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Decision-making in Software Evaluation: like to, want to and have to

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Abstract

This paper presents findings from three participative case studies in the selection of a Remote Assistance application. The needs for a Remote Assistance application were different: vanity project, commercial pressure, COVID-19 imposed travel bans. The case organisations had different motivations, different evaluation approaches and different decision flows. However, none of the organisations followed the formally described approaches of criteria definition, criteria ranking, score calculation and decision. The studies show chaotic and iterative processes which are influenced by participants' attitudes and humours more than by formal procedures and business-school teachings. The motivations for IT-use appear to influence the decisions more than the (in-)formality of the evaluation process. The paper concludes with a discussion of the findings and proposals for further research.

Keywords: decision-making, software evaluation, service management, ethnography, qualitative study

1 Introduction

This paper presents three organisations which demonstrate different decision-making processes in the assessment and selection of a Software for Service Management.

The paper is structured thus: in the introduction, and argument for investigating the decision-making process for software evaluation is made. This is followed by a literature review of (1) Service Management applications and (2) seminal decision-making approaches. The findings section describes the decision-making processes in the three organisations. The final section discusses the findings, critiques the study, and presents some conclusions.

Modern enterprises depend on Information Technologies (IT). We cannot picture a business (in the developed world) which could flourish without a mobile phone, website, card-payments, some sort of accounting software (be it Microsoft Excel) and, nowadays, a social media account (Twitter, Instagram, and so on). The use of ICT has long been linked to sustained comparative advantage and superior organisational performance (El Sawy,

2003; Venkatraman, 1994). Commercial enterprise-grade software has been a focus of Information Systems (IS) researchers for a long time.

Choosing the "right" software has a direct impact on organisational performance and is, therefore, an important business activity (Tsai, Lee, Shen, & Yang, 2009).

The selection, implementation and continuous use of technologies are well-researched phenomena. A search for "ERP selection process" on Google Scholar returns a staggering 346,000 hits (40,000 of those in the last five years). However, enterprise software is changing, as are the expectations of the users of these systems. The changes are exacerbated by the progress of "-as-a-Services" (Platform as a Service, Software as a Service and so on), and the proliferation of IT in personal spaces (notably the availability and capabilities of smartphones). The implementation costs, the licensing models, the modularity and interconnectivity, and the usability of enterprise systems are expected to reflect the ease-of-use of personal software. Traditional approaches to software-selection, evaluation and implementation appear to be no longer applicable.

1.1 Aim and Methodology

The authors have participated in three selection processes for a Remote Assistance (RA) Tool in three different service organisations in 2020. The need for the Remote Assistance in these organisations was driven as much by commercial initiatives as by the COVID-19 pandemic which made visiting customer's sites difficult or impossible. The objective of the paper is to provide an ethnographic account of decision-making in practice and highlight the need for further research in this area. The author is a full-time employee for a software firm which offers an RA-solutions on the market. Thus, the author himself is emerged in the situations described and actively participates in the processes analysed: speaking and understanding the "native language". The research data contains emails, documents such as Request for Information, Request for Proposal, meeting notes and personal notes (Avison, Lau, Myers, & Nielsen, 1999; Hatch, 2012; Silverman, 2013).

1.2 Remote Assistance Software

Service Management is a complex process. It can be broken down into several distinct areas which are also reflected by IT solutions offered in the market. Generally, there are "universal" solutions which cover the whole breadth of service management and "specialised" software vendors who offer "best-of-breed" solutions for specific areas.

This paper's focus is on the selection and evaluation process of one specific feature: "Remote Assistance". This functionality allows the customer to share what they see with

an engineer based in the office or any other location. The engineer thus can guide the customer through problem evaluation, can assist in resolving issues or, can capture additional information to support follow-up work. One set of the communication technologies which allow the engineers to see and interact with remote customers and machines are so-called "mixed reality" technologies (Mohr et al., 2020). These technologies are mature (Lasserre, 2020) and cover a range of applications (Table 1).

Application	**Examples**
Remote Desktop	TeamViewer, MS Quick Assist, Google Chrome Remote Desktop
Video Calling	MS Teams, Skype, Zoom, Facetime
Product Specific Applications	Vuzix VRA, SGS QIIQ
Augmented Reality- Field Service	Help Lighting, SightCall, FieldAdvisor

Table 1 – Examples of remote assistance software (not comprehensive)

There are many providers of such technologies which offer different degrees of complexity and features. The examples given in Table 1 are by no means representative or exhaustive, however, they help highlighting major differences in applications and thus in the suitability of individual applications for the commercial use.

Remote Desktop applications are designed to assist with software related issues on personal computers. These applications can be "ignored" when selecting software for Field Service support for all bar IT-related issues.

Video Calling platforms could be adapted for providing remote assistance: "let me call you on skype and you show me your problem". There are several points which make these technologies unsuitable for use in Field Service. However, these applications are often unsuitable for Field Service as they require existing accounts, certain operating systems, and lack important features such as telestration[1] and augmented reality.

Product-specific applications are feature-rich and tailored to either a specific hardware (e.g. Vuzix VRA only works with Vuzix Glasses (Vuzix, 2020), or a specific service (e.g. SGS' QIIQ is built specifically to carry out remote inspections (SGS, 2019)).

Finally, *Field Service* RA applications tend to have the following properties:

- they are device-agnostic,
- the data for and from RA use can be integrated into other application, and
- the features are generic and complex enough to satisfy many possible applications.

The paper focusses on the evaluation of RA applications of the latter group.

[1] Telestration is the ability to enhance "live" images with additional information. Best known from sporting events when e.g. ball trajectories are displayed on top of the replay-videos (e.g. tennis ball hitting the line)

1.3 Selection approaches

A brief literature review on software selection processes reveals two major streams: a Delphi-approach (Dalkey & Helmer, 1963) and the application of Analytical Hierarchy Process (AHP) (Saaty, 1990). Both approaches have been applied in practice (Ayağ & Özdemir, 2007; Azadeh, Shirkouhi, & Rezaie, 2010; Lai, Wong, & Cheung, 2002). However, both also have been criticised (Dyer, 1990; Goodman, 1987) and "in real life" there are perhaps very few, if any, pure applications of either technique outside a research setting. The details of the evaluated software and the main selection approaches are discussed in the following section.

