# How to create a safe school environment that provides a platform for excellent school results and international business opportunities? Case study: Opinmäki

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***Abstract*—** The main aim of this qualitative case study is to provide an improved understanding of the structural characteristics and the dynamic evolution of a safe school environment that provides a platform for excellent school results. Another aim is to analyze how a safe school concept could be seen as an international business opportunity for Finnish companies. The study is based on the results and lessons learned from the 'Security and Safety in Universities' project executed 2009-2010, special attention taken how to utilize that knowledge within a new construction production. The evidences of this case study consist of participatory observation, in-depth interviews with different stakeholders and multitude documents. The study shows that a safe school environment concept could be seen as a new service innovation with a huge new global business potential. The results of the study suggest a four years research road map that trails the path of service innovation development supported by new technology solutions.

***Keywords*—** Prevention of severe targeted violence, Public safety, Resilience of built infrastructure, Safety and security, School security.

## I. Introduction

RYM Ltd, founded in 2009, is the strategic centre for science, technology and innovation of the built environment in Finland. It is a venture for intellectual capital operating in the real estate and construction sector that invests the funds and know-how of companies and public financiers of innovation in research areas most important for international competitiveness [1].

The core of RYM Ltd´s activities consists of research programs based on research strategy decided by the shareholders which the companies implement together over a 3-6 year period. The tentative vision of the Energizing Society Program is that urban planning and construction are a recognized cutting-edge expertise area of the Finnish real estate and construction sector. Ecologically sustainable community concepts based on utilization of digital technology have become a growing and profitable business both in the markets of developing countries and domestically [1].

City of Espoo represents a dynamic intersection between science, business and art. The formation of Aalto University also combined the same three disciplines: science, business and art (In Finnish: Tiede, Talous, Taide = T3). Consequently both Aalto and the City of Espoo have used the notion of three Ts as a way to illustrate this basis for cross disciplinary innovation. Within Espoo this has been branded so that the south-east area of the city is called the T3-area [2].

Espoo has identified three pillars for its own strategy: being a caring city, actively promoting environmentally friendly solutions and positioning itself globally as a leading city for innovation. In line with its strategy and vision Espoo has been actively networking with key stakeholders in the city to establish new initiatives that will support the objectives that are stated in the 2020 vision. One of these activities has been relating to the development of the T3-area as an area that will integrate science, culture and business to provide an attractive innovation environment for creative individuals and leading companies. The area will see a high degree of construction activities over the next ten years, approximately 4-5 billion €. This also supports the idea to take the opportunity to transform the T3-area into a world leading innovation ecosystem [2].

Espoo, as the anchor organization of the Regional Innovation Ecosystems work package within the Energizing Society program, wants to develop new concepts for innovative collaboration between companies, universities and research institutes, as well as the public sector, most notably the city organization. This will be done in the form of action research. Espoo and its partners will initialize and nurture a number of separate demonstration projects. These projects will be rigorously observed and influenced by different research teams that will combine their own research findings with the practical experiences of the people working in the demonstration projects.

Subsequently the Regional Innovation Ecosystems work package will test and institutionalize new practices for the implementation of sustainability demonstration projects using construction activities in the City of Espoo as the platform.

The results of this work package will have an impact on the global innovation research agenda and the participating companies. In addition it will result in a vibrant Living Lab environment, demonstrating what can be done by a city, and

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subsequently attracting new entrants to enter the Finnish metropolitan region.

The formation of the research consortium has taken place by an in-depth evaluation of what particular activities different companies could consider to initiate to support the objectives of the Regional Innovation Ecosystems undertaking. Representatives from more than 20 companies were interviewed, and ideas generated through these interviews were subsequently gradually refined into concrete project plans, with one particular organization responsible for each demonstration project. As a result 8 different demonstration projects have been identified; Safe School Environment being one of them.

