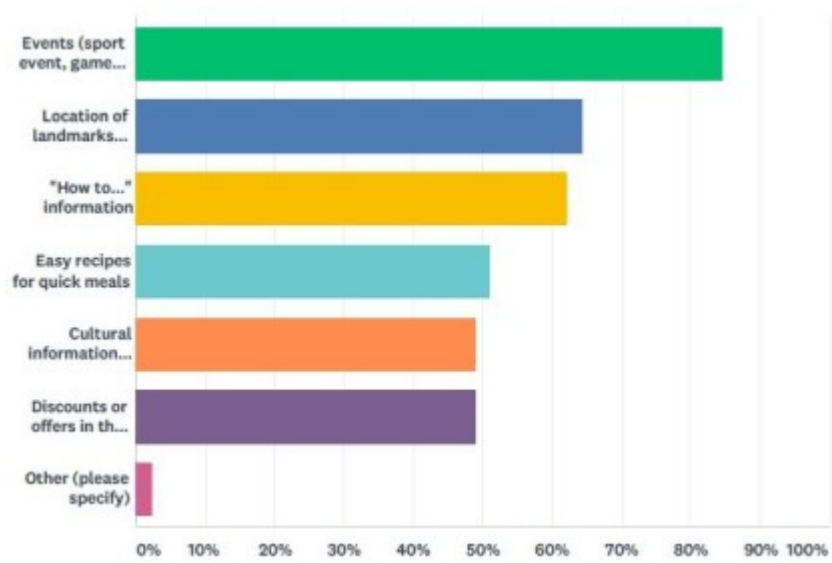
Figure 55: Responses to Q21 of the survey: What kind of information would you like to share with your neighbors/peers?

13   Annex E: Online Platform

The online platform requires design and implementation. Annex D presents the design of the platform in ArchiMate modeling language for a clear understanding of the different relations between governance, architecture, and modules. Finally, the second section presents the platform implementation to visualize the final product.

13.1   Design

Figure 56 presents the platform's design in three layers: 1) business layer, 2) application layer and 3) technology & physical layer. These three layers allow the representation of governance, architecture, and modules in a single diagram. First, governance and the content layer of the architecture are in the business layer. Second, modules and service layer of the architecture are in the application layer. Finally, the network and device layer of the architecture are in the technology & physical layer.
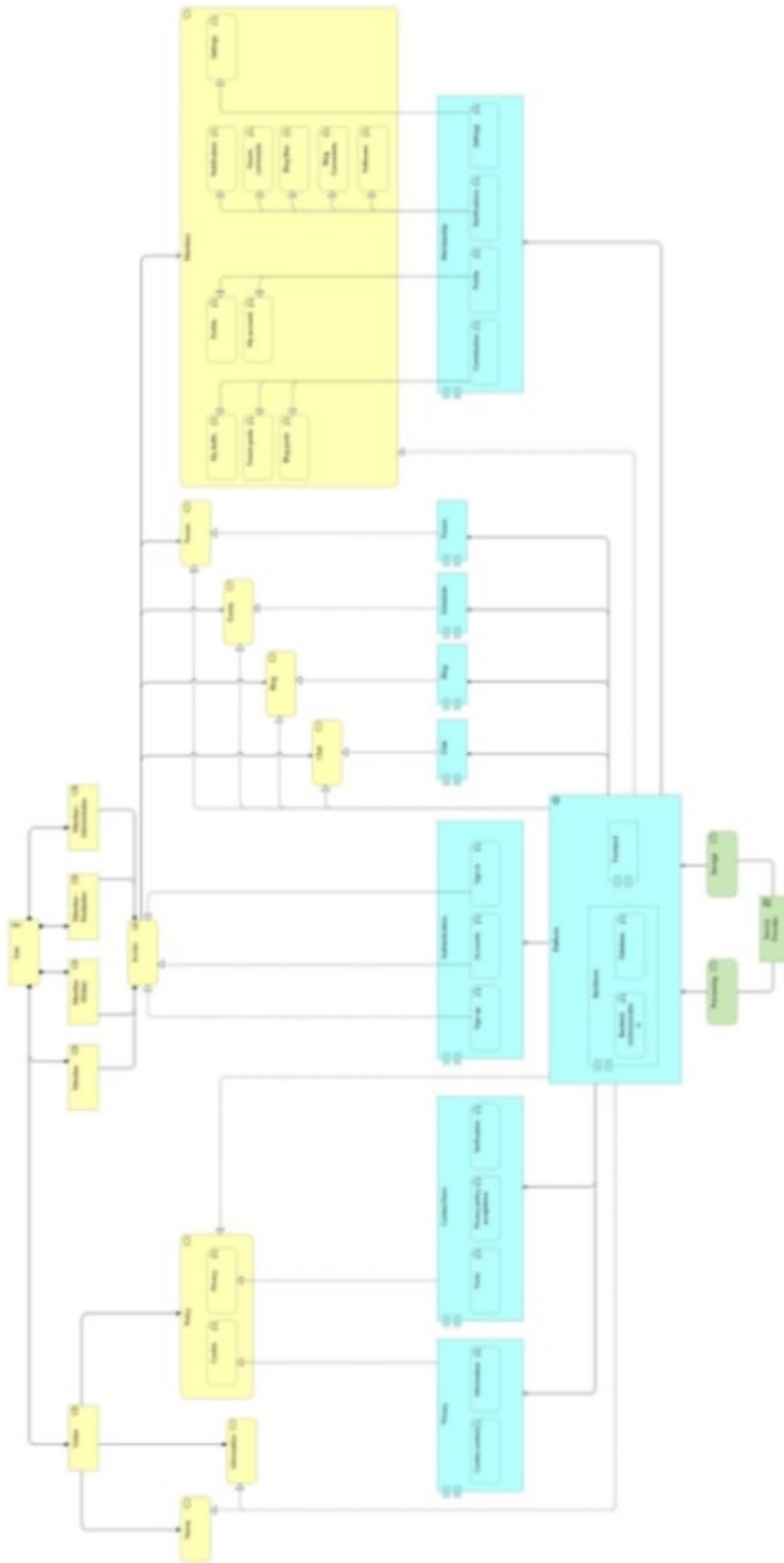
Figure 56: Design of the Platform