2 Literature review

Literature provides ample examples of how software selection *should* be done, using approaches such as Analytic Hierarchical Process, Triangular Fuzzy Numbers, Trapezoidal Fuzzy Numbers, Interval-valued Fuzzy numbers, Intuitionists Fuzzy Numbers and combinations of those (Piengang, Beauregard, & Kenné, 2019). The aim of this paper is not to discuss any of these approaches in detail, but to report on how organisation go about selecting software in practice. Further, much of the business software evaluation and selection literature focusses on ERP software and not on Service Management. Thus, the literature review focusses on (a) the introduction of the servitization-terminology and (b) the overview of the decision-making literature.

2.1 Services vs products

Services are a major economic activity in all the of the UK, Euro-Area and the US with 70%+ contribution to the GDP. In Japan and China, services contribute 69.6% and 53.4% to the GDP respectively (ECB, 2020; Plecher, 2020). Many products which were traditionally offered as hardware artefacts have been replaced by services with the actual product becoming just "means to an end". The process of product-replacement by outcome-based services has been labelled "servitization" by Vandermerwe and Rada (1988) and has since received increasing interest from scholars from different disciplines. The major differentiator between a "product" and a "service" from the provider's (or producer's) point of view is the goal alignment between the supplier and the consumer (Sousa & da Silveira, 2017). Product manufacturers sell the "potential" whereas service organisations sell the "outcome" of the product use (Andrews, Dmitrijeva, Bigdeli, & Baines, 2018; Mont, 2002). For example, in a product-world, I buy a hair-clipper (a product) to potentially have a nicely trimmed beard (outcome), but I could also use the

trimmer to cut my hair. In a service-world, I buy the nicely trimmed beard (outcome). Arguably, the "product" used to deliver a service becomes less important while the quality of service becomes more important. This results in many positive effects such as long-term customer loyalty, recurring revenues, ability to introduce new and innovative products (Bikfalvi, Lay, Maloca, & Waser, 2013; Crozet & Milet, 2017; Mont, 2002; Wang, Lai, & Shou, 2018). Simultaneously, the provider is now not evaluated by the quality of the products but by the quality of service. Maintaining and supporting an effective service organisation becomes a priority (Ambroise, Prim-Allaz, Teyssier, & Peillon, 2018; Gebauer, Fleisch, & Friedli, 2005). There is a broad agreement that organisations who intend to expand their service offerings must make adjustments to organisation's culture, structure and processes (Ambroise et al., 2018; Dahmani, Boucher, Peillon, & Besombes, 2016; Gebauer et al., 2005; Kinnunen & Turunen, 2012; Mont, 2002).

This also implies a focus on ICT support for the service organisation (Wang et al., 2018). One of the subjects receiving little attention is the *selection* of new Information and Computer Systems required to support the evolving and growing service organisations (Wolf, 2020). A plethora of research has been focussed on product-centric ICT- the Enterprise Resource Planning Software (ERP). Unlike ER, Service Management Systems (SMS, also Enterprise Service Management (ESM), Asset Service Management (ASM) and Field Service Management (FSM) Systems) tend to be more light-weight in terms of licensing cost, implementation effort and training (Enterprise Resource Consulting, 2014). A typical ERP implementation (according to personal experiences and google-searches) takes anywhere in the region of 6 months to four years. An SMS implementation is expected to be completed within 6 months, perhaps a year. Finally, SMS systems are increasingly expected to be offered as-a-Service, reducing overall operational cost (QYResearch, 2020).

The lower price-hurdle, faster implementation times, easier deployment through SaaS-model make acquisition, implementation, and selection of Service Management Software different from ERP. Thus, decision-making processes and evaluation approaches may be different. This paper presents three of such evaluation processes for further discussion.

2.2 Decision making

Our modern understanding of a decision-making process is routed in the psychology domain, although it could be argued that the economists investigated the issue as early as the 18th century (Edwards, 1954). Despite our best efforts to formalise decision-making,

decisions are made based on individual feelings, interpretations and beliefs (Tversky & Kahneman, 1974). Formal decision-making models describe how decisions *should* be made, not how they *are* made (Slovic, Lichtenstein, & Fischhoff, 1988). Conflicting decisions are common even when the decision-making is based on formal evaluation criteria (Tversky, Slovic, & Kahneman, 1990).

In the case of formal selection procedures for ICT (Figure 1), many researchers agree on the need to formally state the assessment criteria as one of the first steps in the evaluation process (Azadeh et al., 2010; Tsai et al., 2009; Zaidan et al., 2015).

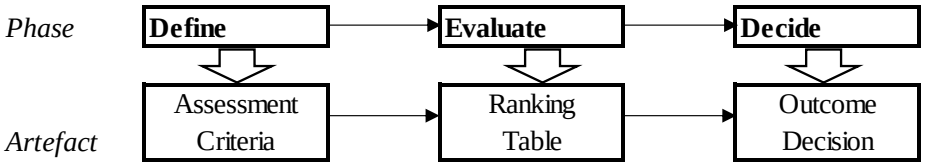

Figure 1 – Decision making phases

Across the studies, the criteria list commonly includes "usability", "functionality", "maintainability", "efficiency", "reliability", "security", "extensibility" and combinations and paraphrasing of these generic terms. The criteria are broken down into specific "features", "use cases" or "requirements". Here, again, the terminology varies, and all the above terms are present in literature and practice. The literature proposes different methods for compiling these criteria-requirement lists. Petter, DeLone, and McLean (2013) reviewed over 140 studies and identified a list of fifteen factors which directly contribute to IS success (Table 2). These generic factors can be translated into evaluation criteria.

