

Investigating the Relationship between Problems and Solutions in Design: Insights from Frame Innovation

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Abstract

Nowadays problems are considered more complicated, intersected and overlapped than before, which makes it essential for designers to change their conventional way of thinking and doing. Designers can change their way of thinking by a better understanding of the relationship between problems and solutions in design. This research examines this relationship through the role of the mediating factor that connects the problem space with the solution space. Then, different case studies done by different organizations and design studios have been analysed to propose a holistic view on how the relationship between problems and solutions in design works. The proposed relationship structure is based on KeesDorst's framework of 'Frame Innovation'. By viewing this relationship, designers can understand how to create different themes for solving design problems and they would also be able to translate those themes into wide range of solutions. This paper also points out four main elements that draws the relationship between problems and solutions in design. Those elements are 'Problem Layers', 'Problem Context', 'Themes' and 'Solution Concept'. Three main findings were concluded from this research. The first finding is that designers need to know where exactly to build their stories. The second one is that the wider the problem context, the more themes designers have. The final finding is that themes are more related to the problem space than the solution space. By understanding the relationship between design problems and solutions, designers would navigate their way of thinking to make sure that the final outcome not only meets user's needs and desires, but also solves the core of the problem.

Keywords: Frame Innovation; Problem Space; Solution Space; Problem-solving; Themes; Mediating Factor.

Introduction

The new technological paradigm that appeared by 1970s has caused many revolutionary changes. By introducing information technology to the society, a new way of living, communicating, managing and producing has been materialized. This technological revolution has also caused a new entry point of the complexity of the society, economy and culture. That resulted in the emerging of new social forms that could be considered more complex than before (Castells 2011). The more complex the society becomes, the more challenging the problems will be. In order to make the social aspects less complicated, a new type of sociology has emerged which is called 'physics of the society' (Ball 2012). In that sense, what mattered is understanding the predictable average of individual actions and choices, so problems that face the society become more understandable and manageable.

As a result, nowadays problems need designers to change their conventional way of thinking. In this context, Dorst pointed out that the nature of problems we face consists of many elements which change overtime and that makes the system borders unclear, that is why problems become 'open, complex, dynamic, and networked' (Dorst 2018). Thus, designers tend to come up with different solution for the exact same design problem. One way to explain why this happens could be because designers are usually biased to their way of dealing with the problem. Therefore, designers are identified by the type of solutions they produce, but not by the type of problems they solve. For example, industrial designers are called so because they produce products for industrial organisations and fashion designers are called so because they produce attires for fashion firms and so on (Lawson 2006).

Moreover, Design thinking process is considered as a process that consists of many iteration actions of going back and forth till a final solution is decided (Brown and Katz 2011). These kinds of iterations happen through a mediating factor that helps designers to shift from the problem to the solution.

In other words, this mediating factor can be described as an emergent bridge that identifies problem-solution pairing (Dorst 2006). In addition, design thinking could also be defined into two distinctive spaces problem definition and problem solution which are referred as problem space and solution space respectively. Problem space is an analytic sequence where all problem elements are identified and determined. Solution space is a synthetic sequence where all the requirements are met in a balanced way. Creative design is more about refining together the formulation of both spaces: problem space and solution space which is referred as the 'co-evolution' of problems and solutions (Dorst and Cross 2001). The goal of this research is to identify this mediating factor to reach an understanding of its role in the relationship between problems and solutions in the design process. This research paper works as a step of many other steps in finding a way to trace the structure of design problems and matching that with the way designers tackle these problems.

In order to identify the mediating factor that connects problems and solutions in the design process, six different design processes have been collected and examined to compare between the mediating factor in each one of them. Afterwards, three different case studies have been collected and analysed to visualise how the mediating factor could affect the relationship between problems and solutions in the design process. Then, the resulted relationship structure has been evaluated and criticised by two different design thinking expertise to look for rooms for improvements.

The Mediating Factor in the Design Process

Human-Centred Design (HCD) has helped designers with different techniques to communicate, empathize, interact and stimulate users for a better understanding of their needs (van der Bijl-Brouwer and Dorst 2017). That distinguishes HCD from any other traditional design practice because of its natural focus of the insights and activities with the potential user rather than designers' personal bias practices (Giacomin 2014). The focus of HCD on users' needs and desires helps designers to formulate an understanding of what users want which, in turn, guides designers to the appropriate solution from their point of view. In that case, users' needs are considered as vital factor in determining on where the solution should be oriented, which what we call 'the mediating factor'. The mediating factor of the design process can be defined as the bridge that helps designers to move from the problem space to the solution space in the design process. In addition, there are different factor that affect designers' decision on solutions beside the mediating factor such as available budget, project timeline (Lawson 2006) and designer's expertise (Dorst and Reymen 2004; Cross 2004). This research focus is on the mediating factor and its role in the relationship between problems and solutions in the design process.

