Why (shelter) innovation in the humanitarian sector is scarce: integrate building resilience in the emergency and recovery response

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**Why (shelter) innovation in the humanitarian sector is scarce, Integrate building resilience in the emergency and recovery response**

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**Abstract**

Items that bring relief after a war or disaster, such as shelters, often find their origin in other industries. In the last years the SRG did a number of product developments of disaster response items. At the same time, they did dozens of product development trajectories for the building industry. In this paper the product development for the building industry is compared with the shelter industry, with the aim to find the similarities and differences and to learn from it. The goal is to give the reader insight into the specific conditions that apply to product development for the humanitarian sector and especially in sheltering and housing. Due to the complexity not all aspects are discussed, also not all knowledge or all cases are written down in respect to the paper length. The results show that “why (shelter) innovation in the humanitarian sector is scarce” is mostly of non-technical nature.

**Keywords:** innovation, product development process, disaster response, role of the humanitarian sector, business case, shelter
1. Introduction

For decades organizations in the humanitarian sector are acting in many ways in the field of disaster response, relief and recovery. Not only do they send their staff and volunteers to help, but also distribute a variety of goods and items. These items bring relief on necessities such as watsan, food and nutrition, non-food and shelter (The sphere project, 2011). Many times the solutions used in the field originate from other branches, such as the military, recreational or domestic industry and are partially adapted for the use after a event such as a disaster. Sometimes items are specially designed and made for relief purpose.

In the past 6 years the Shelter Research Group (SRG) of TU/e did a number of product development trajectories of disaster response items, mostly shelter related (Erkelens et al., 2010) but also on watsan and energy. All of these product development processes where done using a proven product development method (Lichtenberg, 2002) for the (building) industry. At the same time the researchers of the SRG also developed a large number of successful product developments for the industry in general (mainly building industry) and encountered a substantial difference between the two industries.

In this document two industries (humanitarian and building) are compared through the generally acknowledged topics that are drivers for either a successful business case or innovation / product development. Most of the results are experience based and some are coming from the cases that are described. The aim of this comparison is to sketch the innovation obstacles or restrictions that may be present. This gained knowledge may well bring possibilities to adjust or change the process or system behind the start or implementation of innovations in the humanitarian sector.

2. Methods

To achieve market introduction, an effective product development method and a well defined business case are necessary. Both follow their own method. Not following the formats will often lead to ineffective and unsuccessful trajectories and the product will not make it in the market.

A new product must fulfil a certain demand. Therefore, all product development trajectories must start with the description of the incentive for the development. For companies, this is usually defined by a business case, since the goal for a company almost always is to make profit, either through selling new or improved products, or by optimizing their production process. For the non-profit sector there are other drivers such as employing people, maximizing community support or producing something the industry sees no commercial potential in (profit), but fulfils an urgent need of a society. For humanitarian agencies the goal is to help and protect conflict and disaster affected populations. This means that product chains can function completely different.
2.1 Business case

Before initiating a business or a product development it is common to reason on the pros and cons, this is often described in a document called a business case. There are many ways and methods to write a successful business case, but in general it has the following key elements/chapters; 1) Product & organisation outline, 2) Market research, 3) Vision, mission, strategy and business model, 4) Team, 5) Risk and road mapping, 6) Financial plan.

In the first chapter the unique selling proposition (e.g. product, service), core competences (what makes it so unique) and the present state of the venture are explained. The second chapter is the market research where political, economic, social, technological, environmental and legal factors (PEST analysis), together with a SWOT analysis are used to review the strategy, position or idea. The third chapter is on the ambition of the company or project, including the vision, mission and values, the strategy and the business model. Chapter four is on the team that is going to do the project or work in the company, their characteristics and if external support is needed. The operational risks and road mapping are written down in the fifth chapter, indicates the current and future market state, the distribution channels and for example what resources are needed. The last chapter is a financial overview, including incomes, expenses and the estimated break-even point. In the annexes of the business plan more in-depth information can be added, such as researches, studies and analyses.