13.2 Implementation

The platform implementation has, as a result, a series of webpages that allow the users to interact with the platform. Behind any page, there is a specific module that allows its operation. The platform's frontend is responsible for the final presentation of the pages and the support of different types of data.

The present section of the Annex shows the final version of the platform. The implementation of the platform has, as a result, the human-machine interface (HMI) that allow the user to interact with the services and in turn with another user. Therefore, the implementation is going to present pages/subpages associated with each module in the order of appearance when using the system.

13.2.1 Cookie Policy

After the home page finish loading, the cookie policy page provides information about cookies and asking consent to install cookies for the operation of the system and collection of data. The cookie policy page is part of the privacy module.
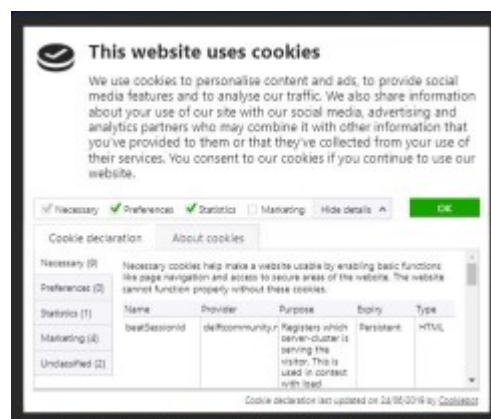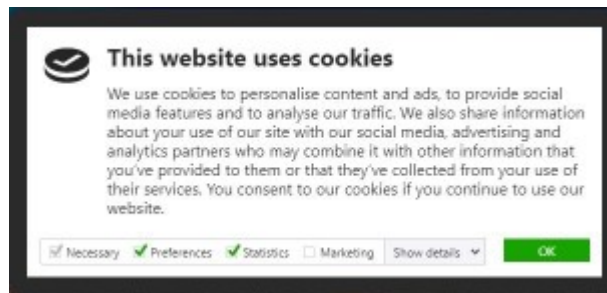
13.2.2 Home