The rising question here is where this mediating factor is located in the design process. In order to find an answer. Six different design processes are examined to locate the mediating factor in each one of them to understand how it is defined. Collected design processes are Lean UX, Design Sprint, Design Thinking, OODA, Double Diamond and Frame Innovation. Each design process is used for a specific design field which makes it different in the way it progresses and in number of steps. Lean UX can be defined as a fast software design process that helps start-upsto come over organization slow workflow to find flaws quickly in order to improve the designed product (Liikkanen et al. 2014). Lean UX process consists of four main steps: forming assumptions and hypothesis, designing, creating a minimum viable product (MVP) then learning and research (Grama 2016). If we examine Lean UX design process carefully, we will find out that the shift from problems to solutions happens extremely fast, that makes the mediating factor between problem space and solution space exist in the very first step which is hypothesis. First, design practitioners come up with a quick assumption based on what they know by now to form a starting point for the design team. Then based on that assumption, a hypothesis is formed by declaring four different fields which are business outcome, target users, user outcome and new design features (Gothelf and Seiden 2016). This 'hypothesis' where designers decide to narrow down and come up with a quick conclusion to move on to the solution space. Therefore, 'Hypothesis' here is considered as the mediating factor.

Design Sprint (DS) is a product design framework that combines business strategy, behavioural science and Innovation to design a product or service (Knapp, Zeratsky, and Kowitz 2016). DS consists of five different steps understand, diverge, converge, prototype then test. DS process shifts from the problem to solutions in 'converge' step, which can be defined as ranking different possibilities to pick one to focus on. In 'converge', designers tend to choose one possible scenario to focus on in order to design a prototype and test. Therefore, 'converge' here is considered as the intermediate step that helps designers to switch to the solution space. On the other hand, Design Thinking (DT) is a design process that has been introduced and shaped by the design consultancy IDEO (KELLEY 2001). DT process can be defined as a

discipline that uses designer's sensibility to match users' needs with technology and business strategy (Brown 2008). DT process consists of six different steps: understand, observe, point of view, ideate, prototype and test. The intermediate shift from problems to solutions happens in the 'point of view' step which is defined as a visualisation step that summarises insights collected from previous steps to reflect user's perspective (Brown and Wyatt 2010; Thoring and Müller 2011). Once designers imagine what users looking for, they can step into the solution space.

Thus, 'point of view' is considered as the mediating factor in DT process. OODA is a problem-solving framework that was developed to understand why American fighter pilots are performing better than their adversaries in the Korean war (Plehn 2000; Sweeney 2002; Alex 2000). OODA is an acronym for observe, orient, decide and act, which are the four steps included in OODA framework. 'Decide' here is similar to 'hypothesis' in Lean UX process, as commanders need to make a hypothesis then act to test it (Brehmer 2005). 'Decide' here is considered as the intermediate step that helps actors and commanders to move on to the action phase to validate their hypothesised solution. Furthermore, The Double Diamond Model developed by Design Council UK is a design process that contains four main steps: discover, define, develop then deliver (Council 2007). 'Define' here is similar to 'point of view' in DT process, where designers define challenges collected from discovery phase in a different way. This definition phase is considered as the mediating factor of the double diamond model, as designers tend to ask questions like which matters most? which should we act on first? These questions guide designers to the solution space where they can start developing different solutions (Council 2015).

Frame innovation is a framework that has been introduced by (Dorst 2015b). Frame innovation consists of nine different steps: archaeology, paradox, context, field, themes, frames, futures, transformation and integration. Themes here are defined as the analysis that ends with a selection of themes related to the problem space on a deeper level. Based on those themes, designers can move on to the solution space. Themes in frame innovation model are considered as the mediating factor that bridges the problem space to the solution space. So, in order to move on to case study analysis to understand how this mediating factor or step work in the problem-solution relationship, a comparison need to be conducted to decide on a framework or a model to analyse case studies based on.