2.2 Product development

There are many routes to do product development varying from out of the blue or trial and error as well as experience or evidence based. Successful innovation in the (building) industry will generally take 2 to 4 years and it is recommendable and mostly done in a structured way (Otto et al., 2001, Magrab, 1997). With the use of an analytical systematic approach (Roozenburg et al., 1998), it is possible to realise a product solution step by step according to clear boundary conditions set beforehand. This approach is systematic by means of making combinations and variations of (sub) solutions to solve the problem. Before this takes place the problem has been analytically structured analysed into sub problems.
Figure 1: Product development from “zero” till “success within the market” in six phases
(Lichtenberg, 2002)

A proven product development method has been defined by Lichtenberg (2002), which is based on a business case approach and generally focuses on systematic analytic product development methods to solve (sub)problems and issues. This method divides the product development process into six sequential phases; situation analysis, strategy, creation, development, realization and market diffusion (see fig. 1). In the first phase, situation analysis, the image of the company, its position in the market and the key features of the team are analysed. The aim of the strategy phase is to get to a focused project definition by doing a SWOT analysis and generating product market combinations (PMC’s). These first two phases have great similarities with the key aspects of a business case. In the creation phase the product market combination are complemented with boundary conditions and then translated into product ideas, for example through drawings. After selection and analysis some ideas, mostly one or two can be converted into a prototype. The creation phase is followed by the development phase where further development is executed, such as the optimization of the prototype in order to limit the chances of failure in the following phases e.g. by calculation, tests and market tests. When one or more aspect within a phase are not satisfactory, it is sometimes needed to reconsider design decisions and go one (or two) phases back (go/no go). The realization phase is a preparation to market introduction. The sixth and last phase, the market diffusion phase, covers the period from first market introduction until proved success.

Both the business case approach and the product development method are used to analyse the cases of emergency and recovery response item development and the (building) industry developments. Notice that the business case method has more focus on the long term financial aspects of the new product and that the product development method has more focus on the technical aspects.
3. Case studies

For this case study research the product development processes of a number of disaster response items were used for analysis. Some of the cases described are written down anonymously, obviously this has to do with not wanting to compromise one of the parties involved. Moreover this doesn’t affect the exemplary function the cases should fulfil.

Because the most off the developments where shelter related, the focus area will be on shelter solutions including tents, transitional shelters, ready made structures and semi-houses. This is also the most closely related to the building sector. The SRG was involved in housing for Haiti and Pakistan (2010), the Collective Centre (2007-present) and cardboard shelter (2009) development, energy solutions, mapping methods of existing shelter and much more (Erkelens et al., 2010, Haas, et al., 2011, Innovative Shelter website).

3.1 Collective Centre

After a disaster, permanent community buildings (e.g. schools) are mostly used for first relief of refugees. These buildings play an important role in the local community. However, these buildings are preferably not used for long term sheltering because that will hamper local recovery. Currently, non-permanent, rapid deployable collective centres are not available in the market. The Dutch Red Cross challenged the experts from the Shelter Research Group to develop a semi-permanent collective centre. A full scale prototype of an innovative (easy deployable, semi-permanent, reusable, lightweight, low cost) Collective Centre was developed, which can be assembled and deployed within a couple of hours without the need for trained staff or heavy equipment. This Collective Centre can be extended by modules of 4m and was tested a number of times.

It was a real technological challenge to develop a system for a semi-permanent collective centre, which is at the same time easily deployable, low cost, lightweight, modular and consisting only of a minimum number of unique building elements and still capable of handling high forces. The developed collective centre has a long technical lifespan (5-50 yrs) and can be reused and setup in a minimum of time and without heavy equipment or power tools, which usually will not be available in an emergency situation. The possible ways to use the Collective Centre are endless for example as shelter, hospital, marketplace, school. The interior of the Collective Centre can be subdivided and it can structurally resist Hurricane Class 1 as well as heavy snow loads. Therefore, it is safely applicable in most countries worldwide (see fig.2) (Haas, et al., 2011)

3.2 Haiti two storey house

After the Haiti earthquake many projects for reconstruction of houses in Haiti where started. One donor wanted to apply a frame-type structure that could be later filled with sheeting/bricks
as a replacement for destroyed houses. The Shelter Research Group was asked to check the proposed solution. Structural engineers of the SRG however stated that the supposed solution would definitely not suffice under Haitian weather conditions. Specifically, the structure would suffer from stability problems. Based on available wind data and a combination of Dutch and local wind calculations (hurricane-proof), a new solution was presented using the clients design preferences and an optimization for local wind conditions. This resulted in a more robust, however reliably safe building with a reference lifespan of twenty years (fig. 3).