After the consent granted in the cookie policy page, the home page becomes accessible. This page has connections to the main platform since uses the services of the backbone and frontend modules. The home page displays in the upper section the menu of the platform for access different services and the log-in which starts the access process. Furthermore, the page displays information using storytelling to communicate a positive message and encourage participation. In the bottom part of the home page, it is possible to find the contact form that uses the module with the same name.
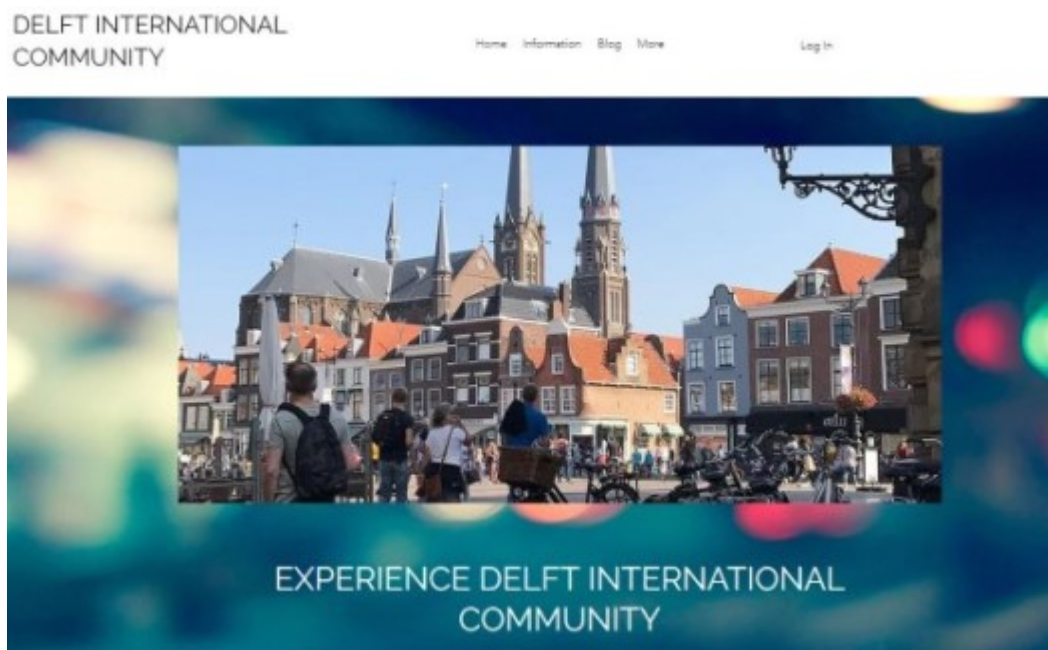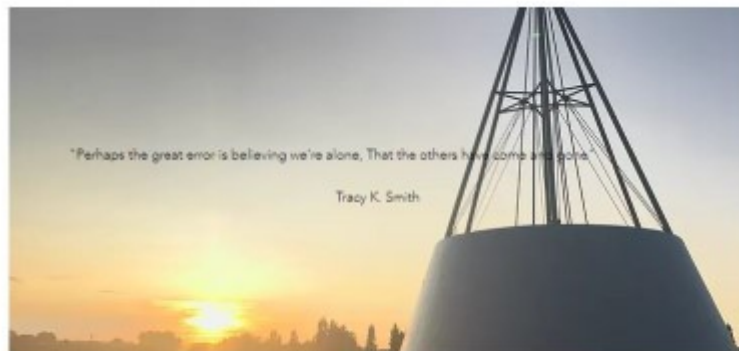
13.2.3   Contact Form

The contact form does not have a specific page. However, this section of the home page has a connection to other pages interacting with the submodules verification and privacy policy acceptance. The first submodule lunches the ReCAPTCHA page for the control of viruses and spambots. Finally, privacy policy acceptance launches the privacy policy page.

Contact the Community Next to You

Pedro Perez   danny_dmb@yahoo.com

Information request

Information request

☑ "I have read and agreed to the Terms of Use and Privacy Policy." View terms
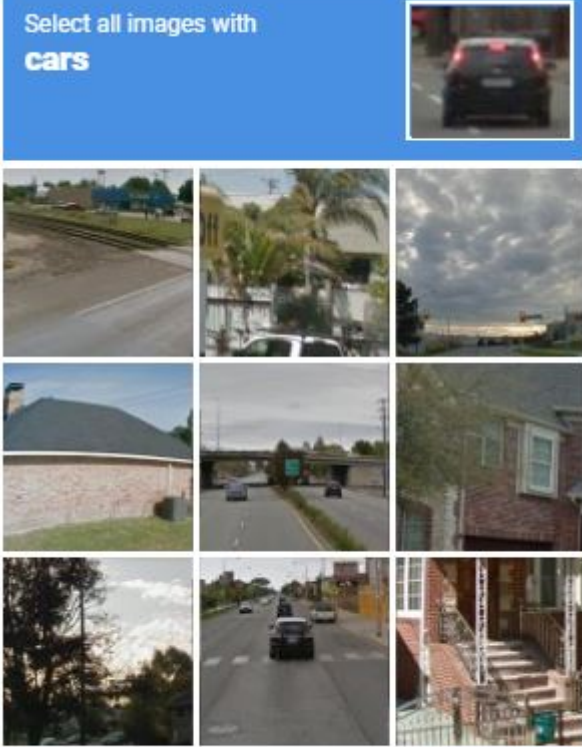
☐ I'm not a robot

Submit

Select all images with
cars

VERIFY

13.2.4 Private Policy

The private policy page is associated with other pages since is accessible on demand. This page displays information about the term and conditions, collections of data, and third party's information and policies (i.e. the service provider WIX)

DELFT INTERNATIONAL
COMMUNITY

Home   Information   Blog   More   ∨   Hello Danny Morales 🔔

Privacy Policy

What type of information do you collect?

We receive, collect and store any information you enter on our website/platform or provide us in any other way. In addition, we collect the Internet protocol (IP) address used to connect your computer to the Internet; login; e-mail address; password; computer and connection information and purchase history. We may use software tools to measure and collect session information, including page response times, length of visits to certain pages, page interaction information, and methods used to browse away from the page. We also collect personally identifiable information (including name, email, password, communications); payment details (including credit card information), comments, feedback, product reviews, recommendations, and personal profile.

How do you collect information?

