Stakeholder/Value Approach to Integrating System Development Model and Dependability Analysis: CS-GPE Case Study

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Abstract

The paper is focused on a value-based approach applied in a research project for the study and evaluation of current communication solutions/systems for large-scale public events (CS-GPE). On the basis of stakeholders/value dependency analysis new solutions for dependable communication systems have been proposed that are flexible and adaptable to suit uncertain and turbulent environments. The project has also introduced a system development model for such environments, to prove the feasibility of new technical, service, and business concepts through an iterative approach in which users and other stakeholders participate throughout the process and demonstrate the expected benefits of developing new communication system architecture and mobile multi-media application services, such as location based services and VoIP applications.

Keywords: stakeholder/ value approach, system development model, dependability analysis, communication system.
1 Introduction

The project Communication Systems for Grand Public Events (CS-GPE) is a research project for providing a reliable and secure communication system for grand public events such as music festivals, outdoor concerts, summer festivals and other celebrations. The communication requirements for these events are different from more traditional communication systems. These systems are time-limited, geographically focused, have a specific topology, and generate a variety of business opportunities for both local and global actors.

CS-GPE introduces a life-cycle model for a system operating in an uncertain and turbulent environment. The requirements and conditions of such a system development process can be characterized by being ever changing and their success requires continuous involvement of all the success critical stakeholders. The conditions for these real time systems can be described as:

“The organization is undergoing constant change and system requirements are always changing. The requirements of the system are unknown or uncertain. It is not possible to define requirements accurately ahead of time because the situation is new or the system being employed is highly innovative. Here, the development methods must emphasize learning. Models, which take advantage of prototyping and rapid development, are most appropriate as well as those that make the maximum use of reusable code, and a highly modular design.” [3]

The system development model helps to prove the feasibility of new technical, service, and business concepts through an iterative approach in which system stakeholders participate throughout the process to demonstrate the expected benefits and of the developed system and to identify future application services.

2 System Development Model

For developing a system operating in an uncertain and turbulent environment, the
involvement of all the success critical stakeholders plays a vital role for the system success. So a stakeholder/value approach has been taken to understand the needs of different stakeholders and their complex and changing interactions with the system. The development of the system has to be based on:

- **Understanding the Environment**

  The environment in which the system has to work is changing with time and so do the system requirements. Collecting data in such cases is not simple because it requires knowledge about all the stakeholders needs and their problems as well as what are the future expectations from the system.

- **Time-limited Environment**

  For collecting data and getting knowledge about the system environment, a major limitation is time. Grand public event like music festivals, outdoor concerts, summer festivals are time limited events. They occur for a certain period in a year. In that limited period all information must be collected to make a better system.

- **Stakeholder Involvement**

  Involvement of all the stakeholders is a key component for the success of the development process. It is very complex task to motivate all stakeholders to take part and provide information/feedback.

- **Event-Driven Iterative Approach**

  It can be noticed in the below illustration of the process model elements (Fig. 1) that the event-driven process has to be coordinated with the period of the grand public event (GPE).

- **Stakeholder Coordination**

  The CS-GPE success depends on the exact following of the GPE timetable and the stakeholders' coordination. The stakeholders belong to different business fields and
have different interests in the system. To make them follow the timetable and coordinate with each other is a complex management job.

Figure 1 shows the life-cycle model stages of the CS-GPE.
Figure 1: Life-cycle stages of the CS-GPE: Development and Evolution

- Initial investigation
- Strategy
- Hypothesis
- Screen out Requirements
- Prototyping
- Improved System
- Testing & collecting feedback
- Real-time testing & collecting feedback
- Analysis
- Stakeholder/Value Analysis
- Screen out improvements
- Improved System
- Stakeholder Workshops
- Data Collection & Testing
- Design
- System
- Analysis
- Stakeholder/Value Analysis
- Improved System
- Analysis
- Stakeholder Workshops
- Data Collection & Testing
- Development Phase
- Evolution Phase
- Event-Related Time
The life-cycle model can be divided into two major stages that are:

- Development stage
- Evolution stage

Here are the CS-GPE life-cycle system model elements applicable for turbulent and uncertain environments.