The outline of this paper is as follows. Chapter 2 of this paper discusses the theoretical background of this study consisting of three different viewpoints: how to create an innovation; how to make large-scale urban build infrastructures more resilient against attacks and disruptions of different kinds; and why severe violence in schools and other educational institutions has become a rising concern in many developed countries in recent years. Chapter 3 presents the research targets and methods applied in this study as well as how the research process has proceeded. Chapter 4 covers the descriptive data about the case being studied; Opinmäki (Learning Hill) 1st phase. In Chapter 5, the research findings are presented and evaluated against the theories presented in Chapter 2. Chapter 6 sets out the conclusions of the study and answers to the research questions. The last chapter also includes an assessment of the study and suggestions for further research.

## II. Theoretic Framework

### A. Innovation Creating

There are multiple paths how innovations are created and commercialized. One model that gives a practical and structured framework for innovation work is the NABC approach created by Stanford Research Institute (SRI). NABC highlights market Needs, solution Approach, solution Benefits and Competition of any solution being created. Within the NABC framework, the following questions should be answered:

What are client's needs? A need should relate to an important and specific user-client segment or a well identified market opportunity, with the market size and end customers clearly stated [3].

What is our compelling solution to the specific client need? Draw it, simulate it or make a mock-up to help convey your vision. As the approach develops through iterations, it becomes a full proposal or business plan, which can include market positioning, cost, staffing, partnering, deliverables, a timetable and intellectual property (IP) protection. If you are developing a product, it must also include product specifications, manufacturing, distribution and sales [3].

What are the client benefits of our approach? Each approach to a client's need results in unique client benefits, such as low cost, high performance or quick response. Success requires that the benefits be quantitative and substantially better - not just different. Why must we win? [3]

Why are our benefits significantly better than the competition? Everyone has alternatives. We must be able to tell our client or partner why our solution represents the best value. To do this, we must clearly understand our competition and their value proposition and our client's alternatives [3].

When dismounting NABC, the following questions in Table I help to outline the customer's strategy.

TABLE I. NABC QUESTIONS [4]

| | |
|---|---|
| Need – market need | What need have you identified your clients/market?<br>What is the problem to be solved? How important is it?<br>Who are your potential clients?<br>How big is the potential? |
| Approach – product, service or solution | What is your solution or new idea?<br>What it does, how it works?<br>Benefit to the customer? How it meets the customer need?<br>Why do they buy / use this product / service?<br>What makes it unique?<br>Business plan? Where the money comes from? |
| Benefit – benefit in relation to costs | How much do your customers are willing to pay?<br>What is worth the benefit in relation to costs?<br>How important / critical solution for the customer?<br>Who makes the purchasing decision? |
| Competition - competitive situation | Why the solution is better than the other?<br>Who and what are the competitors?<br>Why do customers buy from you? Why not other suppliers or partners? |

### B. Resilience of Built Infrastructure

Modern critical infrastructures include not only physical components, but also hardware and software. These integrated systems are examples of cyber–physical systems (CPSs) [5]. Very often, urban built infrastructures represent a critical node within the intertwined networks of an urban area.

Despite the fact that a substantial part of our critical infrastructures today rely on complex systems of communication networks, there is just as much of a need to take into account the equally vulnerable built infrastructures of modern urban areas. Many of these, be it transport systems of different kinds, large school/university campus areas, sports arenas or shopping malls have already been evaluated regarding their resilience against major terrorist attacks, school-shootings or disruptions of other natures. However, shortages in the emergency preparedness are common, e.g. with regard to shopping malls the following gaps have been found [6]:

1. Very little money has been spent to upgrade security since 9/11.
2. Training of mall security staff on preventing and responding to attacks remains inadequate.
3. Hiring standards for prospective security officers have not changed substantially since 9/11.
4. Risk assessments are rare, and emergency management plans are frequently developed without the input or participation of first responders.

Making large-scale built infrastructure in urban areas more resilient against attacks and disruptions of different kinds is an endeavor that requires multifaceted and multifunctional cooperation between various players of the security sector [6], [7]. In this case, resilience not only includes concepts and technologies to make built infrastructure more robust against attack and disruption, but also to integrate aspects such as energy efficiency, multi-functionality and overall sustainability of large-scale infrastructure.