In Lean UX, DS and OODA, the mediating factor is referred as 'hypothesis', 'converge' and 'decide' respectively, but the issue here is that this hypothesis, convergence or decision is based on designer's subjective understanding of the problem, not based on a logical analysis for dimensions of the problem space. Thus, this step is usually done using voting or polling to move on to the next step (Banfield, Lombardo, and Wax 2015). On the other hand, DT and double diamond represent the intermediate step in 'point of view' or 'define' based on observations and insights from users, but user's desire is only one piece of the problem space. As the problem space usually contain different intersected parts which makes it as defined earlier 'open, complex, dynamic, and networked' (Dorst 2018). However, themes introduced in the frame innovation model come after four steps of refining the problem space to understand its borders and context (Table 1). That makes frame innovation model suitable enough to analyse different case studies based on.

Frame Innovation

Framing was first mentioned by Donald Schön in 1987 as a way of how designers think about what they are doing. As professional practitioners and ordinary people always think about what they are doing while doing it. They ask themselves many questions such as: What are the criteria for judgment on this or that? What are the procedures? How am I framing the problem that I am facing? Therefore, Framing could be considered as framing problems in certain ways according to the design profession (Schön 1987). According to this, framing in design could help us to understand designer's behaviour in terms of the problem that he set for himself.

To frame a design problem, designers need to start from the known part of the abduction equation as they need to start from user's hidden needs and desires (Outcome) then they can think of objects or systems (What) with certain working principles (How) to achieve desired values (Dorst 2015a). This backward thinking process helps designers to create frames and new perspectives of viewing the problem which affects the outcome of the design process. Moreover, Framing was identified as a creative leap that allows an original solution to be produced. Framing also allows designers to dig deeply into the problem to figure out the core problem that lies behind client's definition of the problem. By doing this, framing could help designers to create alternative view of the problematic situation, as well as helping them to come up with different range of responses and possibilities (Paton and Dorst 2011). Investigating the problem deeply means discovering how the problem evolved from its original form till its final form which is usually seen by the client. When clients usually propose a design problem to designers, they propose the final layer of it and designer's mission is to dig deep into the problem to find what Dorst calls 'the problem behind the problem' (Dorst 2015a). In this study we will refer to this as 'Problem Layers' which can be explored by understanding the problem background, user's needs and desires, user's behaviours and the final layer seen by the client.

This also is compatible with the design engineering model that views the problem as tree-like and that the structure of the problem could be broken into sub-problems and sub-sub-problems (Rozenburg and Cross 1991).

Model	Process	Mediating Factor	Definition of The Mediating Factor
Lean UX		Hypothesis	Hypothesis consists of four different fields: business outcome, target users, user and new design features.
Design Sprint		Converge	At this step designers need to narrow down what they already have rather than adding to an already large pile of broad possibilities.
Design Thinking		Point of View	Point of View (POV) is a notion about the problem that reflects user's perspective (could be a persona, a mind map, a matrix, etc.).
OODA		Decide	Decide stage involves what to do next which leads to act which is doing what have been decided based on previous stages
Double Diamond		Define	In define stage, the insight collected from the discovery phase can help designer to define the challenge in a different way.
Frame Innovation		Theme	Theme analysis ends with a selection of themes that are relevant to the problem situation on a deeper level at which players in the field have much in common.

Table (1): A comparison between mediating factors in different design frameworks

Designers need also to explore the inner circle of stakeholders involved in the design problem to gain better understanding of their practices and behaviours. Which is called ‘Context’ in frame innovation model (Dorst 2015b). Furthermore, Design is usually seen as a tool for radical change and developing systems, services and environments. In order to achieve that, new design ideas should be done by a variety of many different actors and stakeholders beside designers (Bjögvinsson, Ehn, and Hillgren 2012). That makes it essential for designers to map different stakeholders in the problem context. This research examines ‘Problem Context’ by determining two different types of stakeholders which are: problem owner and key stakeholders.

In addition, Dorst mentioned 'Themes' which can be defined as elements relevant to the problem situation on a deeper level (Dorst 2015b). This paper studies 'Themes' and different ways to create them which affect designers' decision on final solutions. Themes also could be considered as where problem space and solution space meet. As creative design is a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration processes between the two notional design 'spaces': problem space and solution space (Dorst 2006). In that sense, if 'Problem Layers' and 'Problem Context' are considered as part of the problem space, then 'Themes' could be considered as the mediating factor or the transition step to the solution space. Exploring the solution space requires different ideation and conceptualization sequences, so alternative ideas could be elaborated in a balanced way. This balance is crucial to ensure that the outcome is suitable for all players in the system (Lindberg, Meinel, and Wagner 2011). Corresponding to that, the solution space will be identified here by 'Solution Concept'. 'Solution Concept' is the interpretation of themes into realistic solutions that could be applied and evaluated.