- **Development Stage**

I. **Initial investigation**

The process start by identify problem in existing system or a need of a new solution for a turbulent and uncertain environment with continuously changing needs. Initial investigation is made to the environment, its need and stakeholders, their complex interaction with the system.

II. **Hypothesis**

On the bases of this initial investigation hypothesis is made about the environment

III. **Developing Strategy**

As the event is time limited, it is very important to make a clear strategy how to deal with the environment in order to learn more about it in short time duration. Questions like what data need to be collected and how it will be collected, are clarified by setting out a strategy. In the strategy the data collection methods are addressed to make it sure that the data that has been collected is not biased and reflects the real environment.

IV. **Real time testing and data collection**

At the event real time testing is made to know the current situation of the infrastructure and its problems and weaknesses. Other than measurements (like: TEMS for cellular mobile networks, NetStumbler 0.4 for Wireless-LAN) and testing, data is collected from the stakeholders that are gathered for the event and may not appear until next year. The methodology used to get information/feedback
from stakeholders in the project CS-GPE was based on interviews, questionnaires and stakeholders’ workshops.

V. **Stakeholder/Value Dependability Analysis**

On the basis of collected data and reading from testing, the hypothesis is tested. Corrections are made and analysis is done based on the collected information to learn about the stakeholder interests and their interaction and requirements from the system. As the stakeholders belong to different fields their interests may collide with each other and so do their requirements from the system. So it is very important to perform a stakeholder/value dependency analysis which will identify the success-critical stakeholders and the stakeholder-system dependability attributes relationships and their intensities. This analysis will be used to make tradeoffs in case of requirement collision and will contribute to the development of a Win-Win balanced system.

VI. **Screen out requirements**

Through this analysis, requirements are screened out for the future system.

VII. **Early Architectural Concept**

The next step is the early architectural concept development in which early concepts are formed about the system architecture that will fulfill the requirements.

VIII. **Prototyping**

These concepts are then refined and a prototype is built to be tested in the next upcoming large-scale public event.

IX. **Real time testing/collecting feedback**

With the help of the prototype, real time feedback is collected.

X. **Stakeholder/Value Dependability Analysis**

The collected information about the experience of people using the prototype and the problems they face or their wishes from the system are analyzed. This analysis gives a clearer picture of the system role and the stakeholder interactions with the
system. It brings upfront if there are any problems with the prototype and the improvements that are needed.

**XI. Screen out improvements**

In this stage improvements to be done are screened out.

**XII. Design and build-to-improvements**

Following the improvement screening, the system is designed and built.

**XIII. System Release**

The improved system is released for the next event.

- **Evolution Stage**

After the development stage, the system enters into a cyclic evolution stage. A cycle has the components shown in the Figure 2. As the system requirements and stakeholders’ interactions with the uncertain and turbulent environment are ever changing it follows that an iterative life cycle process is required to cope with changes.

Figure 2 shows a process cycle.
3 Dependability Analysis Model

The above-discussed iterative process model has been applied for developing the communication system for grand public events. In this section one of the important model steps that is stakeholder/value dependency analysis is presented. This step brings into light the advantages of an iterative approach in which users and other stakeholders participate throughout the process. The analysis will be made in the light of project Communication System for Grand Public Events (CS-GPE). The large-scale public event studied in the project CS-GPE was the Hultsfred Rock Festival in Sweden.

Stakeholder/Value Dependency (SDV) analysis provides a possibility to evaluate a communication system in terms of contributions of existing and new computing and communication technologies to the improvement of system’s dependability. To perform the dependability analysis the steps are: to identify the success-critical stakeholders of the specific system (here CS-GPE), followed by the identification of system dependability attributes, and the characterization of the relative strengths of stakeholder dependencies on various dependability attributes of that system.

A dependable communication system is vital for large-scale public events.
Nowadays, in addition to booking artists, hiring facilities and contracting services, communication services should also be considered when planning outdoor events and festivals. The SVD analysis helps to understand the nature of dependability of a communication system for large-scale events, and to assess the business, user, service and technological aspects. The business models and value chains for traditional telecommunication services are based on a long-term view to justify the necessary huge investments. The value constellations for short-term, large-scale repetitive events have different priorities, as the time for generating value is short.