Success Factors	Evaluation Criteria
Enjoyment	User Experience
Trust	
User Expectations	
Attitudes Toward Technology	
Organizational Role	
Task Compatibility	Feature / Function
Task Difficulty	
IT Infrastructure	Non-Functional Requirements
Relationship with Developers	
User Involvement	Project Execution
Extrinsic Motivation	
Domain Expert Knowledge	Organisational capabilities
Management Support	
Management Processes	
Organizational Competence	

Table 2 – Success Factors vs Evaluation Criteria (extended from (Petter et al., 2013))

The Delphi-approach (Dalkey & Helmer, 1963) offers another alternative: the subject matter experts can be asked to compile lists of expected and required features. First, these lists are compiled individually. They are then refined through several iterations when details are qualified, for example after a Request for Information (RfI) has been sent to potential suppliers. Selecting experts from different disciplines (or business areas) will provide a rounded picture which is closer to completeness than a list compiled by experts from one discipline. For example, the IT will have a comprehensive list of security requirements whereas Customer Support would contribute a list of functional requirements for handling complaints. One of the advantages of the Delphi-model is that the responses are handled in a non-competitive way and that there is a reduced chance of experts (or departments) influencing each other's decisions. Direct alternatives for Delphi are committee-meetings (with which everyone reading this paper is more than familiar), and expert panels (Goodman, 1987).

The definition of assessment criteria is a challenging task. First, the difficulty is in naming the requirements. End-users and subject-matter experts are aware of their wishes, but not of the capabilities of ICTs available on the market, thus also not the important distinguishing factors (Walsh, 2017). Second, the level of granularity: too abstract requirements will be "fully complied with" by any software vendor. Too precise requirements would dictate a solution and would exclude potentially superior solutions which do not fit exactly. Finally, research shows that expert generated ideas are never comprehensive and miss out important and significant suggestions (Slovic & Lichtenstein, 1983) – the criteria-list will always be incomplete.

Once the list of evaluation criteria has been compiled, the alternatives are rated against each criterion. Several methods could apply here. Simple scoring, weighted scoring, fuzzy algorithms can be used (Ayağ & Özdemir, 2007; Azadeh et al., 2010; Bernroider & Koch, 2001; Lai et al., 2002; Zaidan et al., 2015). Any of these approaches have their advantages and drawbacks. Obviously, simple scoring beats everything else for simplicity. Many alternatives can be compared against each other quickly. However, this also means that each criterion carries an equal weight, e.g. "data security" is as important as "price" (Table 3).

	PROD A		PROD B		PROD C	
	value	rank	value	rank	value	rank
User Experience	5/10	3	6/10	2	7/10	1
Security	10/10	1	7/10	3	9/10	2
Price	1.1 Mio	2	1 Mio	1	2 Mio	3
Summary Rank		6		6		6

Table 3 – A simplified example of a simple-scoring decision table

Intuitively, we recognise that oversimplification of evaluation criteria and ranking does not produce satisfactory answers and support in decision-making.

More complex algorithms call for a reduction of alternatives with the elimination of weaker alternatives (Ayağ & Özdemir, 2007). But how do the decision-makers know what the "weaker alternatives" are? The elimination process requires evaluation and calculation. Additionally, the more sophisticated the algorithm, the more prior knowledge in the data preparation and execution is required. Even simple weighted averages (Table 4) present problems of adjustment and correction. For example, because of a high relative value attributed to price, an inferior product could win.

Criteria	Weight	PROD A		PROD B		PROD C	
		value	rank	value	rank	value	rank
Comfort	20%	5/10	3	6/10	2	7/10	1
Safety	30%	10/10	1	7/10	3	9/10	2
Running Cost	50%	110	2	100	1	200	3
weighted total Rank (∑rank*weight)			1.9		1.8		2.3

Table 4 – A simplified example of a weighted average decision table

Further, the criteria evaluated using mathematical algorithms need to be measurable or ordinal (Azadeh et al., 2010). Evaluations of "fuzzy" requirements such as "easy to use" or "appealing UI" are difficult in a real-life business context.

Regardless of the evaluation method, the final question is: How to decide what the score for a criterium should be? For example, judging the top-speed of two cars on a 1-10 scale. Car A's top speed is 160mph, car B's is 145mph. Does Car A get 10 points? Does Car B get 9, 8 or just 1 point?

The following section presents the evaluation processes observed in practice.

3 Findings

The author observed the evaluation- and the decision-making processes in three separate organisations during 2020. This paper covers the selection process for a Remote Assistance tool (RA). This section starts with the introduction of the software under

evaluation and then describes the overall selection process, finally presenting the processes in each of the three organisations.

3.1 Introduction of the evaluated software

This study describes the evaluation process for Help Lightning RA software. This section is intended as a brief introduction of the basic features to explain how the software can be evaluated and deployed in the field.

Help Lightning RA is a web-based Software as a Service. The application is available as an HTML5 application accessed through a web browser. There are also native applications for Android, iOS and wearable computers e.g. Vuzix and Zebra. Although the RA application can be executed in the mobile browser, the native app for Android and iOS offers additional comfort. First, as the application does not need to be downloaded each time, the start-up time is shorter. Second, the application is best used in a landscape mode (to accommodate the control buttons on the right-hand side of the screen (Figure 2); the installed application automatically opens in landscape mode. Finally, the native application uses the entire screen and thus makes better use of the space available for the video.

To initiate a Remote Assistance call, only one user must be registered and logged in to the application. The registered user can be reached by any other user (registered or not) via her dedicated URL. Registered users can contact each other directly or can invite other users to join a call by sending them a text message or an email.

The application interface for registered and non-registered users is identical, with the difference that registered users have the options to initiate a call, record the call and take pictures (Figure 2).

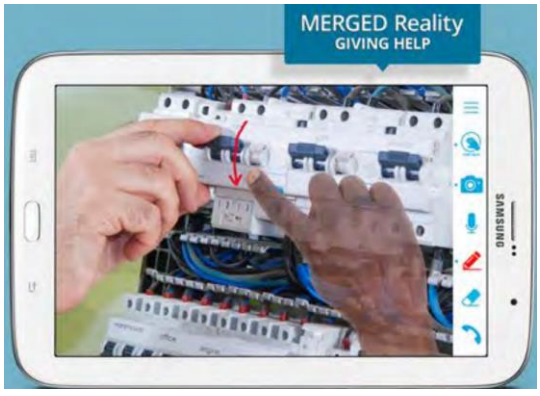

Figure 2 - Help Lightning User Interface (from helplightning.com)

Each Help Lightning customer has a dedicated tenant on the SaaS platform and the data is not shared across organisations. As would be expected, the platform complies with national and international data protection regulations, conforms with modern

authentication mechanisms such as two-factor-authentication and single-sign-on, and offers adequate data encryption for data in transfer and data at rest.