Today, IT equipment waste a lot of energy and for that reason, system architects have to pay more attention on energy saving matters because energy saving reduces total costs.

Sensor networks have been used in a variety of applications, such as environmental monitoring, traffic control, military identification and data collection. Their main function is to oversee the area, including one or more object detection, identification, localization and tracking. The sensor network consists of one or more data center, called sink node and a number of affordable and low-power intensive sensor device or sensor nodes [8].

One method to describe the system management functions is based on system management approach [9]. The authors of [9 demonstrate the effectiveness of the method by providing illustrative examples of energy-saving measures that do not include only computer equipment but are also available in a data center environment, such as environmental sensors are used.

Geocast protocol, proposed in [8], for the sensor networks reduces energy consumption at a time when information is sent from sink node to sensor nodes in a geocast region. It facilitates in-network data integration, and thus saves energy during the reporting sensor data to sink node [8].

Sensor networks may have temporarily set up for example to rescue personnel, hence the network protocol and network algorithm must have opportunities for self-organization. One important feature of the sensor nodes is low power consumption. Therefore, sensor network protocols focus on power saving. The sensor nodes are often not accessible to, so sensor nodes lifetime must be as high as possible and the meantime between failure must be as long as possible. Sensor node's lifetime is proportional to the power supply. Stranded power must be effectively managed [10].

Lack of energy problem is considered one of the most serious threats in wireless sensor networks. Exploiting of the sink mobility to reduce the energy gap in a hierarchical problem in large wireless sensor networks, which are based on bees algorithm is one solution [11].

Power saving is a key issue for portable devices. Therefore, power saving in idle mode is a very important part of the activities. In idle mode it is not necessary to obtain more than one active interface. In addition, this interface could also be in idle mode until the incoming packet raises it. After activating the flow of information could be transferred to the most suitable access interface [12].

Since most of the equipment can be assumed to be battery-powered, energy management is important. This is directly related to the service negotiation stage: the amount of energy, which is liable to perform service, is one service parameter. Power management can be handled by turning off the machine parts that are not needed by the active services [13].

The European construction industry (including civil engineering, architectural designs as well as building/construction) is already a strong player on the global market. Globally significant building projects of massive impact (Dubai, Shanghai, etc.) are often realized by European designers/builders.

### *C. Severe Violence in Schools*

In the world, over 300 school-shooting cases are known and over ten cases where the perpetrator(s) have been prohibited to perform the attack at the last moment or earlier [14]. The definition of a school shooting is [15]: (1) a student or a former student brings a gun, a sword or a similar weapon, or explosives/flammable liquid to school with the intention of killing somebody, (2) the gun is discharged and/or weapons, liquids or explosives are employed, and at least one person is injured, and (3) the shooter attempts to shoot or otherwise kill more than one person, at least one of whom is not specifically targeted. All school-shooters have been males from eleven to roughly 25 years old [16].

A analysis about the minds and thoughts of school-shooters done in July-October 2009 over ten school-shooters from USA and one from Finland reveals issues about the background, personality and mentality of the school-shooters that contributed to the committing of a school-shooting [17]. The study covers two different parties' research results on the persons of the shooters as well as possible warning signs for shootings. School-shootings are influenced by several factors; one being the psychological profile of the shooter. Other factors are e.g. family relations, school environment and social relationships. In [17] the focus is on the person who commits the school-shooting and his micro environment, which is family.

The backgrounds of the shooters do not give one direct and unified answer to why these specific students decided to go on a rampage in their school. The backgrounds and psychological qualities of the shooters vary widely. They are influenced by mental health problems, traumas and many other factors. Some of the shooter's problems seem to be created and exist only in their own minds, such as the conflicting reports by witnesses about the shooter not being bullied while the shooter himself has felt that he was bullied [17].