![Figure 2: Collective Centre prototype](image1.png) ![Figure 3: Haiti house design](image2.png)

4. Results

It is common to start from a business case before the cost and time consuming product development process is started. The results of the comparison between the building and shelter industry are also presented in this sequence. Started by the market chain, customers and competitors and market mechanisms are described, followed by the financial plan, innovation, innovation investments and purchasing products and risk. Than the typical product development factors are introduced such as; start of an innovation, involvement during development, boundary conditions, product development time and production and the testing of prototypes.

4.1 Market chain

The focus within building industry chain (see fig.4) is on the next party in the chain as the source of income for the entire chain. However within the shelter industry the whole production chain from raw material till trade (see fig.5) focuses on the purchaser, who is not the customer/consumer/end user. The consumer of the shelter industry is not involved in the chain except being a consumer. Secondly it looks like there is no real connection between the NGO purchasing for example a shelter and the development/production that happens earlier in the chain, one of the reasons for that can be their core principles and purchasing methods (see paragraph 4.4, 4.7 & 4.9).
4.2 Customer

In the building industry the customer is not always known when a building is built, the customer in those cases is for example project developer or investor that does an investment and hopes to sell with a profit to the end-customer. This project developer or investor has a short term interest. On the other hand one could expect more end-customer-involvement or – thinking from a housing association because they want to rent out the houses for a longer time span to the customer. In both situations, the customer shall be guaranteed that his product (the house) that he/she is buying or renting will function properly for a certain period. When problems appear (e.g. roof leakage), the one liable in the chain (contractor/roofer) will be held responsible for the repair or replacement (fixing the roof).

In the humanitarian sector it is not quite clear who the customer is, one could ask himself/herself if the donor (who pays) is the customer or possibly the humanitarian sector (purchases) or the beneficiary (customer). And if for example a shelter fails, who is liable and who will give guarantees?

4.3 Competitors and market mechanisms

Within the (building) industry it is common practice that innovative results such as new technologies or knowledge are protected by patents. This will protect the intellectual property of their innovation and with that also their investment. Common beliefs in the industry are that protection is vital to maintain the lead in the very competitive market. In contrast to that, the humanitarian sector aims at being open source and believes that when technologies/knowledge is shared, industries are willing to start producing for them at a lower price and that automatically several competitors will appear on the market and start price competition. This is not true for products that need to be developed but can work if a product exist already longer on the market. On the other hand the industry will think that when technologies/knowledge is open source their competitors can start producing at any time and shall therefore not do any investments in developments or starting up production. The financial risk would be too high.
4.4 Financial plan

Within the building industry every company in the chain has to have a positive cash flow beginning at the raw material industry till the end client. Each has its own business case or model. Within the shelter industry chain, this is a bit different. The humanitarian sector depends largely on donors and help the consumer (refugee, IDP, affected population), but with this satisfying the donor due to the fact that they exist by the fact that the donor is donating money. This implies a totally different “business” model and chain.

Money flows into the humanitarian sector mainly by fundraising form the public or from formal donors. Most of the money is allocated or earmarked and can therefore not used for other initiatives such as innovation.