3.2 Evaluation processes

The evaluations took place in February-March (organisation 1), March-May (organisation 2) and July-August 2020 (organisation 3). The evaluations were time-limited to a six-week evaluation period and one week for decision-making. The evaluation timelines and processes for assembling teams, documentation of findings and communication with the supplier were similar in all three organisations (Figure 3).

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Assemble prospect's Project Team									
Setup evaluation tenant									
Kick-off meeting (1-2h)									
Cadence meeting (30 mins)									
Progression meeting									

Figure 3 - Typical RA-evaluation project plan

Once a project team has been assembled, an introduction session with the supplier and a training session with the evaluation team is held. KPIs and assessment criteria are agreed between the supplier and the prospect. The prospect gets a six-week access to a trial tenant and carries out their evaluation. The evaluation is accompanied by the supplier and progress is captured in weekly briefings. Finally, a progression meeting is held where the prospect announces their decision to progress or reject the implementation. During the six weeks, the prospect agrees to use the RA application for a range of scenarios to ensure that all the must-have and should-have requirements are evaluated.

Some of the requirements can be tested easily and can be given a definitive score. For example, “Multi-lingual interface” – the supplier can simply provide a list of supported languages. Other criteria are somewhat difficult to evaluate “device agnostic” – if the application supports Android 6+, going 5 years back: would that be a “yes” or a “no”? Yet other criteria, such as “ease-of-use” are purely subjective and will depend entirely on the user’s disposition towards technology.

3.3 Introduction of the organisations

The service organisation observed during this study are two German SMEs (organisation 1 and 2) and one subsidiary of a larger German service provider (organisation 2).

The first organisation (ARR) provides damage Assessment, Repair and Restoration services. The second organisation (PTI) is a service provider for Physical Technical

Infrastructure for telecommunication services. The last organisation in this study (MMM) is a Mining Machines Manufacturer.

The organisations vary in size, ownership structure, type of services provided, geographical dispersity of the workforce and customers, as well as with regards to corporate culture and internal politics.

There are several drivers for service companies to introduce Remote Assistance (RA). Specifically, in 2020 restrictions on travel and social contacts caused by the COVID-19 pandemic meant that some "non-essential" services could not be carried out. Arguably, a broken-down washing machine is non-essential from the societal macro point of view. From an idiosyncratic individual viewpoint, there are few things more "essential" than getting the washing done. Service organisations were looking for innovative alternatives to provide (non-essential) services while keeping their staff and customers safe.

Another argument for RA is commercial. First, by providing RA services, the SLA (Service Level Agreement) fulfilment is likely to go up (it is usually quicker to call the customer than to drive there, bringing average resolution time down). Second, by reducing the number of field service assignments, the driving time and thus cost can be reduced (not to mention the positive impact on CO2 reduction, traffic congestion and other environmental benefits). Third, by visually inspecting a reported failure in addition to other data available (such as error codes and verbal problem descriptions) before sending out an engineer, a more comprehensive analysis can be carried out, the correct skills for fixing the issue can be identified, the necessary parts ordered, thus increasing the first-time-fix rate and avoiding secondary visits.

To achieve these benefits, the organisations required certain functionalities or features which they considered "essential". The main evaluated features are summarised in Table 5.

	ARR	**PTI**	**MMM**	**Category**
Video clarity	X	X		functionality
Augmented Reality features	X	X	X	
Device agnostic	X		X	deployment and operation
Wearable/ custom devices support		X	X	
Windows, iOS and Android support	X	X	X	
Web-application	X			
Ease-of-use	X			user experience
Multilingual interface			X	
Durability of recording	X	X		non-functional features

Table 5 – evaluated features by category and organisation

All organisations required basic augmented reality features: telestration, document sharing, merged video streams (one participant can "interact" with the other participant's video) and capture of still images. Neither organisation wanted to be limited to a device or operating system. Two of the organisations required the software to be functional on "non-conventional" devices – either wearables or custom rugged devices. Video clarity over 4G networks was important in two cases. Notable, that PTI did not place any specific emphasis on user experience. All organisations had must-have requirements towards some functional features and operations.

3.4 Organisation 1: ARR – Like to be seen modern

ARR have contracts with home-insurers who request ARR's services when the insured households report damage e.g. from a burst pipe or a fallen down tree. Contractually, ARR's customers are the insurance companies, practically, the customers are the insured landlords and the tenants who have suffered the damage.

ARR employ around 1,400 people in 35 locations across Germany. Around 1,000 engineers and damage assessors based in the field. Another 100 people work in the customer care centre. They deal with first-level assessments over the phone and book appointments for engineer visits.

The service offered is two-fold: for the insurance companies, ARR provides damage assessment and evaluation (how big is the damage, accidental or malicious). For the landlords and tenants ARR provides emergency repair services (e.g. board up a broken window) and, if requested, restoration and repairs (e.g. replacing the broken window). The lucrative part of the business is the repairs. However, once the immediate danger is averted, the insured is free to contract any building company for the restoration. Great customer experience during the assessment phase is therefore vital for ARR to get the lucrative restoration contracts. ARR is under pressure from two sides: on the one hand, the insurers like the idea of "digitalisation" and are selecting their contractors based on the availability of innovative technologies which offer a better customer experience to their customers. On the other hand, ARR is competing with local building-contractors for the restoration contracts. ARR assume that by offering superior service in the assessment phase they will get more repair- and restoration work.

ARR's idea was to offer a "digital pre-assessment" using RA. A customer service employee would contact the customer and would assess the damage remotely. Potentially

rendering remote help, e.g., guiding the customer to the stop valve to shut off water leaking from a pipe. This would give ARR several advantages (Table 6).

Advantage	Explanation
SLA adherence	Insurers use the average time for first assessment as one of the KPIs. If the first assessment can be carried out over the phone during the first phone call, the average time would be reduced dramatically
Customer experience	ARR's customers are in distress. Faster help and immediate remedy will improve customer's experience
Assessor efficiency	Assessing the damage remotely may save assessor trips, thus reduce travel times. If a visit is still mandatory, the pre-visit assessment may provide additional information to shorten assessment time
Engineer efficiency	Assessing the damage remotely may allow the right engineer with the correct equipment, tools and materials to be dispatched and to locate and fix the damage quicker
Digital innovation	Offering digital tools to customers (landlords and tenants) can support ARR's self-image of an "innovative organisation"

Table 6 – ARR's expected positive outcomes

It is important to note that ARR saw SLA's, customer experience and digital innovation as main drivers. Improved efficiency was only secondary and was mentioned "only" to justify a business case.