When you conduct a transaction on our website/platform, as part of the process, we collect personal information you give us such as your name, address and email address. Your personal information will be used for the specific

13.2.5 Information

The information page presents information about the use of the platform, basic information about the interest area, and disclose the goal of the platform. This page has a connection with the main platform since the main purpose is to carry information to the users or visitors.
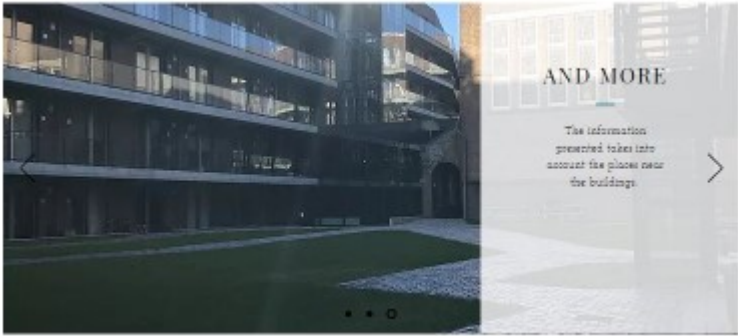
How does it work?

The platform has different functionalities, some are visible to any visitor and others are only available for members. If you are an international student in Delft you can become a member and contribute with the content.

The first step is easy, become a member by signing up. It is necessary that you provide a valid email account for communication purposes. After the verification, you can enjoy the benefits of the platform.

- Blog.- This feature is public, which means that all blogs can be seen for visitors or members as well. However, posting in the blog requires being a member and express your desire to write your opinions and interest topics (Send a message through the contact form on the home page).

- Forum.- This feature is only accessible to members. The forum offers the option to share multiple contents in different formats. You can follow other members or forums that you find interesting. It is possible to comment and like posts of other members to share your support or if you simply like the information.

- Events.- This feature is only accessible to members. The events section presents public events that happen in the city and events created by members.

- Chat (beta).- This feature is a beta release and only accessible to members. You can communicate with other members in this live chat. Join the conversation.

AND MORE

The information presented takes into account the places near the buildings.

BLOG

The blog presents general topics from our community members to the public. The topics are general and go from temperatures in summers to pieces of advice if you are new in the city.

MEMBERS

Do you live in the area described in the information section? Become an active member of the community. Pass your knowledge and experiences to the newcomers (i.e. bikes are just the beginning). We all can make a change.
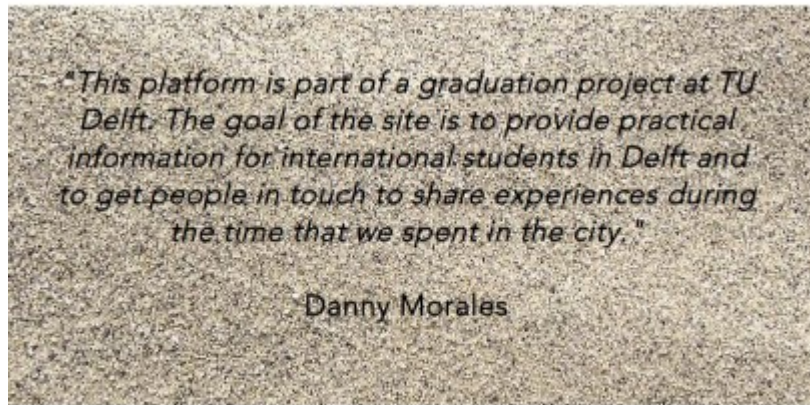

EVENTS

This section informs you about events happening next to you. If you are a member and want to create an event this section is for you.

FORUM

Members can collaborate and share in the platform. You have several categories and a multitude of media formats supported so you can express yourself. Did you find a cheap & nice place to have breakfast? Share it with your neighbors.

"This platform is part of a graduation project at TU Delft. The goal of the site is to provide practical information for international students in Delft and to get people in touch to share experiences during the time that we spent in the city."