4.5 Innovation

Industries all over the world are constantly innovating to remain relevant and viable. Furthermore, it is needed to e.g. keep a constant turnover, create growth and beat the competition or to react on changing legislation. In the building industry it is the same but it sometimes happens that the market introduction of an innovation will be postponed till legislation demands it or competitors appear with new products. In the building industry architects want extreme designs and new features to realise an impressive, pioneering, innovative and modern building for their customer. When the contract phase starts, and the design of the architect is transferred to the constructor, the constructor will often start to limit his risk by removing new features and innovations. This is one of the reasons why the building industry is not the most innovative industry around. Innovations of medium or large size, take time (up to 4 years) and will therefore not be incorporated in the construction of a project. Small size innovations or innovation by addition can be done in limit amount of time and will find their way in a new building. If on the other hand one sees every new design of a building as a prototype (with existing components such as bricks or windows) the building industry compared to other industries can be seen as innovative.

In the shelter industry not a lot of innovations seem to have taken place, if one for example compares the tents used in Napoleon time with the current family tent used by many humanitarian actors. The same was concluded within the research of a warehouse shelter in the EU funded project S(P)EEDKITS, problems regarding the structure and the foundation that appear in the 80’s also appear in the recent years.

4.6 Innovation investments

Within the industry its common to invest a part of the turnover in R&D, the global average was 7.6% in 2011 (web EU), for the Dutch building industry this is approximately 0,2-0,4% (Gijsbers, 2011). The investments for innovations in the shelter industry are not known by the
authors but are estimated to be fairly limited in comparison with the turnover. Clear is that a donor is not interested in long term investments in innovation but they want direct relief for the consumer even do this can have more effect in the long run.

In the past (2006-2011) there was the Transitional Shelter Standards & Prototypes project initiated by the Shelter Centre, that involved shelter industry partners with the aim to innovate and develop a new transitional shelter. Although some of the shelter industry partners worked on their prototypes during the whole process via a process of feedback and revision together with humanitarian actors and invested money, effort and time in it, this didn’t result in procurement of many newly developed shelters by the humanitarian sector.

### 4.7 Purchasing products and risk

The purchase of products can depend on several issues, one of the most well-known is cost but also quality, production, payment and delivery times, contacts, track records etc. are important. Procurement in the building industry is down in none restricted way, taken into account the former issues. Only if it is a public building, there are at least three contractor quotes needed. And even then the contractor does not need the quote of three subcontractors. Innovations will enter the market when contractors or subcontractor are willing to take the risk or producers or suppliers can be held responsible. Following this procedure, the risk is not transferred to the client or customer.

In the humanitarian sector procurement is mainly done by bidding or tendering. At least three suppliers have to bid in order to be able to choose the final product. This way of procurement is common in the shelter industry. In both cases it is done to spend the public money in a responsible and accountable way. The shelter industry shall not only make a decision on e.g. cost and quality but also expertise, track record, references and financial situation of the past years of the company. Due to these criteria it is very hard for a new producer, with or without a new product, to penetrate the shelter industry. Innovation is blocked easily due to these criteria. Secondly it seems like within the shelter industry suppliers are not held responsible for the product they deliver in the same way as in the building industry. Sometimes the reason is simple, as destination of product and the end user are not always known, and the one distributing the product is responsible for taking care that it will be used in appropriate circumstance.

With money from appeals or donation often comes the obligation to help a certain amount of people, consequently the amount of money per person is fixed. When two different tents can procured and they are the same but the first has a lifetime of 3 months and the second has a lifetime of 12 months but double the costs of the first, it is easily possible that the first solution is chosen, although from the viewpoint of total process cost it is not optimal. This can be due to other restrictions each player in the chain has. Furthermore it also possible that innovative new products are not incorporated due to a lack of knowledge for example on new materials or systems by the people judging a product. On the other hand, one is hardly to blame for making
a safe decision on a product that should be applicable in the field worldwide under a variety of circumstances after an unknown event.

4.8 Start of an innovation

In the building industry innovations are started by producers, that are driven by; architects/customer needs, market changes due to legislation or business reasons and are almost always funded by own resources (or state grants). Continuous innovation is needed to maintain a business.