From the previous literature survey, we can summarize that there are four main elements that could help us understand the relationship between problems and solutions in design which are: problem layers, problem context, themes and solution concept. These elements were chosen based on the framework of 'Frame Innovation' and related works to ensure some basic standards when analysing different case studies.

Case Studies

Some professionals and designers prefer to consider design thinking process as a linear model in a way to find logical understanding of the design process (Buchanan 1992). In this research paper, the design thinking process will be considered in terms of a linear model for two different reasons: The first one is that the linear model makes it easier to understand the relationship between problems and solution through the design process. The second reason is that analysed case studies have already been designed, finished and implemented in real life not undergoing ones. In that sense, considering design thinking according to the concept of a linear model makes it logical enough to search for relationships or inputs and outputs.

This research analyses three different case studies done by different organizations and design studios. Case studies were selected based on their fields to ensure a variety of different solutions to see how the relationship between problems and solutions works in different design fields. These case studies were also selected based on the availability of the information needed for the analysis to ensure that the four main elements mentioned earlier could be extracted. Three different case studies were collected from Designing Out Crime Research Centre in University of Technology in Sydney, IDEO and Digital Surgeons. IDEO and Digital Surgeons are considered two of the pioneer design consultants in the field of design thinking. Collected case studies were analysed into details using a diagram that shows relationships between the two different spaces of the design problem and the design solution. The analysis was done in a way to have a holistic view from the beginning of the design process till the final solution.

Analysing Case Studies

The following case studies were collected from different types of resources like websites, reports and books. Each one of these case studies was examined carefully and any part of them could belong to problem layers, problem context, themes or solution concept was underlined to be used then in the analysis. The analysis is done by using X-Y axes to show the relationship between the main parts of the problem space and the solution space. X axis was used to explain the depth of the problem by showing its different layers starting from the problem background, needs and desires, behaviour based on those needs and the final issue seen by the client. Y axis was used to explain the width of the problem and to show different stakeholders involved in the design problem. Themes were located along these two axes depending on each case. Afterwards, the analysis diagram continues to show the interpretation of themes into solution concept.

Case Study No. (1): King Cross Street

King Cross Street is a project done by Designing Out Crime Research Centre in University of Technology in Sydney (Designing Out Crime Research Centre 2013). In this case study, the problem layers start with the fact that King Cross street is a street full of bars with many young people that get drunk late at night with no transportation to go back home. That lets them start feeling bored till they go into a fight with each other and that result in high crime rate and insecurity in the street. If we go through the different layers of the problem, we will figure out that the core problem here is that 'They start feeling bored', but the seen problem here is a street with high crime rates. The problem context or the width of the problem has many stakeholders including the problem owner here which is the police department with their desire of safety and security.

Besides, the key stakeholders like bar owners and their desire of having many customers. In addition to many other key stakeholders such as the city council, neighbours, ...etc, stakeholders' behaviours and practices influences the chosen theme.

One of the themes that was created here was to entertain young people all night till the morning, so they do not get bored and fight each other. The aspiration here was based on the core problem detected by understanding users' needs and desires. Choosing to entertain young people in the street results in managing their feeling and expressing energy in a healthy way. That resulted in a chosen theme that is aimed to solve the problem before it happens. Cutting the problem from the roots, which ends with coming up with many solutions related to how to entertain them all night long. One of the solutions were about arranging entertaining events like music festivals which helps in coordinating the crowd by offering them alternative activities than waiting. The other solutions were about offering benches and seats for chilling and volunteers for guiding.

This resulted in many beneficial values such as comfort, guidance and convenience. The outcome values of each solution have not only a benefit for users, but also for stakeholders included in the problem context and the new stakeholders included in the solution space as well(Figure 1).

Case Study No. (2): Designing Waste Out of the Food System

IDEO with their client 'The Rockefeller Foundation' worked on how to solve the problem of wasted food which resulted from changing of eating behaviours and mass-produced food (IDEO 2020). People usually do not want to miss any food offers and they order more than they need. This result in 1.3 billion tons of wasted food every year (United Nations 2020). Two different themes were chosen. The first one was based on users' desire of trying many different types of food as they did not want to miss anything, so the chosen theme was to offer them subtle substitutions. Subtle Substitutions theme results in coming up with many solutions to let users try everything, but in smaller amounts to save more food without missing the pleasure. The second theme was based on the final layer seen by the client as the chosen theme was how to make proper connections between designers and different stakeholders to support each other. These connections will help in making use of the wasted food to reuse it or to think of better ways or concepts to make the best use of it by reproducing without throwing it a way.