No easy and quick answers exist when trying to recognize a school-shooter. Finding a shooter from a school community is like sniping blind folded. In preventing school-shootings the key issue is to create a sense of community and togetherness in a school. The students must have possibilities and means to vent their bad feelings in a controlled environment and seek help. One preventative measure is not enough but we need several measures that will form a safety net for recognizing the problems of the students and to offer help to them [17].

A lot is discussed about how to deal with this issue. However, a large part of the discussion has been directed towards general problems in the society, cultural changes and of course how to react to the attacks when they occur and what to do afterwards. These questions have initiated a notable amount of different development projects. Consequently, not many of these projects have been concentrated on the tactical and operational level of prevention, specifically on precise and timely prevention of severe targeted school violence [18] .

Challenging accidents and criminal incidents such as school-shootings require effective action from all safety and security organizations involved. Many rescue and law enforcement operations require a transfer of information during a change of personnel responsible for the operation. This exchange is referred to as role shifting. The issue of transferring information and role-shifting during a multi-actor operation is a difficult question including effective decision-making, and managing related risks [19].

## III. Research Methods and Process

This case study has been deliberately designed to be part of a larger, mixed methods demonstration project 'Safe School Environment' within the 'Regional Innovation Ecosystems' work package of RYM Ltd's 'Energizing Society' program.

One aim of the larger study is to develop an integrated concept to improve the safety, security and resilience of large-scale urban developments. The project focuses on large-scale buildings, building complexes and building arrangements such as schools, shopping centers/areas, sports venues or combinations of business centers with underground transportation nodes. Safety, security and resilience against disasters should be included at the design and planning phase of such projects, leading to robust built infrastructure invulnerable to natural and man-made disasters. The project will take into account the state of the art of built infrastructure protection products as well as planning and engineering tools.

The target of this case study is to contribute to our knowledge of the phenomena of 'safe school environment'. An explanatory case study with regard to the construction project 'Opinmäki 1st phase' was conducted in order to gauge its merits as a world's safest school environment and understand how the different stakeholder roles functioned within it. In this study, the case study method of research was chosen because the original question needs an answer to the question "how" [20].

The original research question is:

*RQ1- How to create a safe school environment that provides a platform for excellent school results and international business opportunities?*

The original research question is specified and divided into two sub questions:

*RQ2 - What are the roles of different stakeholders in creating a safe school environment?*
*RQ3 - What kind of unique advantages a safe school environment benefits different stakeholders?*

The unit of analysis of the case study is the concept how to create a safe school environment. The data collection was done through participatory observation, interviews and documents produced during the 'Security and Safety in Universities' project [7] realized in Laurea University of Applied Sciences in 2009-2010 as well as during the planning of 'Regional Innovation Ecosystems' work package and Opinmäki [21] 1st phase construction project. Exemplars of students, teachers, police, rescue services and other security professionals were interviewed. The data collected from documents include data from the 'Regional Innovation Ecosystems' work package plans, the Opinmäki 1st phase project plans as well as the Security and Safety in Universities project materials; minutes of meetings of the steering group and project group, theses, project work and reports by students and Laurea personnel. The use of different research methods, such as the NABC-approach [3] and different sources of information was done to strengthen the validity of the study.

## IV. Empirical Context and Target

This chapter introduces the empirical context and target of this study. An introductory overview of the case study construction project Opinmäki (Learning Hill) is provided.

Opinmäki campus in the heart of the new Suurpelto city area in Espoo is an international and multicultural community which offers users of all age's possibilities to learn and to enjoy inspiring free time. The campus is an open and cooperative meeting place which is full of life every day of the year. Its premises can be used by all actors of the campus and residents of the Suurpelto area. Interaction between different language and cultural groups is characteristic to Learning Hill. The campus will include a Finnish primary school and an International school working in English. Also day care is offered in two languages [21].

Premises of the campus will be built at two lots. In addition to school and day care also library services, adult education, cultural, sports, youth and residents' park activities are also offered at the campus. Multipurpose premises and equipment can be used by all the actors of the campus. Also yards, playgrounds and outside facilities are planned in such a way that everybody can use them. Common premises offer plenty of possibilities to a new kind of cooperation and synergy gains [21].