3.1 Success-Critical Stakeholders

Stakeholder dependability analysis is a way to know if the system will fulfill the future stakeholder requirements of that will evolve with time once the system will become operational. For screening out system dependability attributes the first essential step is to identify the major classes of success critical stakeholders. These stakeholders have their own ways of interacting with the system and exhibit different patterns of dependency on dependability attributes.

3.1.1 Identification of Success-Critical Stakeholders

We are going to identify the success critical stakeholders for a dependable communication system for grand public events (CS-GPE). Figure 3 shows the success critical stakeholders and their interactions with the system. Depending upon their interactions with the system the stakeholders have different patterns of dependency on the dependability attributes with different relative strengths. As illustrated in Figure 3 the different stakeholders involved with the CS-GPE can be classified into the following major classes:

- Infrastructure Providers
- System Controllers
- Infrastructure Brokers
- Infrastructure Consumers
- Administrators
Infrastructure Providers

The Infrastructure Providers are the stakeholder class supplying the infrastructure components that will be used by them and other classes of stakeholders. In the context of CS-GPE, organizers and service providers like Mobile Network Operators (MNO) and Internet Service Providers (ISP) are the active members of this class.

In their role as communication providers, they directly depend on the communication system for the availability and protection of their and other’s information. The communication system ability to provide privacy and security is

Figure 2: Major success-critical stakeholders at an early project stage
critical for them. They use the communication system to update the information about the event, which is essential for efficient event operation and to communicate messages concerning problems and emergencies. The quality of service of the system plays a key role for this class as they use the communication system frequently and extensively for their own needs and also provide services for other stakeholders. Other system attribute that is important for Infrastructure Providers is the possibility of the system to evolve in order to fulfill the communication requirements of each specific event. Infrastructure Providers may play more than one role and so could have other system dependencies.

**Infrastructure Brokers**

The stakeholders in this class use the infrastructure to offer different services to customers. In the context of CS-GPE, Halebop belong to this class. They collect information about the event and process it to produce a more refined and customized services for visitors. They also belong to the class infrastructure consumers but they have special needs and system dependencies in their role as brokers.

For Infrastructure Brokers the confidentiality and integrity of information they receive and send through their services/applications is very critical, any wrong news can damage their own and their organization reputation. Also reliability and availability of the infrastructure is critical to them as time is the key factor of their success and they have to launch the service before their competitors in order to win the market.

**Infrastructure Consumers**

This stakeholder class use the infrastructure provided by the infrastructure supplier class. They are event performers (artists and their teams), press and visitors. These stakeholders use the infrastructure to get and send information in and out of the event area. Their main concern is with the availability of the communication system but even that is not required to be present all the time. They can be very
numerous (approx. 30000 and more) so system capacity is important to provide services to this class. Other than that this class depends on quite a few attributes like accuracy of information, and sometime also requires confidentiality but the level of their dependency on these attributes is not severe.

**System Controllers**

System controllers are the stakeholders that control the communication system and are responsible for its proper working and availability. This class depends directly on system functionality and system safety and physical security are important to them. These stakeholders are the organizers and service providers (MNOs and ISPs) but the organizers share stronger dependencies than service providers.

**Administrators**

Administrators share dependencies with the above discussed class that is system controllers but they have their special need and dependencies. Their tasks involve monitoring and managing system resources, security operations, user requests, system backup etc. In the context of CS-GPE the organizers are the active members of this class. Their duties depend on the system reliability, accuracy and availability for successful completion. As belonging to the above class their have indirect dependencies on system attributes such as: safety, security, and survivability.

**Maintainers**

Maintainers share dependencies with the above-discussed class that is administrators. Their tasks involve maintaining the communication system. In the context of CS-GPE, the organizers belong to this class. To maintain the system in terms of operations and services, system reliability, safety and survivability are critical for them.
Developers

In this class are the stakeholders involved in development activities such as requirements analysis, design, programming, and testing of the infrastructure and the applications during the system’s life cycle process. In the context of CS-GPE, the members of research and development project “Wireless Festivals” [http://projects.celtic-initiative.org/DB/] are the active members of this class. Developers do not have direct dependencies with the communication system but do depend on the system to perform prototyping, testing and getting feedback etc. Their concerns with the system include abilities to be upgraded and support future needs of the end users.