Producers that are already involved in the shelter industry are probably always busy to improve their product even if it was only by optimizing the production to increase their profit. Producers that are not yet in the shelter industry seem mostly triggered by events such as disasters, wars or droughts that appear in the media. From that point, these producers see a new market and will try to sell their (often) not yet developed idea or try to sell their non-modified existing product by contacting the humanitarian industry/NGO. At these moments the humanitarian industry is flooded with new ideas and product, but because they are busy dealing with the currently affected population they have only limited time to deal with these companies or initiatives. For that reason it is likely that these ideas and products will remain unobserved. The Collective Centre and other development have shown that entering a new market like the humanitarian industry takes a lot of research and time to understand the industry and to find out what the state of the art is. Therefore the chances are that most ideas, that pop up after a media event, have limited direct market value and need much more time to be market ready.

4.9 Involvement during development

To develop a successful and effective product not only a good list of boundary conditions is necessary but also the involvement of important stakeholders. Their knowledge, experience and needs are of great value. In the (building) industry exchange of knowledge is common due to the fact that everybody profits from working together. A brick producer will work together with the architect if a special brick is needed, idem for the contractor if a special masonry method is needed to produce the wall. There is constant interaction between the members in the chain and with this interaction also commitment to purchase a specific developed product. This interaction is there on different product levels (raw material, semi-finished products, components) and results in unique to mass produced products. When there is no interaction in the chain, innovation shall be scarce.

In the shelter industry, commitment of the humanitarian sector to the private industry is not preferred due to fact that they need to be impartial and don’t want to commit to an individual producer. By sharing humanitarian knowledge by interaction with the private sector or academia, new products are much more tailored to the use in the field and therefore help the customer out even better. This is also the way the Collective Centre and the Haiti two storey
house was developed. When knowledge is shared between the humanitarian and the private sector and these results in a good and demanded product, this does not ensure that this product will be instantly bought by the humanitarian sector, due to its procurement procedures. Involvement or interaction also has a side effect, when someone from the humanitarian sector shares his knowledge and provides a product developer from comment, he/she shall say that he/she is not talking as a representative of the humanitarian sector, not even for the particular organisation he/she is working for, but on his personal account.

4.10 Boundary conditions

One of the first things to do when an product development is started, is setting up a list of boundary condition, this list contains items as: intended use, lifetime, rules/regulation, size, wind, earthquake, climate conditions, risk etc. During the development this list of boundary condition is constantly used as a start and control point for the development. In this phase interaction between the important stakeholders to compile this list is of great importance to develop a successful product.

Setting up a list of boundary condition for a shelter development is much more complicated than for the building industry due to the fact that most pre-stocked shelters must be situation independent, location independent, disaster/war independent, customer independent and should fit the term “one-size fits all”. Furthermore, in the building industry, there are for most product/component norms like ISO, DIN or EN available. Together with governmental legislation, it is possible the determine a part of the measurable boundary conditions. Some actors in the humanitarian sector have setup guidelines (such as the Sphere project or Transitional Shelter Standards) that provide some grip but most of them give too much space for an engineer for interpretation. Secondly, most norms that are used are intended for other purposes, like festival tents or camping tents, that either have a bigger purchase price or aren’t for long-term use.

During the development of the Haiti two storey house the boundary conditions (e.g. size) where adjusted, the reason for that was the participatory approach that was chosen. This is of great value because the beneficiaries are more committed and it helps to secure ownership, but for a structural engineer it means that he has to restart doing all his structural analysis calculations, which cost a lot of time.

4.11 Product development time and production

Doing product development for the building industry in a structured way, takes a lot of time, up to two to four years from start to market diffusion. Also the (investment) costs are high due to man-hours, prototypes, production setup etc., throughout this period the product does not result in a profit. If the whole lifecycle of product is considered profit fluctuates (see fig. 6). The
The building industry is considered slow compared to other industries like the pop-cd industry, hence the time in the market is also very long.

![Figure 6: Lifecycle of building product compared to a pop-cd (Lichtenberg, 2002)](image)

Getting the Collective Centre from a prototype to a production ready model took approximately one year of optimization on technical and materials before production could start. This can result in great disappointment in the humanitarian sector because a prototype looks like a production ready model. Therefore the Collective Centre could have been applied in the field already for many times but in practice didn’t. Luckily there are no dedicated production lines needed to produce the Collective Centre, otherwise more investments and time was needed. Setting up a dedicated production line can take up to one year production can be started. A dedicated production line takes a lot capital investment, that (for example) a bank will only lend when there are already orders for one year running time.