The problem context includes restaurants and hotels as a problem owner and food suppliers as one of the main key stakeholders. Restaurants and hotels need to save money spent on food and food suppliers need more customers with less producing fees. That influenced the final solutions in the first theme by proposing small meals in open buffets by one meal at a time. This helps in reducing and controlling the food production process (Figure 2). In the second theme, different solutions have been produced by establishing 'Food Waste Alliance' to connect designers to experts to stay engaged for any innovative ideas for food waste. Another solution has been produced in the second theme which is 'City Harvest'. City Harvest is an organization that delivers food waste to soup kitchens in New York city.

If we have a close look here, we will find out that the first theme was chosen to solve the problem from the roots and prevent wasting food in the first place. On the other hand, the second theme was chosen to deal with the problem after it happened. Two different themes, two different tracks and benefit for all.

Case Study No. (3): IMEND

IMEND is a project done by digital surgeons that aims to solve problems related to repairing electronic devices (Digital Surgeons 2020). The seen layer of the problem is that there are many apps and services that help customers get their electronics fixed in no time with home services. Therefore, competing in such an environment needs more innovation. The problem layers have been discovered and users' needs and behaviours have been detected. Users usually want to save time and resources to get their electronics fixed in no time. Thus, the core problem here was the need for a new service that could be innovative enough to compete with other service providers. The chosen theme was to make the new service as the new uber of phones. This theme was influenced by electronics repair businesses with their desire of getting more customers and technicians who look for job opportunities.

This resulted in a solution that lets freelancer technicians and customers act in a two-way marketplace creating benefit for all stakeholders making sure that their values are met. The final outcome is a value of accessibility that helps users to save money and time. It also helps technicians and repair businesses to get more customers. In this case study, the chosen theme is based on the final layer of the problem which was aspired by the overwhelming market of competing services (Figure 3).