3.2 Stakeholders Needs, Technologies, Requirements

After defining the critical success stakeholders the next step is to identify their needs, technologies, and requirements in order to motivate the selection of dependability attributes and the stakeholders’ different patterns of dependency on these attributes.

3.2.1 Organizers

The organizers were using a number of communication technologies to perform different tasks. The needs which motivate them to use different technologies can be summarized in the following table:
From the above analysis we can outline the following requirements for the communication system that are important for organizers.

- **Should reduce the number of devices they have to carry with them.**
- **Without the problem of congestion, guaranteed to be connected all time.**
- **Network can be built without digging trenches for cables (as it is not allowed in the area).**

*Figure 3: Technologies used by organizers.*
With security and reliability, especially that could provide them with confidentiality (so that press cannot be able to eavesdrop on security people).

- On which calls can be redirected.
- Should carry voice and data and video.
- Should provide multicast/broadcast services.
- Reach the whole group and reach any person in the group.
- Should be connected with both intranet and Internet (But it is important that if a person is given access to Internet, it will not be able to get in to intranet. The integrity of the intranet should not be compromised)
- Should be upgraded with time and advancement.
- Should be used even if they are surrounded by people and loud sound.
- Easy to install in less time and less human effort.
- Do not need high expertise to work with.
- With possibility to install new services.
- Should provide services including messages, book meetings, calendar, tasks and address book etc.

### 3.2.2 Service Providers

The service providers were using a number of communication technologies to perform different tasks.
All these service providers have developed their own network without any collaboration with each other although they all had same purpose that is to be connected to their intranet and Internet for three days of festival. The reasons for this independency were (as analyzed by us):

- It seems to them more economical to do it independently.
- It was more time consuming and required more management to do it together.
- They are not sure whether they will be here for the next year event (Skatteverket and Aftonbladet).
- It was not fruitful to deep managements just for one year event of three days.
They do not need to collaborate to find a solution as TeliaSonera provided them with a cheap solution.

Although they are very different actors their requirements can be outlined as follows:

- Easy to install and work with.
- Secure and reliable.
- With high capacity and speed (especially in the case of SVT).
- Should provide them connectivity to their main offices and also to Internet.
- With a possibility to have prioritized connection (to have guarantee to be connected all time with high quality).
- Should provide ways to visitors and audience to communicate with them (SMS polling).

3.2.3 Visitors

The third stakeholder using communication system was general public (visitors). They bring their GSM and 3G phones to the festival with subscriptions from TeliaSonera, Vodafone, Comviq etc. Although most of the mobile network operators had placed extra equipments to increase the capacity of mobile network for the festival visitors, still visitors faced problem to connect to people inside the festival and also to people outside.

![Figure 5: Technology used by visitors](image)

During the event of 2004, a survey was made and questions were asked from roughly 100 visitors to know their problems and expectations from the
communication network. The following information is important to know before any requirements are outlined for visitors. Visitors mostly come in the group of 2-5 people. Major reasons for coming to the festival are music and meeting new and old friends. About the communication devices, 97% had mobile phones at the festival out of them 40% were GPRS phones and 4% had 3G phones. 43% had Comviq/Tele2 as operator, 23% had TeliaSonera and 19% had Vodafone. It was also discovered that visitors make most of the calls to their friends in side the festival. On the services side, 71% had voice mail and 20% had e-mail service and 28% hand free. Visitors expressed that they would like to have services that could help them to locate their friends and know about festival program and its updates. 44% declared willingness to pay to have such services.

As visitors mostly come in groups, it would be attractive to them to have multi casting, group messaging. 40% of the questioned visitors brought their GPRS phones and 4% 3G. It can be expected that the trend will grow and to the next event say, 20% or more will bring 3G phones. Almost all of them showed interest in new services and 40% said they are willing to pay for new services.

Visitors’ requirements can be summarized as follows:

- Economical.
- Provide voice, voice messaging, data and video and Internet.
- Available all time.
- High speed and capacity.
- With positioning services like FriendFinder that could help people to find each other through their wireless devices.
- Group messaging service.
- With locking and locating technologies in case lost and damage.