The 1st phase of Opinmäki will be ready in summer 2014. Its scale is 9 500 hym2 and 14 800 brm2 and budget 43,0

million Euros without VAT. The total scale of Opinmäki campus will be circa 13 300 hym2 [22].

Within the negotiations with leading civil servants of City of Espoo, it is found out that developing Opinmäki as a world's most ecological and safe school environment, the reputation of T3 area as an innovative area will increase further. Also, its international attractiveness will increase more.

Finnish schools have traditionally had good learning outcomes and a good safety level, but school satisfaction of students needs improvement. Pleasant satisfaction in schools can be improved by changing the school environment safe and responsible manner, creating cohesiveness and sense of caring. The student must feel being a valued member of the school community. School students must learn to accept difference, to respect and appreciate with other students as individuals. Teachers have a vital role in reducing disparities in valuation of different students. This is achieved by the fact that teachers know their students [23].

Bullying at school must be addressed early on and have to invest, because the feeling of security increases as to eradicate bullying completely off. Teachers' presence of breaks reduces bullying and demonstrates to students that their safety is important. Good school climate evolution requires a genuine commitment to diversity and acceptance of respectful neighbor arbitrating of all people [23].

Table II summarizes elements how to improve school satisfaction.

TABLE II A SAFETY SCHOOL [23]

| A DECLARED BEHAVIORAL RULES | |
|---|---|
| Adults | Genuine commitment – Responsibility – Own example – More time – Taking care of – Familiarize |
| Ambiance | Safety - Responsibility - Cohesion - Taking care of - Equality – Appreciate all the people - Accepting diversity |
| Education | Empathy - Problem-solving skills - Self-control confidence - Media literacy - Alternatives to violence – Trust |

To make school a better place to learn, it calls for change to the behaviour of people in a way that all contribute to diminish the negative impact, there is on the school environment.

Appointed by the Ministry of Interior "Multipurpose facilities safer" working group was relying on existing data to make suggestions on how public authorities and industry collaboration can improve a multi-office security. The proposal shall include the main multi-premises security challenges and proposals for how these challenges can be overcome by improving safety [24].

Multi-purpose premises is defined by the Finnish Ministry of Interior: open premise, which is free of charge and with many players such as shops, cafes, restaurants, cinemas, libraries and other public and private services [24].

Key challenges of the security issues for multi-purpose premises as the continued use of security tools and practices in the extension of their daily activities. Typical factor affecting safety issues in multi-purpose premises is a disorder of behavior. Threatening behavior and unpredictable behavior disorder is a threat to security and customers and employees of the premises. One safety factor can also be organized large public events in the premises [24].

Threats to human lives for special incidents - such as e.g. fires, power failures, explosions, shooting incidents, terrorist acts - must be prepared. Although, the probability of such incidents is small, they are serious events, and their significance can be really outstanding [24].

A key recommendation to improve safety, the committee proposes the following measures [24]:

1. Designated person responsible for security. Management of the premises owner must be a person who is responsible for security cooperation throughout the property. A person must have required skills and training for the task.
2. Integrated security management system (SMS) of the premises. Risk management is easier when the state has SMS, practices related to security matters as well as between the different actors in the security training and guidance. The security situation in the audit should be regular.
3. Shopping centers SMS updates and use of management scale and practical performance. Finnish Shopping Center Association's co-coordinating the project produced a safety management tool includes a risk mapping, crisis management, statutory obligations is the harmonization of practices and collaboration as well as security technology guidance and tools.
4. The various authorities of the persons designated by the security cooperation spheres. Contact person promote the exchange of information, carry out and support pre-emptive cooperation with government and acts as an expert in security development. Authority and on duty Emergency Response Centre (ERC), however, are responsible for liaison with emergency situations.
5. Common familiarization training model with persons working with the existing security systems. Work should be done in connection with induction in security systems.
6. Uniform requirement for government policies for the granting and supervision. Operators must have uniform procedures for example, construction supervision and police and fire departments domains.
7. Emergency and safety plans for self-control targeting the entire building and all parties. The rescue plan should be described in the implementation of self-control mode, which can be shown to self-provisioning and maintenance of continuity. Security activity must specify a time window within which safety measures have been taken. Self-monitoring to document, must be regular and continuous as well as

maintenance and inspection items have to be in charge.