The development of the two storey house for Haiti was started as question from the field to structurally check a design already made. Due to fact that the donor wanted to start building soon, the check had to happen quickly. When the structural check didn’t turn out to be positive, a completely new design was asked urgently. A product development process of least two months was compressed into a couple of weeks, something that is rare in the building industry but more common in the shelter industry.

### 4.12 Testing of prototypes

In the building industry it is uncommon to test every building that is built. Testing of semi-finished products or building components is more usual but only happens limited due to cost. Almost everything is developed and designed bases on calculations, for instance structural calculation or ventilation calculation. Sometimes elements of the building are tested according to the available norms. When the building is designed, calculated and possibly some parts are tested, construction will start. After the construction phase the contractor and all other parties up in the chain guarantee the (sub) functions that the building should fulfil.
The shelter industry is more tempted to test everything before field application, “seeing is believing” is applicable on this industry. Due to this a problem is introduced, it is considered unethical to test new products with people that are affected by war, disaster or malnutrition, therefore most tests are done with less vulnerable groups. Compared to general industries, like car or mobile phone industry, this practical way of testing after a development is uncommon. The need for testing can possibly be led back to insufficient regulation, program requirements, and specifications or to the lack of appropriate guarantees.

5. Discussion

This document has the aim to positively contribute and to discuss possible gaps within the shelter industry, based on the comparison with the (building) industry. The results shows that in general problems with innovation or innovative products are not of technical nature but mostly because of the industry chain, competition, market mechanisms, procurement methods, finance systems, decision making, knowledge sharing, specifications, risk taking and guarantee giving etc. With this knowledge, possible adjustments can be made in the chain or systems used and with that the tension between various stakeholders in understanding the customer can be reduced, which can result in more sustainability of effective sheltering. Although this is an evolving phenomena within this specific area of research and in the case studies, it would be good to potentially direct future longitudinal studies at testing this aspect within the case studies to extend the effectiveness and efficiency of sheltering further. Secondly this aspect can be set against the main commercial and technological considerations within the product development process to contribute also.

With the start of the IFRC-Shelter Research Unit (SRU) and UNHCR Innovation a first step is set in improving and resolving these problems, the SRU for example has been established to improve humanitarian shelter solutions through enhanced technical research and innovation. UNHCR Innovation was formed with the mission to drive innovation both inside and outside of UNHCR to further the collective ability to serve persons of concern worldwide with the latest tools, platforms and processes. The Refugee Housing Unit (RHU) shelter is one of their collaborative projects together with the non-profit foundation RHU design team/SVID and is funded by the IKEA Foundation (IKEA Foundation website).

Secondly, an EU funded collaborative innovation project S(P)EEDKITS is started last year where academia, humanitarian sector and industry work together in the development of disaster relief items and therefore learning from each other’s systems, procedures and principles.

6. Conclusions

With this research and the existing knowledge from the (building) industry the product development for disaster relief items can be improved. This leads to more and better
innovations (products) for the disaster affected population and therefore can help to build resilience in the aftermath of an event like disaster or war.

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The Shelter Research Group (SRG) was formed at the Eindhoven University of Technology (TU/e), Department of the Built Environment, with the objective to actively support the humanitarian aid movement providing innovative solutions for post-disaster sheltering. The SRG consists of members with different backgrounds and interests such as product development, building technology, building physics, structural engineering and impact measurement. All members are academia, have a wide network within the industry and are collaborating closely with the humanitarian sector.

References


Lichtenberg J.J.N. (2005) Slimbouwen®, Boxtel, Æneas, the Netherlands


Shelter Centre website: [sheltercentre.org/meeting/material/transitional-shelter-standards-prototypes-projects](sheltercentre.org/meeting/material/transitional-shelter-standards-prototypes-projects) [Accessed March 2013]