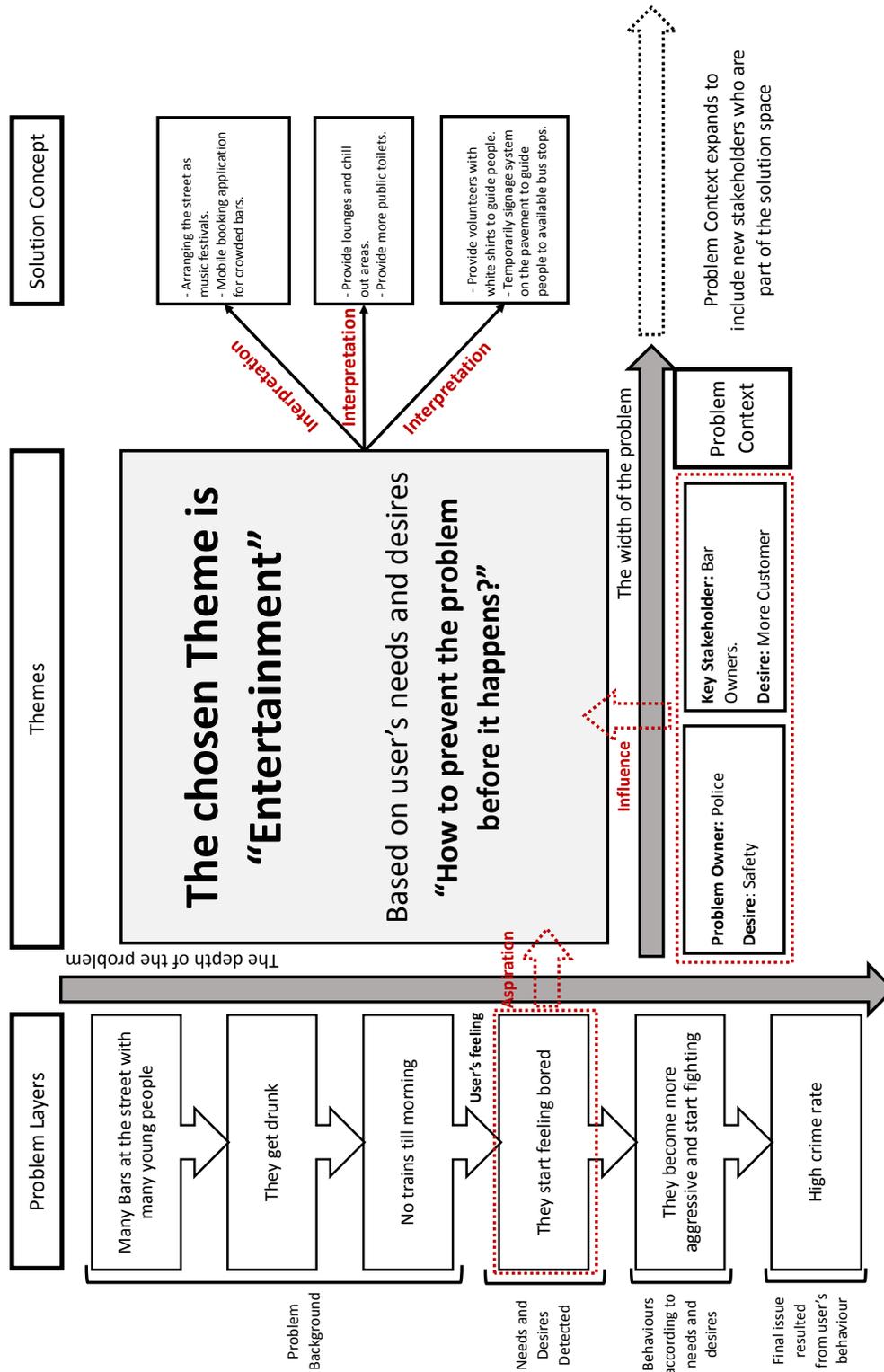


Figure (1): Case Study No.1

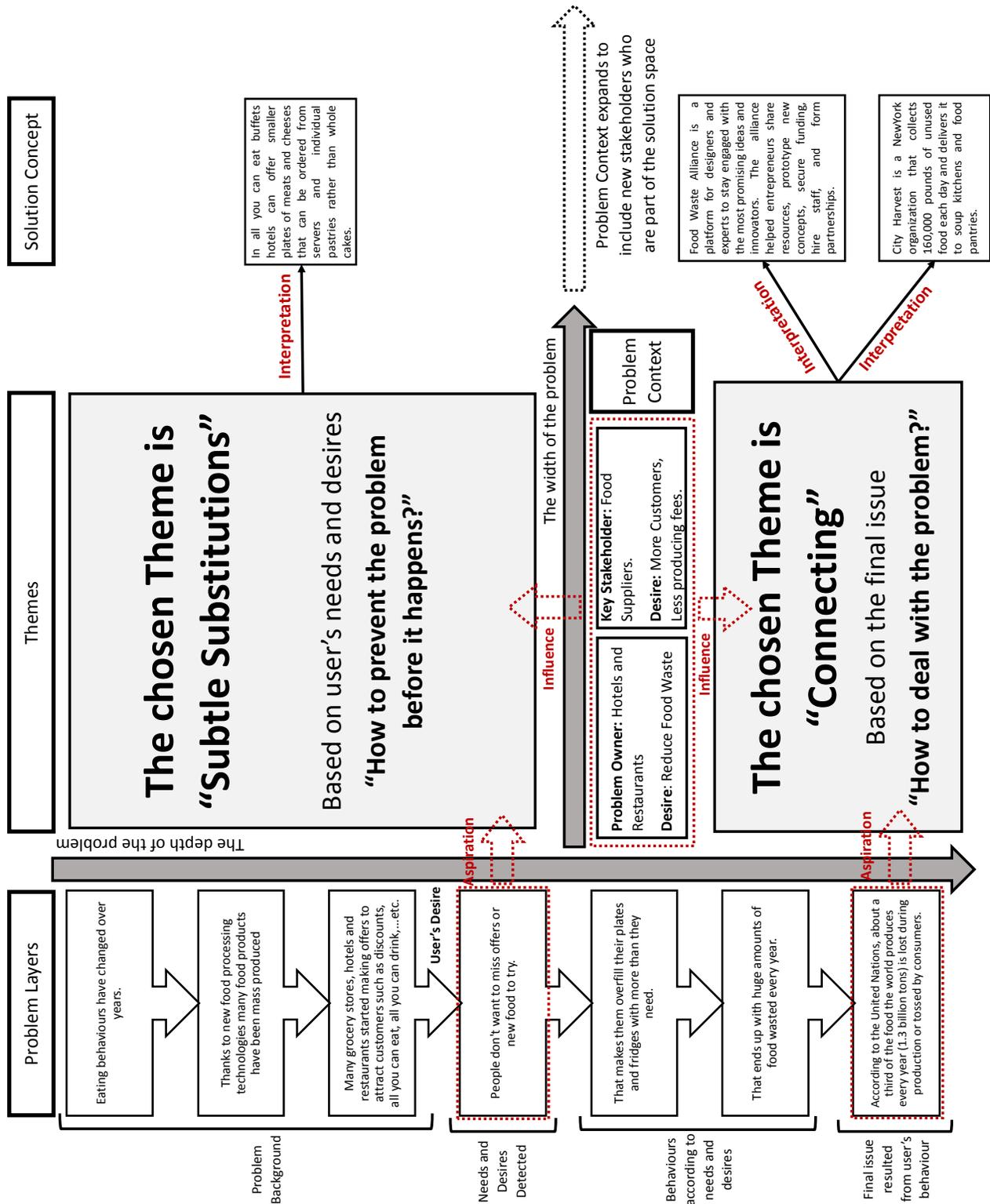


Figure (2): Case Study No.2

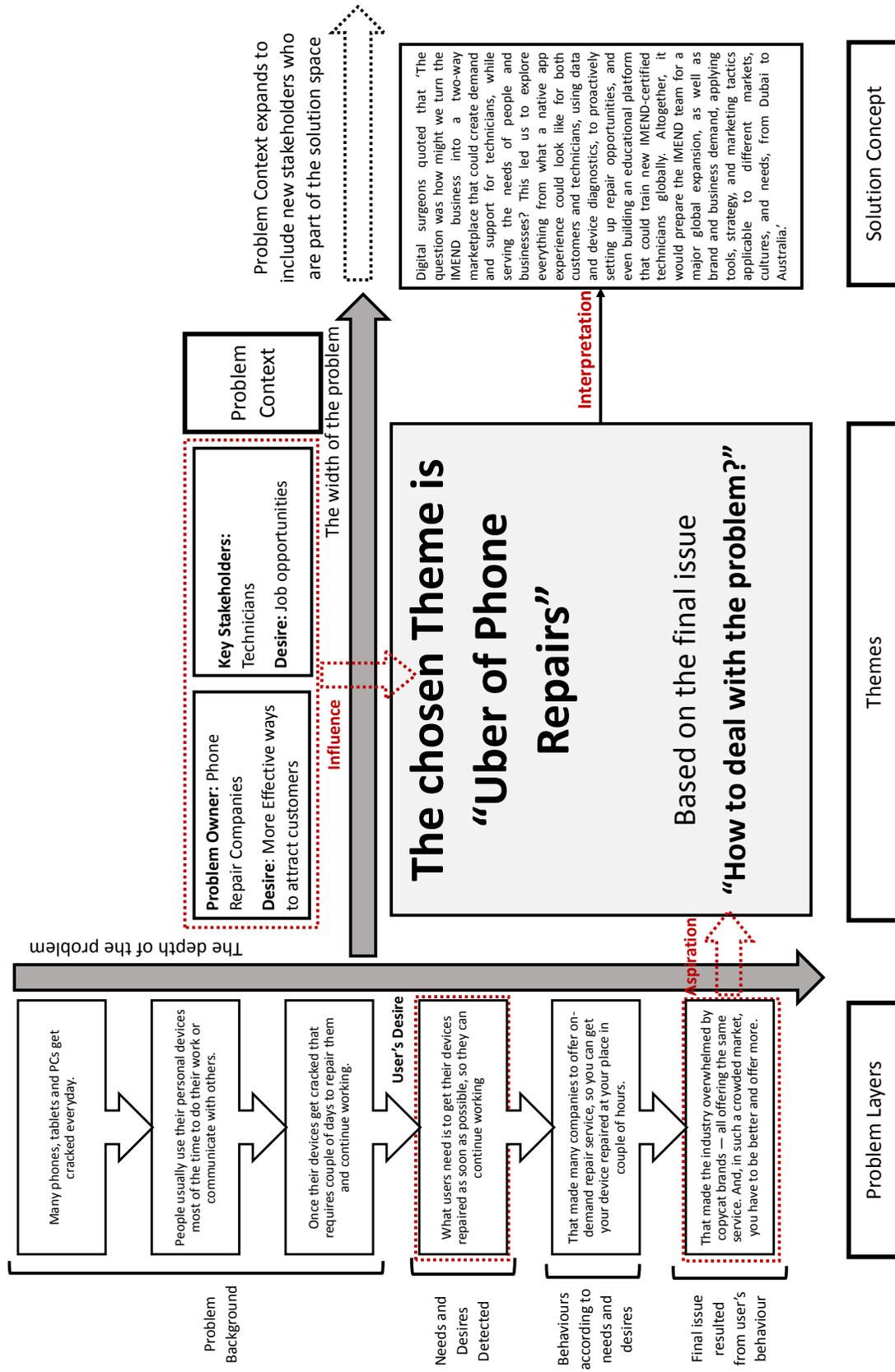


Figure (3): Case Study No. 3

Results and Discussion

The previous analysis gives us a holistic view on how the problem space and the solution space have been handled in each one of them. Three main findings have been found through this analysis.