3.3 System Dependability Attributes

The above mentioned requirements associated to different stakeholders are used to identify the primary attributes of system dependability that success-critical
stakeholders require:

**Dependability Attribute Class: Quality of Service**
- Provides good quality voice, data and video (Performance)
- With high capacity and speed (Capacity, Speed)
- Provide services with accuracy and consistency (Accuracy, Consistency)

**Dependability Attribute Class: Security**
- Can be connected to intranet and Internet without compromising confidentiality and integrity (Confidentiality, Integrity)

**Dependability Attribute Class: Robustness**
- With high reliability and availability (Reliability, Availability)
- Can withstand disasters (Survivability)

**Dependability Attribute: Evolvability**
- With a possibility to be upgraded

**Dependability Attribute: Usability**
- Easy to install and use

**Dependability Attribute: Cost**
- Economical

**Dependability Attribute: Safety**

### 3.4 Stakeholder/ Dependability Attribute Relationships

In this section we are going to analyze the stakeholder/dependability attribute relationships and their intensities.

#### 3.4.1 Empirically Determined Stakeholder/ Dependability Attribute Relationships

In the start of the project CS-GPE, hypotheses were made about the stakeholders
and communication system dependency attributes which have been indicated by thin lines in Figure 7. The hypotheses were based on the empirical analysis of stakeholder win-win negotiations regarding requirements for a communication system to improve existing large scale public event services. The bold lines are the added relationships discovered after real time event experience.

![Empirically Determined Stakeholder/Attribute Relationships](image)

*Figure 6: Empirically Determined Stakeholder/Attribute Relationships*
3.4.2 Analysis of Stakeholder/Value Dependencies

The stakeholder value dependencies are analyzed within the scope of the project CS-GPE:

The Communication System for Hultsfred Rock Festival (Large Scale Public Event) has three different types of stakeholders to satisfy. These stakeholders are: i) organizers of Hultsfred Rock Festival (Musiclink); ii) different service providers (Halebop, Aftonbladet, SVT etc); iii) the general public (visitors). In this section we are going to analyze the stakeholder dependability on different communication technology attributes. With the help of this analysis we will outline specifications/requirements of the communication solution that could fulfill their future needs.

Organizers are currently using a number of communication technologies including DECT (Digital Enhanced Cordless Telecommunication) phones, GSM (Global System for Mobile Communication) and 3G (Third Generation) mobile phones, PDAs (Personal Digital Assistants), walkie-talkies and sign language. Along with these technologies, they have to employ 6000 volunteers every year to manage the festival. The organizers have to spend approximately 1 million SEK to provide food to the volunteers. This is really a high figure itself but they have to spend even more to fulfill their communication requirements. They have to give free tickets to university to get computers to establish their own exchange system that could direct their calls from their office place to their phones at the festival site. It is very hard to get the cost in some figures but one can get clear idea that they spend lot of human and economical resources to meet their communication needs.

To work out the requirements for any architectural concept of a future communication system it is necessary to know the conditions that lead them to use so many devices. Stakeholder dependability analysis helps us to understand the complex stakeholders’ interactions with different communication technologies. We analyze the uses/needs of the technologies one after the other and to determine why organizers use DECT phones when they have GSM phones and again why they use walkie-talkies when they have DECT and GSM phones and so on.
Organizers use GSM phones to communicate with each other but due to the presence of a large number of people (approx. 25000) using GSM phones in the same vicinity, the GSM network is often overloaded and calls can not be connected. As it is very important for them to be connected all the time they require a backup system that assures their connection to the key persons. The DECT system plays the role of an alternative way of communication and provides them with redundancy and reliability. To have DECT system is cheap for them. They see it as a ‘sunk cost’ since they already have a DECT system at their office. During the festival they bring this DECT system to the festival site. But there are other costs involved, too. They have to bring the system and have to employ human and financial resources to make it up running on every event occasion and additionally they have to establish their local switching system to get their calls on their DECT phones.

GSM and DECT systems provide the organizers with very few possibilities regarding voice and SMS (Short Message Service). Although GSM network can provide more services like group messaging, video, Internet, intranet etc with upgradation to 2.5G and 3G, organizers cannot rely on that because of the network congestion problem. To manage the festival in efficient way they need to communicate in more ways. They require a schedule about who has to do what and when, so they can see who is responsible for what, what has been done, and what has been left. Such communication needs lead them towards PDAs with wireless applications. On PDAs with wireless services they can have their task sheets; they can receive and send individual and group messages, personal profiles and many more. Such services are in the developing stage and some of them were tested during the event of 2004 by a student project WHAT from BTH (Blekinge Institute of Technology).