8. Instead there is a need to create a crisis organization that is responsible for crisis communications and debriefing. Status of safety systems (alarm, alert, and other security systems) have to be designed fully functional.
9. There have to be a control room for monitoring and coordination of the security situation.

The main objective of the Wireless Sensor Systems in Indoor Situation Modelling II (WISM II) Finnish Funding Agency for Technology and Innovation (TEKES) research project is to develop the building indoor situation modeling system, which are based on static or mobile autonomous wireless sensors to gather information in real time. Moreover, additional data information from other data sources such as electronic building map, visual observations or through-wall radar image can be connected to situational model. An operational requirement definition is carried out for the system in cooperation with different authorities. Authorities are involved in the project. Situation modeling system is needed in various applications, such as fires or other emergencies, where immediate action is required by the police in situations (such as a hostage or a school shooting cases), intelligence operations, the urban crisis management, etc. The commercialization of the developed system and its subsystems will be evaluated, and the project will also study the market, in particular, Finnish security industry perspective [25].

USN (Ubiquitous Sensor Network) platform [26] prevents man-made disasters. By implementing the USN system, it is possible to monitor and control the situation in real time and to evacuate people from affected area or to find a solution before the situation becomes critical. It is also possible to prevent the disaster from happening by quickly find the root cause and by removing the cause quickly. By implementing the USN system people's safety priority can be ensured. Ad-hoc network in this case has been built between the sensor nodes. It consists of two types of sensor modules: 1) sink node and 2) sensor node. Sink node is the basic node for sensor network applications; it also collects the final data. The nearest node of the basic data collected by sensors in a sensor node sends data forward. Basic sensor information for example sensor name, location and sensor model name can easily access. System evaluates the risk of disaster by analyzing collected data, the threshold, and the risk index [26].

Technical Research Center of Finland (VTT) coordinates project which has 22 European operators in SmartTouch collaboration. The project developed Near Field Communication (NFC) basic techniques and looked for areas of applications. One of those application areas is teaching and learning. VTT has, together with the city of Oulu, exported technology to schools. Oulu upper class students when entering the classroom, touches lightly with their NFC mobile phone a reading device, which registers the student's presence. First-class students have in their backpacks a NFC – a card which registers their school entry. Such new technologies and practices kind of NFC facilitates and speeds up its initialization, if the technology is easy to use, reliable, secure and activities are available to all customers [27].

## V. Research Findings

In this chapter the research findings of this study are presented. The chapter is largely based on the data gathered between 2009 and 2010. Comparisons are made between the theoretical aspects raised in Chapter 2 and the information gathered in the empirical part of this study.

### *A. Safe School Environment Concept as a New Service Innovation*

A safe school environment concept could be seen as a new service innovation. When categorizing research findings by bringing the NABC logic and presentation of value creation in the context of the Safe School Environment, the following observations could be made.

#### *1) Market needs*

Meeting the threat of severe violence in schools is all in a day's work for students, teacher and other actors. With the globalization trend, the threat will increase and spread all the more.

#### *2) Solution Approach*

Mobilizing the recommendations created within the Security and Safety in Universities project [7], a radical change will be born. It could formalize a new technological and service standard that offers significant opportunities to the line of business. Opinmäki could be used as a proof of service concept prototype.

#### *3) Solution Benefits*

The new service concept which integrates the strength values of Finnish school system (publicity, transparency, equality and excellence) with safe school going in dynamic global environment. This combination offers an enormous global business potential.