Danny Morales
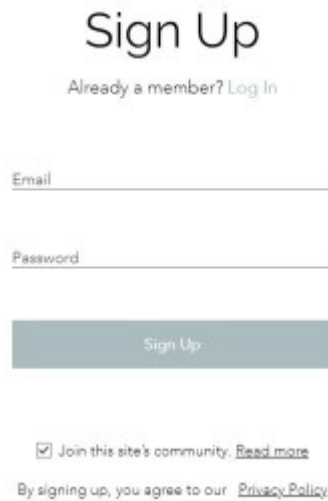
13.2.6 Blog

The blog page is visible to all visitors of the platform. However, accessing the services of the page requires becoming a member. The blog page displays the blogs created for members and permits the publication of long text with the purpose of share experiences that can connect to the public.
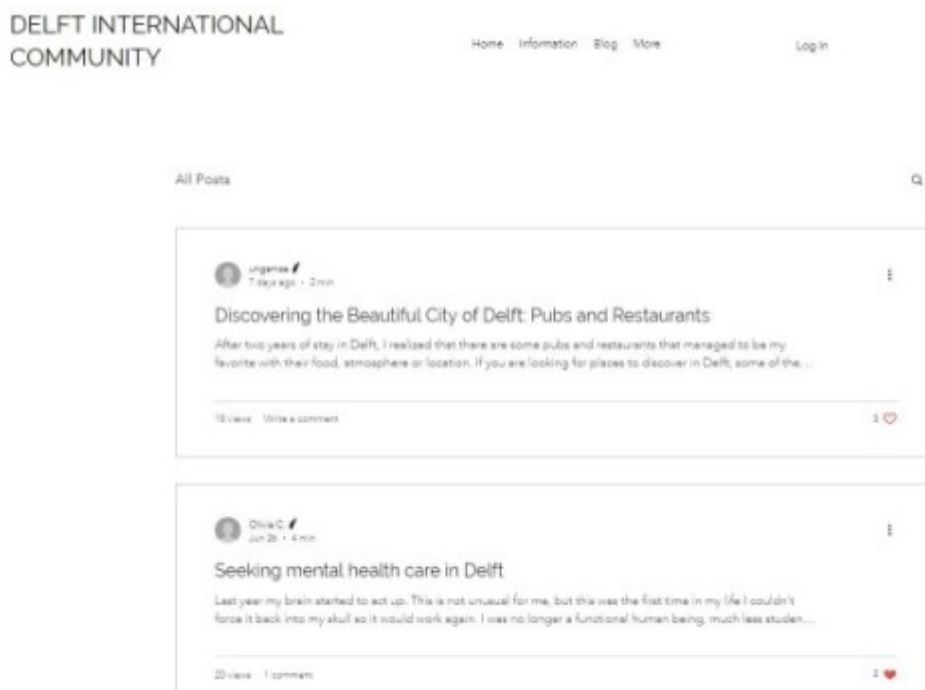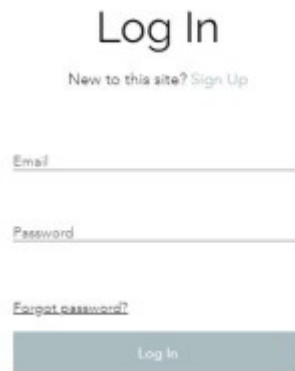
13.2.7 Access

The access page is a collection of different small pages that work together to allow the users of the platform to register as a member and authenticate to get access to the services of the platform. The access cluster has connections to the authentication module. The pages connected are sign-up, sign-in, and my account. However, my account is part of the membership module and only uses information collected on the sign-up page.

Sign Up

Already a member? Log In

Email

Password

Sign Up

☑ Join this site's community. Read more

By signing up, you agree to our Privacy Policy

Log In

New to this site? Sign Up

Email

Password

Forgot password?

Log In

13.2.8 Members

The members page is a collection of 11 subpages that work together to display information about the members and their activities. This cluster has a direct

connection with the membership module. Furthermore, Different pages connect to different submodules and it is possible to locate the connection in the design section of this Annex.

DELFT INTERNATIONAL
COMMUNITY

Home   Information   Blog   More   ∨ Hello Danny Morales 🔔
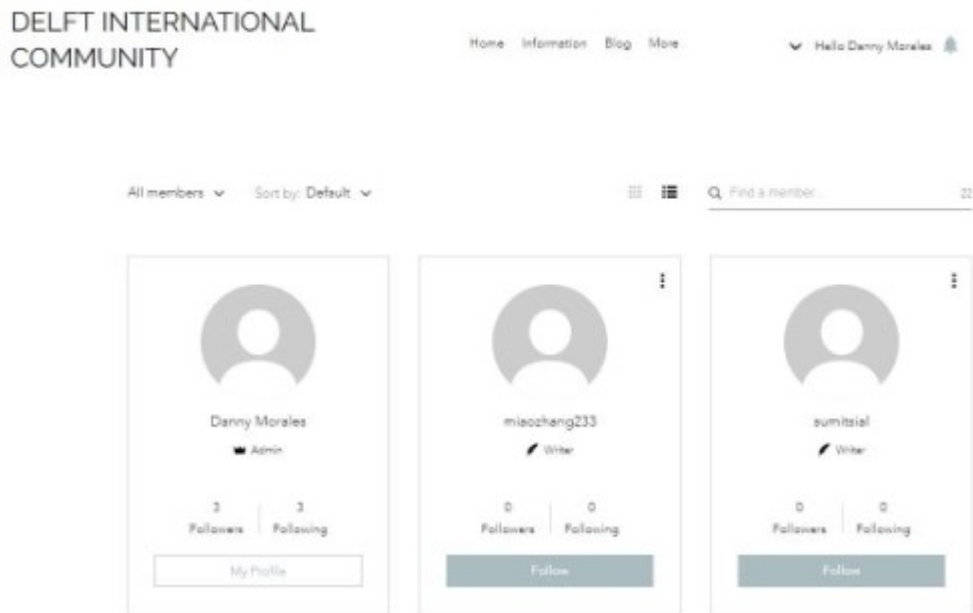
About   ⋮

0 Like Received   0 Comment Received   0 Top Comment

Hi

📷 🎥

Danny Morales
👑 Admin
3   3
Followers   Following

Edit

Profile

Blog Posts

My Drafts

Blog Comments

Blog Likes

Forum Posts

Forum Comments

My Account

Notifications

Settings

My Account
View and edit your personal info below.