- The first one is that designers need to understand well where to build their stories. There are two ways to deal with the problem space and build themes either by cutting off the problem before it happens or dealing with it after it occurs. Each way of them produces different range of solutions and values for all stakeholders. Thus, designers need to look carefully where to put their themes along the X axis (problem layers). That explains why different designers come up with different solutions to the same design problem which is related to the way they decide to build their themes. This also explains the notion of ‘fifty different solutions to fifty different problems’ instead of ‘fifty solutions to the same problem’ (Harfield 2007). In that sense, the design problem is considered as a deep layered issue instead of one bulk issue and designers decide on building their themes along those different layers.
- The second finding is that the wider the problem context the more themes designers have. It is difficult to come up with solutions that works for everyone. As each one of the stakeholders need to benefit from the outcome, so the more stakeholders that designers have, the more themes they can build. In that meaning, the problem context is stretchable as it expands to include more stakeholders that could be part of the solution. This also settles Dorst’s definition of ‘context’ (Dorst 2015b).
- The third finding is that themes are more related to the problem space than the solution space. Themes were identified earlier in this paper as a space where the problem space and the solution space meet. From the previous analysis, we found out that themes get aspiration from the problem layers and they are influenced by stakeholders’ desires and behaviour from the problem context. And the solution concept is just themes’ interpretation. That makes themes’ connection to the problem space is much stronger than the solution space.

Evaluation

These findings have been discussed with two design thinking expertise at Department of Design Strategy, Graduate School of Design, Kyushu University by using unstructured interview form. Their comments were concentrated on three main points: the visualised structure, good sides and points to consider in future research. Regarding the structure, interviewees commented on different ways to present the structure that explains the problem-solution relationship. Interviewee A mentioned that sequence of ‘problem layers’ could be upside down depending on the way that designer could imagine the problem sequence. Interviewee B also commented that this structure is easy to imagine if the project is already designed and finished, but if the project is still undergoing, the structure would be difficult to imagine. Moreover, interviewees appreciated the way that the presented structure simplifies the problem-solution relationship, as it helps to imagine inputs and outputs along the process. Regarding points to consider for future research, Interviewee A commented on the way that ‘problem context’ could be improved, as presented structure doesn’t show clearly stakeholders’ contribution and effort on themes decision. Interviewee B commented also about other factors that affect designers’ decision on choosing themes or deciding on solutions like budget for example. As limited budget could affect designer’s decision on preferring low budget solutions other than expensive ones (Table 2).

Conclusion

This research tried to discover the relationship between problems and solutions in design using a holistic way of visualization based on KeesDorst’s framework of ‘Frame Innovation’. This relationship is understood through the mediating factor of themes that bridge the problem space with the solution space. This research tried also to answer some basic questions that comes to the mind of designers on why and how to decide on solutions. This was done by analysing different case studies done by different design studios and organization. Three main findings have been unearthed which can be concluded as follows:

- Building themes in different locations along problem layers produce different outcomes.
- The problem context is expandable as it includes many different stakeholders that may appear in the solution space.
- Themes’ connection to the problem space is stronger than their connection to the solution space.

This research could be considered as a step in the journey of understanding how design problems could be formulated and design solutions could be chosen. This needs to happen through connecting literature with the analysis of real-life case studies to make it more credible to imagine. In future, this analysis needs to be expanded to include other factors that could affect designers’ decision on choosing themes such as budget, designers’ expertise or project timeline.

Another way to improve this analysis in future could be done by examining problem-solution relationship through ongoing design projects. By understanding the relationship between design problems and solutions, designers would navigate their way of thinking to make sure that the final outcome not only meets user's needs and desires, but also solves the core of the problem.

	Interviewee A	Interviewee B
Structure	'Problem Layers' could be presented upside down depending on designer' preference	Presented structure is applicable for finished projects, but what about ongoing ones
Positive Side	The relationship is presented in a way that makes it easy to imagine inputs and outputs along the process	The presented structure is easy to read
Need to consider	'Problem Context' need to be illustrated in a way that represents each stakeholder contribution and effect on the chosen theme	Other factors that could affect decision on themes such as budget need to be presented in the structure

Table (2): Interviewee Feedback

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