#### *4) Competition*

So far, no total concepts are on the market; only isolated consultants and vendors of guides and security technologies. Finland is a compact community of good repute based on trust and neighborhood, especially Finnish school system has made shining name for itself. Here, a new integrated service standard for safe school environment and strong educational system could be made.

### *B. Resilient School Infrastructures*

School infrastructures represent a critical node within the intertwined networks of an urban area include not only physical components, but also hardware and software. However, a comprehensive approach to develop resilience concept for a combination of such systems, as they are often

designed in modern urban areas, has not yet been approached thoroughly.

The strong position of European construction industry in global markets must be invigorated by the initiation of an integrated approach to better protect large-scale built infrastructure like schools. Obviously, such an effort offers a wide range of new market opportunities for a wide range of European players. Evidently, this not only includes players developing genuine security technologies, but also requires smart and unconventional business solutions to bring together the different aspects addressed by the concept of resilience. This will ensure that aside from the already established players on the field, new and young SMEs can contribute to such an approach with their niche ideas and concepts.

A systematic approach to resilience enhancements for large urban built infrastructures begins at the design stage. Opinmäki 1st phase is now at this stage. Key persons for success are the gatekeepers of architectural, electrical, communicational, pipe and other infrastructural designers and decision makers. These gatekeepers must have the powers to make amendments to plans in the course of the project affecting to the costs, also. In other words: normal vender-supplier tendering rules do not apply in which all detailers regarding usability scenarios and their supporting structures and technologies are frozen on the date of tender.

Public-sector could utilize innovative procurement as a particularly effective demand-side mechanism for increasing private sector R&D activity, expenditure and output [28]. Opinmäki is a potential subject of this instrument.

### C. Roadmap for a Safe School Environment

Answering to the increasing threat of severe violence in schools, both technical and "soft" tools are needed. Integrating school safety and security, Finnish strong educational system and sustainable development, a new school concept could be developed. As a result of this case study, the following four years research roadmap is created.

TABLE III RESEARCH ROAD MAP

| Year | Service family | Technology family |
|---|---|---|
| 2011 | New global business potential (NGBP) is specified; agreements, working programme, international partners | Requirement analysis, consortium formulation |
| 2012 | Research and development phase of NGBP, outlining of standardization paths, proof-of-concept, | Piloting of the concept of a new innovative procurement |
| 2013 | Proof-of-value prototype, testing, de facto standardization | Developing technical solutions supporting the service family |
| 2014 | Proof of self-sustaining use, de jure standardization (if necessary) | Spreading of new technical solutions as a part of the service family |

## VI. CONCLUSION

This chapter evaluates the research process and the findings of this study from the viewpoint of the research questions of the study. Finally, suggestions for future research avenues are made.

### A. Answering the Research Questions

The main objective of this paper was to provide an improved understanding of the structure and evolution of the safe school environment. The existing knowledge and the empirical data on the research topic were presented and evaluated. The following analysis summarizes the research work from the viewpoint of the research questions RQ1, RQ2 and RQ3 in this study.

The answer to RQ1 is to follow through a four years research road map that trails the path of service innovation development. Table IV shows the answers to RQ2 and RQ3.

TABLE IV ANSWERS TO RQ2 & RQ3

| Stakeholder | Role | Unique benefits |
|---|---|---|
| City of Espoo | Building developer; Innovative procurement instrument user | Good reputation of the area; Innovation-friendly public procurement framework |
| Students, personnel, other users of the school | End-users | Safer operational environment |
| Service companies | Service providers | New global business potential |
| Security technology and construction companies | Developing technical solutions supporting the service family | New global business potential |

### B. Suggestions for Further Research

As being a proof-of-concept prototype, Opinmäki is a good opportunity to develop European standards for the safety and security of large-scale urban buildings, building complexes and building arrangements.

This paper was a startup for a research to find out what kind of methods and tools there are to be used when we discuss about safety environment – and especially how to create this safety environment in schools. In this paper there are some successions for safety environment and how to continue in research framework about this issue.

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