To be useful for ARR, an RA application must fulfil some critical requirements (Table 7).

Requirement	Explanation
Clear HD video with zoom, pan, snapshot functions	Assessment of damage must be done "to scale" and clear documentation is required for damage reports
Augmented reality with user-interaction	To render help remotely, the engineer must be able to point to objects and to indicate what to do with them
Easy-to-use interface	The engineers on the one side are trained. On the other side of the call there are "normal people" in distress. They should be able to use RA without training
No-installation required	ARRs customers will be using mobile devices of unknown make, model, operating system. They cannot be asked to install an additional application on their device

Table 7 – ARR's must-have requirements

The RA application was to be tested with ARR's real customers in one of the 35 locations. The anticipated challenges were end-customer's access to (1) an adequately powerful mobile device to process the video and audio stream at a near-real-time-rate, as well as (2) access to an adequate wireless network.

3.4.1 Evaluation Process: testing with real customers

The business case for ARR was built around improved interaction between the back-office customer service engineers and ARR's customers. The evaluation criteria for the first use case (Table 7) were based on the ability to interact with unknown customers with unspecified devices and an uncertain level of IT knowledge.

The decision to invest would be made by one person – the CEO, who has absolute authority for making investment decisions. ARR is small enough for the CEO to be closely

involved in all operational matters and to control all budgets. There are no democratic votes, quorums, or discussion fora to arrive at a conclusion; the CEO's word is final. However, the CEO does consult with his managers and considers their advice when making a final decision.

The project team was compiled of representatives of the Customer Services department and IT department, covering all hierarchy levels (Table 8).

Position	Role in the project	Attitude in the project
CEO	final decisison making, only involved at the start and the end of the evaluation	Productivity and innovation
CIO	confirmation of compliance and fit for deployability and operability	Another application to support
IT Project Manager	Project management for the evaluation project	There are other things to do, but this is a short project
CSO	Head of customer service, responsible for Service KPIs	Any KPI improvement is great for me
Regional Manager	Director of one of the 35 regional offices	I like Computers, that's why they picked me
Customer Service Rep	One of two Customer Servce representative based at the evaluating regional office	I am doing my job well, I don't need other fancy stuff

Table 8 – ARR's project team

The project team was nominated by the CEO, CSO and the CIO. The Chief Customer Officer was the main "driver" for the project – any improvement of service KPIs would look great on his and his team's performance. A location for the evaluation was chosen "at random" – a smaller than average office with fewer than average calls should allow the customer service representatives (CSR) some extra time to "play around" with the software. Additionally, the director of that office claimed to be IT savvy and interested in technology.

Because the project was defined as an IT-project, the IT department was involved. The CIO did not want to start another IT evaluation or roll-out as his department was "stretched with current change requests for existing applications". Still, an IT project manager was assigned to the evaluation project to coordinate the evaluation efforts.

At the project kick-off, it was agreed that the CSR would be the only registered user actively using the system. The regional manager would have daily updates from the CSR and assess how many calls were made using RA software. The CSR would record the call outcome and note whether: additional information was captured, a technician visit was avoided, SLA adherence was improved (e.g. immediate help rendered over the phone), or whether the call was unsuccessful. The call duration and timestamps are automatically recorded in the RA application. The evaluation criteria were also explained:

- Call quality and clarity
- Customer able to use the RA software on their device
- Usefulness and completeness of augmented reality features to help customers.

During the weekly calls, the CSR would provide a summary of successful and unsuccessful customer interactions, qualify the interaction results in terms of KPIs

(reduced number of engineer visits, faster immediate help, additional information for on-sites), and comment on the evaluation criteria. These weekly calls were attended by the CSO, regional director, CSR, IT Project Manager, and the supplier.

It is must be noted that two independent questions were asked during the same evaluation process: the first was the concern of the CEO and CSO: do we need RA at all (would RA deliver the results we are expecting). The other was the concern of IT and CSRs: does the software work and is it going to make my life easier or harder.

The evaluation process failed. The RA call had to be made between the back-office and the customer. For the RA call to be successful, the CSR had to ascertain that the pre-conditions were fulfilled (Table 9).

Pre-condition	**Explanation**
Damage suitable for RA	Only water and physical damages can be assessed remotely. Electrical and biological damage (e.g. fungi) require on-site sampling and measurements
Customer agreement	Trust in technology and ability to use mobile/tablet are not uniform
Customer access	Customer needs to be at the damage location at the time of the call
Device availability	Mobile phone/tablet with a good quality camera and modern operating system and borwser is accessible
Connectivity	3G+ mobile reception or WiFi connectivity (e.g. not deep in a basement)

Table 9 – ARR pre-conditions for an AR call

The CSR was provided with a decision-tree list of questions to ask the customer to decide if the damage could be successfully assessed with RA (

Appendix A). Too few calls were attempted and too few were successful to justify further investment.

The first problem for the evaluation was to pass the first hurdle of identifying any call suitable for RA. The CSR, used to arranging on-site visits, identified one single call in the first week as "worth a try". After a consultation, it was agreed between the supplier, the CSR and the regional director, that not only "straight physical damage" but also other calls are suitable: capturing preliminary data remotely would save time on-site and thus improve efficiency, which was an important KPI.

During the second week, the CSR identified two potentials. Only one agreed to a remote assessment. The RA call failed after a few seconds because of bad coverage.

A few calls were attempted in weeks three and four: a total of nine calls has been made in four weeks. All nine calls were unsuccessful: two of the customers used a Samsung phone with a proprietary browser not compatible with the RA software. The remaining seven calls had connectivity issues. The evaluation was aborted in the fifth week. A post-factum assessment showed that the regional office chosen for the evaluation was one of the smallest offices, dealing with around 12 assessment calls per week, which made finding a suitable candidate less likely. Further, the regional office was in a mountainous sparsely populated area of Germany with one of the worst mobile coverages in the country.