Other than GSM and DECT phones and PDAs, organizers also employ walkie-talkies, sign language and volunteers for communication. The number of DECT phones is limited. It is enough for them to work in the office but during the event the number of workers increase and they require more equipment to communicate.
Organizers do not want to make any permanent investments because they can buy the latest technology of that time but it gets obsolete with years to come and they get stuck with their old equipment. It is not possible for them to dump their old equipment and buy new equipment every year. They require a flexible system and want to utilize their investment as much as possible. This motivates them to rent walkie-talkies to overcome the communication gaps. Although this seems to be a good tradeoff, it opens security holes in the communication system. Any outsider with a walkie-talkie can tune it to the frequency they are using and can hear them. This is totally unacceptable for them as the press could find out about their faults and emergencies at the festival (if there are any!) and can publish them. They do not want to create panic or to have the press representatives be aware of an emergency situation as this fact might hinder security people to do their job. Publishing any miss-happenings will also have a negative effect on the festival marketing and on their future funding. To solve this problem the workers with walkie-talkies use coded language and signal language to communicate confidential information.

As mentioned earlier, organizers also use a large number of volunteers for different purposes, e.g. to backup communication network. Although they use many technologies, organizers cannot be sure to be connected all the time with all the desired persons. So they have to keep a small number of volunteers as backups. In addition, volunteers are required for many other tasks, for example putting up the posters for festival marketing, bringing all the things on the site, setting them on the site, building up the stages and so on. As discussed earlier organizers spend a large amount of money to provide food to these volunteers.

The above analysis gives us a clear picture why organizers are forced to use so many technologies. In addition to these, there are some requirements that are necessary for the communication system to provide efficient management of the festival.

Organizers work in groups to manage the festival. The groups are made according to tasks they have to do for example stage setting group, security group, food
managing group, and so on. In most of the cases there are messages that are addressing the whole group rather than one person, and people belonging to same task group require sharing of same task sheets, and information about which tasks are completed and which ones are left. To fulfill these needs a communication system should be able to support multicasting/broadcasting.

Security is another feature, which is very important for the organizers. At the festival there are a number of press people whose job is to find problems and place interesting headings in their newspapers. Organizers have to be very careful about that and they have invented codes and sign language to secure their communication near the stages. Organizers also provide network access to some of the press people and other workers at the festival. When they provide this service they have to be very careful that the person would not be able to get access to their intranet. They use different physical connections to avoid the threats of such intrusions.

Communication technology is growing very fast and new products are coming in the market every month. The communication speed is getting faster and faster and old products do no longer support such changes. Festival organizers are facing such problems. They have bought systems like 5 to 10 years ago and now the communication requirements have evolved far beyond the services these old products can provide. Festivals are arranged every year and the organizers need to support new communication requirements every year. They require a system that has is flexible and capable to evolve to support new functionality.

Other stakeholders are service providers and visitors. They do not exhibit such complex interactions with the communication system. The communication system attributes important for them are reliability and quality of service and their dependency weights (patterns) can be viewed in Table 1 which gives a complete picture of the results/findings of the stakeholder dependability analysis.
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Table 1. Stakeholder/Value Dependencies
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<th>Organizers</th>
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4 Conclusions

In this paper we presented a life-cycle model for a communication system for grand public events characterized by turbulent and uncertain environment. The model emphasizes stakeholder/value dependency analysis as an important step of the life-cycle process. In the past, this step was mostly ignored or not given enough importance and due to this fact the old system failed to cope with the future needs of its success critical stakeholders.

In the new development model, the stakeholder dependability analysis is the key step for the system success. It helps to identify important system dependability attributes and stakeholder/value dependency patterns. This gives a very clear picture about the system role in relation to its environment and the complex interactions with different stakeholders having different value requirements. In any environment where a system has to fulfill the value requirements of number of stakeholders which conflicting interests, stakeholder dependability analysis is the key to identify the tradeoffs which are necessary to provide a dependable system that will evolve to meet future requirement changes and will satisfy the stakeholder/value dependencies.

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