Login Email:
danny_dmb@yahoo.com ⓘ

Danny Morales
👑 Admin
3   3
Followers   Following

Edit
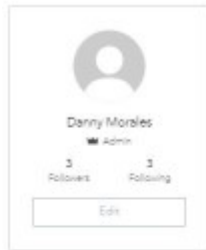
Your Community Page URL
This is your own personalized URL that other members can see.
https://www.delftcommunity.nl/profile/danny_dmb

danny_dmb

Profile

Blog Posts

First Name   Last Name

My Drafts

e.g. Kim   e.g. Smith

Blog Comments

Blog Likes   Contact Email   ⊕

Forum Posts

danny_dmb@yahoo.com

Forum Comments

This is the email we'll use to contact you.

My Account

Notifications   Update Info

Settings

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Privacy Policy

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Notifications

Profile

Blog Posts

My Drafts

Blog Comments

Blog Likes

Forum Posts

Forum Comments

My Account

Notifications

Settings

| RA | rafaelcbfc commented on "Let's see what we can do" | 6 days ago |

Notification Settings

Profile

Blog Posts

My Drafts

Blog Comments

Blog Likes

Forum Posts

Forum Comments

My Account

Notifications

Settings

Blog Subscription
Receive emails about new posts and updates.   Unsubscribe

Blog Notifications   Email Notifications

Likes
Notify me when members like my posts and comments.

Comments
Notify me when members comment on my posts

Follows
Notify me when there are updates about members and posts I follow.

Forum Notifications   Email Notifications

Likes
Notify me when members like my posts and comments.

Comments
Notify me when members comment on my posts

Follows
Notify me when there are updates about members and posts I follow.

General
Notify me about forum updates

Forum Posts

Danny Morales
Admin · Jun 22

Let's see what we can do

Today I was playing with the forum, and decided to post an image with a nice link to Google Maps to show where it was taken. Then, I decided to put a link to an external video: https://youtu.be/yX-sKIZP2zA So, find your category and keep add...

Profile
Blog Posts
My Drafts
Blog Comments
Blog Likes
Forum Posts
Forum Comments
My Account
Notifications
Settings

Danny Morales
Admin

3 Followers   3 Following

Edit

1 comment   17 views   0

13.2.9   Forum

Like the members page, this page is only accessible to members. The forum page uses the services of the module with the homonymous name. The forum displays at the center the main 4 categories and a general category to allow users to create their own threat of information. The forum displays statistics about the content in each section and permits the activation of notifications when new information is available. After the selection of one of the categories, the post inside the category becomes visible and the responses or interaction with different members.

Forum

Explore your forum below to share with other see what you can do, or head to Settings to start managing your Categories.

General Topics	29	3	Following ⋮
Share stories, ideas, pictures and more!	Views	Posts	

How to...	12	2	Following ⋮
Let us know some usefull tips (i.e. fix your bike, make an appointmen...	Views	Posts	

Food	19	2	Following ⋮
Some are good ordering food, others cooking. Share your talents.	Views	Posts	

Events	11	1	Following ⋮
Lets face it, there is not alot of time to go to all events available. Give...	Views	Posts	

Location	23	1	Following ⋮
Find a nice spot in the city for make groceries, a nice park, or simply ...	Views	Posts	

Forum > Location > Running route

Follow Post   Reply

ungamze
Moderator   7 days ago ⋮

Running route

8 comments   23 views

Hello! I am looking for a nice route (maybe in a park or alongside the canal) in Delft to run in the mornings. Please share if you have any suggestions :)

💬 Comment   0 ♡

rafaeldofc   6 days ago ⋮

The park near the lake is superb for that! If it is too far, perhaps along the schie canal (parallel to TU) is also a nice place.

💬 Reply   0 ♡

> ungamze
> Moderator   6 days ago ⋮
>
> Thanks! I will try theese.
>
> 💬 Reply   0 ♡

santiagoed4   5 days ago ⋮

Going to Schipluiden is a nice experinece. It is around 5 km surounded by nature. You will arrive to small traditional dutch town. They have nice coffee;)

💬 Reply   0 ♡

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13.2.10 Events

The events page is accessible to members and presents the service of the scheduler module to the users. The page presents incoming events and allows managing the participants (RSVP) per event. The HMI of the page allows the incorporation of geolocation if necessary. The creation of events is only available to users with specific access. Finally, the RSVP uses a simple form to collect the name of the participants and email address to establish a contact in case that is necessary.