Suggestions to re-start the evaluation in another region, e.g. larger metropolitan regions of Hamburg or Cologne were rejected with the argument that "we need to offer a uniform service: customers in Berlin cannot be offered a better service than those in Kassel".

3.4.2 Outcome: Failure

The evaluation at ARR ended with a project-stop before the trial period was completed. ARR's managers – CSO and CEO communicated that an RA application would not deliver any of the expected benefits. ARR's expectation was that they will win "more repair contracts" if they use RA. They were not able to specify what "more" means in absolute or relative numbers. The evaluation process did not contribute to qualifying the benefits and the suitability of the RA application to help achieving these vague goals.

Two statements (from the CSO) are significant to explain the decision. First, ARR believes that the trial was unsuccessful because of poor mobile network coverage in Germany. ARR understands that densely populated areas have much better coverage for 3G and 4G networks. However, they do not believe that ARR's customers in rural regions should be offered "less service than those in towns". Second, ARR believes that their customer base

is not yet ready for the RA application. They decided to wait for greater coverage (perhaps for 5G network rollout) and an even higher proportion of (modern) mobile phone users.

3.5 Organisation 2: PTI – Want to save money

PTI's services include planning, installation and maintenance of telecommunication equipment including wiring cabinets (the grey boxes you see along the road), Fibre Termination Points (where the glass fibre is converted to copper), cabling (fibre and copper cables running underground), microwave transmitters (antennae for point-to-point digital links) and other equipment required to operate a telecommunication network.

PTI has around 400 employees in 6 locations in Bavaria. There are 250 field engineers and 150 back-office personnel.

The execution of an infrastructure project (e.g. fibre installation in a new development) requires cooperation between different working crews: a street needs to be secured, a hole dug up, cables placed, connected, checked and activated, the road made good again, and the safety barriers removed. At present, the coordination of these project happens in person. Representatives of different work crews (Table 10) get together on-site and align on project plan and execution.

Person (typical location)	**Task**
Planner (back office)	Project coordination between crews
Foreman (on-site)	Oversight of on-site execution for all crews
Safety specialist (back office)	Road closures, safety distances, adherence to legal requirements e.g. traffic lights
Groundwork specialist (both)	Requisition of appropriate equipment and material for excavation and resurfacing
Utilities Coordinator (back office)	Tracing and updating utilities mapping for telecom, gas, water and electricity

Table 10 – PTI's typical on-site coordination participants

There is a strong business case for using remote collaboration. From the typical team of five people (sometimes additional people such as council officials, electrical specialist and others need to attend), only one person is permanently based "in the field", three engineers are office-based, and one person shares her time between the office and the field. All bar one person (the Foreman) manage more than one installation at any given time. At the start of the evaluation process, the office-based engineers spent approximately 40% of their working time travelling between locations. PTI recognises the great potential for efficiency gains from cutting down on journeys to installation sites. Additionally, Planners and Utility Coordinators depend on computers and available software (e.g. project planning, calendars, mapping software, ordinance survey maps, etc.) to perform their work. The use of computers on installation sites is cumbersome, Engineers are taking written notes and

transfer them into electronic format duplicating work. Removing the duplicated activities would improve efficiency.

To be useful for PTI, any RA solution needs to fulfil several requirements (Table 11).

Requirement	Explanation
Multiple participants in a single session	multiple people are interested in seeing the scene for different purposes
Clear HD video with zoom, pan, snapshot functions	Utilities coordinator must be able to "look down the hole" to see the water and gas pipes running along and to align those with their maps
Durability of recording	photographs taken for the Safety Specialist permanently saved for accountability
Hands-free operation on-site with unabstracted view	don't let the foreman fall down a newly dug out hole while he is walking around the building site with a mobile phone
Usability on Android/ iOS mobile phones as well as Windows PCs	on-site, back office and on-the-move engineers must be able to join the calls

Table 11 – PTI's must-have requirements

The "hands-free"-requirement made it necessary to opt for a software which can be executed on wearable devices. PTI evaluated four different devices (RealWare, Microsoft Hololens, Vuzix, and Zebra) with the option to use the software on any of those.

3.5.1 Evaluation process: multifaceted project team

The business case for PTI was built on the fact that the reduction in travel for office-based employees would have a positive impact on bottom-line profitability. The evaluation criteria (Table 11) were based on the ability of one on-site person to show all others around.

The decision to introduce the technology would be formally made by the management team after the decision passed through several "hoops". The financial calculations have been made before the start of the evaluation process and a dedicated project team was tasked with the evaluation. A successful RA tool would then be assessed by the worker's representatives to ensure that no work-agreements are violated by the introduction of new technology. The software and hardware would also be assessed by the IT-department to ensure compliance with legal and internal regulations. The "ok" from the IT-department and worker's representatives are almost formalities. Neither is concerned with the technology's features, functions, potential value. Thus, the decision to "go ahead" is made primarily by the evaluation team.

An evaluation team representing all potential users has been assembled under the auspices of the Head of Service (Table 12).

Position	Role in the project	Attitude in the project
Head of Service	oversight of the project	need some way to hit KPIs
Planner	confirm usability of RA	Extra spare hours would allow me to plan my projects on time
Safety Specialist	confirm usability of RA	I need to see the site with my own eyes - one foot in prison at all times
Utilities coordinator	confirm usability of RA	If I can do it from my computer, I would be happy
Foreman	confirm usability of RA	The sooner I can get through the meetings, the sooner I can get on with work

Table 12 - PTI's project team

The project team was assembled from volunteers based in three different locations. Notable is the absence of a formal project manager: the team was expected to self-organise. The Head of Service did not participate in any of the evaluation activities and accepted his team's decision. His presence on the project team was purely political to signify the project's importance.

The team included two planners who are managing 9 parallel projects between them. At the kick-off meeting, the team agreed that the evaluation will be split into two periods: first few weeks with the planner in the location "North", the remaining time with the planner in the location "South". Further, the team agreed to involve whichever foremen were appropriate for testing as not to rely on the experiences of the single foreman who was officially on the team. The Utilities and Safety Specialists worked with both Planners and thus would participate in the evaluation continuously.

The RA calls were to be carried out between a Foreman on-site, wearing Smart Glasses (an evaluation for those has been carried out in a previous project, the team has decided to use Vuzix M400 smart glasses) and one or more office-based colleagues. The Foreman was to become "eyes and ears" of his colleagues in the office.

During the first week, the Planner, the Utilities Coordinator, and the Foreman (all based in the same location) used the software in- and around the office. All participants are telecommunication engineers by trade: the evaluation approach was very engineer-like. The first RA call was done on WiFi, from one office to another. The participants recorded the call (thus also testing the durability of the call recordings) and shared the recording with the rest of the team and the supplier to highlight the video and audio quality and the possible use of features such as telestration. In the second week, the application was used in the field. The Utilities Coordinator has been to the location already and was not required to attend. Instead, she joined remotely: she could evaluate the software and pretend to carry out her assessment. However, if the attempt failed, her work would not be jeopardised. This call too was recorded, shared with the rest of the team and the supplier. Further in the second week, a Safety Specialist also joined an RA call. In the third week, a

Foreman was chosen “at random” – he was in the “North”-office and agreed to take the Wearables with him. A 5-minute test-call between a Foreman, the Utilities Coordinator and the Planner was carried out to verify connectivity and quality of call at yet another location.

At the beginning of week three, the glasses were sent to the “South” office where the tests were repeated. After five weeks three different foremen, two planners, one safety specialist and one utilities coordinator have tried RA in several locations. A unanimous conclusion was that using RA will reduce the number of time when the office-bases colleagues (planner, utilities coordinator, and safety specialist) must visit the project sites. The foremen confirmed that the Smart Glasses were “good enough” to be worn around the construction site. A recommendation was made to proceed with the project. The Head of Service has requested a formal approval from the worker’s representatives and the IT department.

3.5.2 Outcome: Deferral

The final decision from PTI is outstanding, pending a security review from the IT department. The evaluation team has proven that the expected business benefits can be achieved with RA. Noteworthy is the fact that the “user experience” was secondary to the evaluation. Most PTI employees are trained telecom engineers (even those who moved to back-office jobs). There is a spirit of “if it’s technology – we can manage it”. The evaluation focus was on the safety of the on-site foremen and the video quality which is paramount for (again) the safety of the public (ensured by the safety specialist) and the safety of the infrastructure (ensured by the infrastructure coordinator). The final hurdles by the IT and the worker representatives are focused on (yet again) safety of the data transfer and storage, as well as the safety and comfort of the workers respectively.

3.6 Organisation 3: MMM – Have to deal with the c-word

MMM build mining machines for use in open pits and underground mines in salt and coal extraction. MMM is a manufacturer, however, their business is selling the tonnage of commodity. MMM’s offer is to install, maintain and, if needed, replace the right excavation equipment to ensure continuous mining operation. MMM’s customers do not buy a €2 Million machine, they buy a service of a working machine and pay a share of each ton of commodity extracted.

MMM’s workforce is around 1,000 strong. Most of the people are employed in manufacturing. The service organisation has 150 engineers providing on-site services around the globe. Main usage locations for MMM’s equipment are the US, Germany,

Russia and Ukraine, China, and Australia. Less than 20 engineers are based in the Far East to cover Chinese and Australian customers, the remaining 130 engineers are operating out of Germany.

All MMM's customers have their own trained personnel on-site to operate and maintain the equipment. MMM's engineers would travel to the mining locations on pre-planned maintenance trips or for urgent repairs which cannot be performed by local engineers.

And then the world stopped. MMM's engineers could not go to other countries. China was off-limits, the US are still "risky". Mines in Ukraine and Russia are outside of the EU, thus, any engineer going there would face a compulsory 10-days quarantine when returning to Germany. That's assuming they can get into the country in the first place. MMM urgently required alternative ways to provide services and assist their customers. A remote assistance solution was evaluated as a possible option to reduce the number of trips required and to avoid unnecessary exposure to COVID-19.

To be effective the RA solution must meet essential requirements (Table 13).

Requirement	**Explanation**
Clear video with interactive features	The quality of the video is not essential: most parts, buttons, cogs are large and 480p video is good enough. Interactivity is essential: German engineers must be able to show local techs what to do and how to do that
Multilingual UI	Most MMMs customers cannot speak German. A user interface in a local language was seen as a "must" to get the local engineers to accept the application
Device agnostic	The local engineers will work with rugged, spark free equipment in mines up to 6km deep. No "iPhones" allowed
Android and Windows	MMMs own engineers will be using Windows PCs to reder help, the customer's techs will use the rugged Android mobiles on the "other side"

Table 13 – MMM's must-have requirements

The multi-lingual requirement was easy to verify. The call quality around half the globe and down the earth was the main challenge to be assessed.

3.6.1 Evaluation process: engineering precision

The business case for MMM was clear and urgent. Their engineers could not travel to the sites where the equipment needed to be maintained and repaired. The local and country-wide lockdowns, specifically the disruption to travel into the EU from countries in Eastern Europe, China, and the US, where the bulk of MMM's assets are located, meant that an alternative solution was required fast.

The evaluation criteria for MMM (Table 13) are based around a virtual presence of their engineers at remote mining sites to help the on-site mining- and machine engineers during repair and maintenance jobs.

MMM is a traditional “Mittelstand” business – an SME owned and managed by the same person or a family. The decision to roll out the technology will be taken democratically by a consensus between a representative of the worker’s council, the engineer’s affected, the head of service (who manages their own budget) and will ultimately be signed off by the owner. Thus, the project team reflected the decision-making team (Table 14)

Position	Role in the project	Attitude in the project
Head of Service	oversight of the project	must have a solution to keep the machines running
IT Admin	support evaluation team	introducing new software is another medal on my chest
Senior Engineer	confirm usability of RA tool	I am used to provide 2nd line support, will this make my life easier?
Field Engineer	confirm usability of RA tool	If I can do it from my computer, I would be happy
Field Engineer (WR)	confirm usability of RA tool	I am representing our workers here - this better be non-threatening

Table 14 - MMM's project team

At the kick-off, the evaluation team and the supplier’s team agreed on the evaluation process and the weekly cadence meetings. All three engineers have access to rugged mobile phones and laptops which comply with safety regulations in mines. The devices are similar in make and features to those used by MMM’s customers’ engineers. Further, it was agreed that the RA calls will be performed between MMM’s engineers and known engineers on the customer’s side, therefore, all RA users were expected to use the native application for Android for the calls. The IT Administrator was tasked to ensure that the application can be made available via the internal mobile application management tool.