Time & Location

12 sep. 17:00 – 18:30 CEST
2628 BA, 2628 BA Delft, Netherlands

About the Event

Are you new in Delft?

Join us for a couple of minutes, the meeting is to talk about what you need to know about the city and the platform.

RSVP

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Privacy Policy

DELFT INTERNATIONAL
COMMUNITY

Home   Information   Blog   More   ⌄ Hello Danny Morales 🔔

‹ Back

Add Your Details

*First Name   *Last Name

|

This field is required
*Email

Getting to know each other

12 sep. 17:00 – 18:30 CEST
2628 BA

SUBMIT

13.2.11 Chat

The chat page is accessible to members only and provides the HMI to the chat module. The page allows the visualization of a chat room which is available for any member to exchange information with other members in real-time. The chat
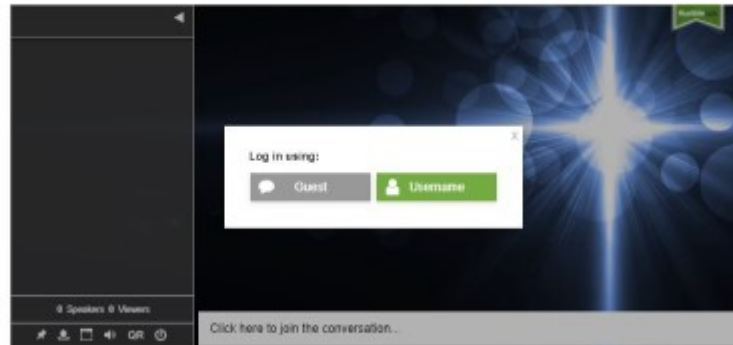
172

page requires a second login as a guest member to post information. The communications are public to any other member connected to the chat at that moment.

14 Annex F: Online Platform Results

After the implementation of the platform, visitors start to interact with the system and the collection of different parameters starts as well. This Annex presents the KPIs of the platform in a general overview and a breakdown of the blog and forum services. The last section of the Annex has the data collected via cookies and the consent related to tracking activity.

14.1 General Overview

The artifact demonstration starts with 60 invitations address to different international students with the link to the main site `www.delftcommunity.nl`. The system presents a total of 180 visits in a period of two weeks. The number of visitors during the same period is 40. Moreover, the number of mobile visitors is 4 and desktop visitors 36. Moreover, from the total number of visitors the platform registers 26 members. Figure 14.1 has the percentage of mobile vs desktop visitors.
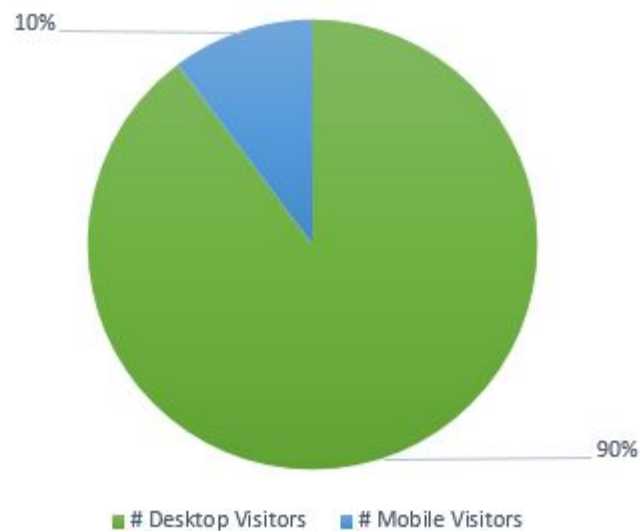
Figure 57: Mobile vs Desktop Visitors

The online platform shows six services during the artifact demonstration. However, two of these services are related to the internal operation of the platform and outside of the scope of the demonstration in terms of insights. Therefore, four services register activities from the users. The blog and forum services register inputs and interactions from the users. On the other hand, the chat and event services do not register inputs but the event service register interactions.

Table 21: Number of inputs and interactions per service

Service	Inputs	Interactions
Blog	3	40
Forum	24	99
Event	0	1
Chat	N/A	0

Table 21 shows the number of inputs and interaction per service of the platform. In the case of the blog, an input is a blog or a direct comment as a response. On the other hand, an interaction in the blog is a view or a reaction in the form of like. The forum has similar definitions, a post or comment are inputs, and views or likes are interactions. The event service considers an input to the creation of an event. On the other hand, a subscription to an event is considered an interaction. Finally, the chat service does not allow the creation of different chat rooms. Therefore, there is no input related to the service, only conversations consider interactions.

14.2 Blog

The blog service allows the creation of posts without any type of pre-classification. Therefore, the information has only topics and not categories like in the case of the forum. The information collected from the platform consists of several blogs, views, comments, likes, pictures, and links. Table 22 have the KPIs for this service.