The three participating engineers were given an additional one-hour training session where all the features of the RA applications have been explained. The training has been recorded to be re-used in case a positive decision was made.

The evaluation went through with the expected engineering precision. MMM has the luxury of access to the machines (they build them in the same location where the engineers are based). As a first trial, the Field Engineers went down to the factory floor and used an RA call with the Senior Engineer to simulate a 2nd-line support call. The Senior Engineer evaluated whether RA would offer advantages over using voice-only calls.

The tests were repeated at different machines, in different parts of the factory with different noise and lightning levels to ensure that the video and sound quality were sufficient for work. After three weeks, an MMM engineer in South East Asia was asked to join an RA call with the senior engineer. As this single call was performed successfully, the evaluating team decided to recommend the rollout of the solution. The company-wide rollout started in the sixth week of the evaluation.

3.6.2 Outcome: Rollout

At the time of writing (December 2020), MMM has been using the RA application for four months. Their engineers were forced to look for a tool to "get a job done". Their evaluation process was very mechanical. The "fanciness" and "richness" of the software were secondary to the ease of roll out and use under difficult environmental conditions of dusty, dark and loud underground mines. MMM was the only organisation to set-up additional training for engineers to ensure that they know how to best operate the software. Their evaluation of software options was focussed on the identification of "what works" and not "what could work very well later", as put by the IT Administrator and echoed by the Senior Engineer.

4 Discussion

The three organisations, initially, could be differentiated by their geographical spread, ownership structure, size. During the observations, arguably only on reflection, the authors noticed that the most striking differences (with regards to the RA evaluation approaches) were in the organisation's attitudes to the "why" introduce RA.

ARR – the damage assessors, played with the idea of being seen "innovative", they are what we have termed a "like to"-organisation: one which likes the idea, however does not know why and what to do with that. On the other hand, PTI – the telco-infrastructure firm, has presented a solid business case and are, what we termed a "want to"-organisation. They understand the potential benefits of innovation and are "keen" on using it. Lastly, MMM – the mining equipment manufacturers, saw their service business model collapse if they did not act. We have labelled them a "have to"-organisation: one which had to act decisively and quickly.

4.1 Outcomes

The case organisations had different approaches to evaluation and decision-making. The first organisation's decision to evaluate RA was driven by a vaguely formulated business case and the management's desire to look "innovative". There was little support from the IT department and low enthusiasm from the shopfloor. The decision-making process was spontaneous, and it remains unclear whose decision it finally was to abort the trials. The second organisation had a solid business case with clearly defined measurable outcomes. Their decision-making process is formal, and the stages and hurdles are well defined. The end-users identified and involved in the evaluation process. The third organisation's decision was driven by necessity and was, put exaggeratedly, a question of survival. In

contrast to the first two organisations, it was not a question *whether* an RA application was necessary, but *what* application was to be used. The decision and the evaluation processes were made by the end-users and their direct managers.

4.2 Conclusion

This paper introduces three organisations evaluating the same software for their use. The software is quite simple (Figure 2), the user interface has seven buttons and a total of seventeen actions which can be performed. The full user manual contains four pages. Evaluating the software and "ticking off" the boxes for required features could practically be done in less than 30 minutes. Yet, organisations spend weeks testing, measuring, and deciding.

The formal evaluation criteria are known a pre-defined (Petter et al., 2013). However, each organisation tends to define its own "must-haves" and assign its own weightings (Tsai et al., 2009). Ironically, these evaluation criteria are proven to be incomplete and to be missing significant requirements (Slovic & Lichtenstein, 1983). For example, none of the case organisations raised the "integration" requirement. All organisations assumed that any RA application will "somehow" integrate into the existing software landscape and will be able to link a request from the CRM to the recording of the RA call and use the RA call duration for creating an invoice in the ERP's financial module.

This study also highlighted the gap between the formally described evaluation procedures (specifically the Delphi Approach (Dalkey & Helmer, 1963) and Advanced Hierarchical Process (Azadeh et al., 2010; Lai et al., 2002)) and the spontaneous decision processes used in practice. In the first use case, the evaluation was very informal "I don't think it works for us", "we pick a trial location at random", "we don't need a formal training". In the second case, the evaluation was more formalised. Specific focus was placed on the recording of the evaluation cases and a near-time collective decision on the ranking of each criterion. In the last case, the evaluation criteria were very broad and unspecific: "must work for us", "must be available in Russian". None of the organisations attempted to define a finite list of criteria, weight the criteria against each other, or to define any scale against each criterion.

The study further highlighted that the evaluation and decision processes are not as linear as described. The criteria, expectations and the evaluation of criteria shifted and changed with new evaluation attempts. The evaluation process was iterative rather than linear, even in the very simple setting as was chosen for this study.

The authors understand that the three organisations presented here are exemplary and may not be used as representative for a population of organisations. However, these organisations highlight important first findings to warrant further investigation.
The next steps are the formulation of a formal decision-making theory during a software evaluation project and the collection of more data to support and refine our findings.

Note: the author is employed by a company associated with Help Lightning. The author is not receiving any pay or compensation for this work. Neither is the purpose of the paper to endorse the use of remote assistance software in general or Help Lightning in particular.

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Appendix A

ARR's pre-RA questionnaire

1. We are trailing a new service: remote assessment. This allows us to assess your damage remotely and provide the report to your insurance straight away. It will save you time for the on-site visit and the report will be done within the next 24 hours, so you will know faster, what part of the restauration is covered by your insurance. We will also be able to provide you with a quote for all repair work and materials involved.
   Would you like to participate in remote assessment?
   A. No → thank you, we'll make an on-site appointment
   B. Yes → next question
2. **Are you at the location where the damage is right now?**
   A. No → thank you, we'll make an on-site appointment
   B. Yes → next question
3. **Do you have access to an Android phone or an iPhone with Chrome or Safari browser?**
   A. No → thank you, we'll make an on-site appointment
   B. Yes → next question
4. **Are you on a WiFi or LTE connection right now?**
   A. No → thank you, we'll make an on-site appointment
   C. Yes → initiate RA call