Table 22: Blog KPIs

Blog Topic	Number of Blogs	Views	Comments	Likes	Pictures	Links
Health Care	1	20	1	2	0	1
Restaurant & Pubs	1	18	0	0	0	0

14.3 Forum

The forum service has a pre-classification of posts in place. Therefore, the information collected includes the forum category and inside the categories each topic. Table 23 has the KPIs of the forum which includes categories, topics, number of posts, comments, views, likes, pictures, and links.

Table 23: Forum KPIs

Forum Categories	Forum Topic	Number of forum	Views	Comments	Likes	Pictures	Links
General	Housing	1	11	3	0	0	0
General	Tourism	1	17	1	0	1	1
How to	Bicycles	1	4	0	1	0	2
How to	Health care	1	8	0	1	0	1
Food	Restaurants & Pubs	1	6	0	1	0	0
Food	Drinks	1	14	3	0	0	0
Events	Sport	1	11	1	1	0	0
Location	Sports	1	24	8	0	1	0

15 Annex G: Interview

The present Annex contains the three basic elements of the interview: introduction, consent form, and protocol. The delivery method of the semi-structured interview is face-to-face with people in the city.

15.1 Introduction

The present interview is part of the graduation project titled Fostering Social Interaction Among Heterogeneous Groups. This study is being conducted by Danny E. Morales-Briones from the TU Delft. The aim of this research study is to collect information about main activities and information of interest from master students to research ways to improve information sharing and connectedness among diverse groups. In previous phases of this research information from international students help in the creation of an online platform. During several weeks the platform has been operational and in service of the international community in Delft. The purpose of today's interview is collecting information about the platform like information posted, functionality, motivation behind its use. The interview will take you approximately 36 minutes to complete. The data will be used for research purposes only, and it will not be shared with any external party. The interview is anonymous, and the data collected is going to be handled as confidential. However, as in any academic project, the information is available for future research and/or it publishes in repositories along with the graduation project. Therefore, any sensitive information that can be recorded is going to be anonymized before its use. In case of any question or contact requirements, feel free to send a mail to D.E.MoralesBriones@student.tudelft.nl

15.2 Consent Form

The present document shows the text including in the consent form. Potential participants are going to receive the consent after being debriefed about the research and before starting the interview. Any recording takes place after the participants sign the consent.

Research Title: Fostering Social Interactions Among Heterogeneous Groups

I have read and understood the study information dated July 2019. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

I consent voluntarily to be a participant in this study and understand that I can withdraw from the study at any time, without having to give a reason.

I understand that taking part in the study involves responding to the question asked in this interview.

I understand that the data provided will be used for academic purposes only. Please be assured that the data are confidential, and the results of any research or analysis using the data will be presented in a way that individual responders cannot be identified.

I give permission for the data provided in this questionnaire to be archived so it can be used for future research and learning. The archived data will comply with the principles of confidentiality previously mentioned.

Name:

Signature:

15.3 Protocol

The interview protocol of the semi-structured interview has the sequence of the interview to guide the interviewer during the interview. Furthermore, the protocol includes the main question, follow up questions and the expected time for each section of the process.

15.3.1 Introduction (13 min)

- Introduction and small talk (5 min)

- Present information about the study (2 min)

- Explain that the interview would be confidential and anonymous (2 min)

- Present and collect the consent from the interviewee (3 min)

- Inform about the recording of the interview and ask verbal confirmation (1 min)

15.3.2 Main Principles (15min)

1. How supportive was the platform for sharing stories and find information? (3 min)

   Which parts were useful? Which ones not? (Follow up)

2. How useful is the information about places and locations? (5 min)

   Why is it useful to you? (Follow up)

3. How identified did you feel with the posts of the platform? (5 min)

   How relevant are the posts to you? (Re-phrase)

4. Would you be willing to interact more if people like your posts and why? (2 min)

15.3.3 Information (12 min)

5. Based on the records of your interactions (present activities to the interviewee), what does it make you contribute/interact with this information? (5 min)

   Why didn't you interact with the other sections? (Follow up)

6. What type of information do you find interesting but could not find? (2 min)

7. What was the topic that you find the most engaging on the platform and why? (5 min)

15.3.4 Platform (9 min)

8. Based on the records of your interactions (present activities per interviewee), why did you choose to interact using those parts of the platform? (4 min)

   Why didn't you interact with other parts (enumerate one unused functionality) of the platform? (Follow up)

9. What kind of features do you think it would make you interact more? (5min)

   Would you consider the platform as your first choice to post and find information during your time in Delft and why? (Follow up)

15.3.5 Closure (10 min)

- Ask the interviewee if there is any information that wishes to add (5 min)

- Inform the interviewee that it is possible to require a second contact for clarification or a new interview for follow up (1 min)

- Inform the interviewee about the next steps of the study (2 min)

- Extend gratitude to the interviewee for her/his participation and goodbyes (2 min)

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