Evaluating Customer Expectance of Mixed Reality Applications in Order Picking

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Abstract
The paper evaluates the triggering criteria for a successful implementation of Mixed Reality in order picking from the decision makers point of view. Relevant criteria are derived with the use of semi-structured interviews and analysed inductively and deductively. The final set of parameters is then presented.

Author Keywords
Innovations Management; Mixed Reality; Augmented Reality; Order Picking

ACM Classification Keywords
H.5.1. Artificial, augmented, and virtual realities; I.4.0. Image displays; I.5.2. Pattern analysis

Introduction
Driven by competition, innovation counts as the economic foundation for the progression of the modern industrial society. The innovative speed is often determined by the fast and efficient implementation of new technologies. Formulated more specifically, competition in warehousing is driving the necessity of being innovative, yet the assessment of the appropriateness of Mixed Reality for order picking is

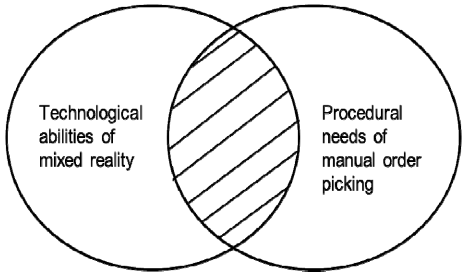

Figure 1. Intersection of the technological abilities of Mixed Reality and the procedural needs of order picking

missing. One of the reasons is the lack of a useful concept for the identification and analysis of the optimal implementation of new technologies in the beginning when the influence on the development is still high.

The aim of this paper is to focus first on the applications side and its needs. The search for the intersection of the technology push and the application pull, lead to the following research objective (as visualised in figure 1):

What expect decision maker(s) as benefit from the technology mixed reality, as contribution to the process of order picking?

And therefore to the research objective of:

Finding the determining criteria and aspects for the use of assisting technology in the area of order picking.

The methodology chosen to elaborate these criteria, were semi-structured interviews.

Semi-Structured Interviews with Decision Makers

The structure of the interview guideline had nine segments to address the different topics and to do this in different depth of detail. The different segments were Introduction, Company and the Interviewee, Investment Process and Behaviour, Warehousing and Order Picking, Potential for Optimisation in Order Picking, Specific Investment in Order Picking, Technology Acceptance Model[1], Figure of the TAM and space for Additional Input.

The content was derived from the methodological and substantial literature review and can therefore be classified in these two topics.

The methodological input consisted of the following input:

- probing [2]
- preventing bias [3]
- validity and stabilising results [14]
- open questions [7]

The input from the literature review could then be divided into the three following areas: Mixed Reality, logistics and innovations management.

Altogether, this included the following aspects:

- information representation [1]
- use of displays [10]
- competition in warehousing [11]
- neccesity of optimisation in logistics [8]
- order picking technologies and any previous experience with them [6], [9]
- cost level of the consignment process [5]
- diffusion of innovations [13]
- TAM [4]

[1] abbreviated as TAM in the following

The Three Perspectives of the Analysis

Frequency: A word frequency count was looking for the topics, most frequent in the interviews and was completely inductive. Furthermore, the out coming topics assisted any further coding.

Technology Acceptance Model: The analysis for the TAM coding used the aspects introduced by the TAM for the initial coding of the transcripts. The so created nodes were then coded more deeply in order to find criteria on a more concrete level and evaluate their weight. This was a mixture of de- and inductive approaches.

Directly Rated Questions: The third perspective focused on the questions that were directly rated by the respondent. The questions are derived from the TAM and aim for evaluating the relationship and weighted network between them. This was a pure deductive approach.

- influence on a technology's abilities in the early stages [12]

Seven possible respondents with the desired background were then identified. Of the seven potential respondents, five were willing to take part in an interview and the research.

All of the interviewee's mother tongue was German and this was also the language, the interviews were conducted in. Their mutual background included several years of experience in operational and strategic positions in their companies. They were in touch with manual order picking either as part of their main activity or at a point of intersection with it.

Qualitative Data Analysis

The analysis was combining three different perspectives to meet the requirements of a combined deductive and inductive approach, as visualised in figure 2.

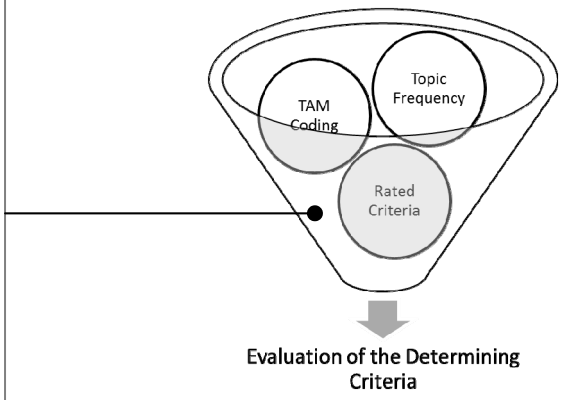

Figure 2. Mixed deductive and inductive approaches for the analysis of the interviews

Altogether, these three different foci offered the possibility to analyse the interviews and evaluate the found criteria with a guideline based on the theoretical models of innovations management and offering the required openness for unprecedented aspects at the same time.

The threefold approach for the data analysis offered one final network and one final list of relevant criteria for the decision making process concerning the application of and expectations from a new technology. The final representation of the criteria is presented in figure 3, the corresponding data is stated in table 1.

Rank		Criterion		Weight
1		Cost Reduction		15,61%
2		Ease of Use		10,00%
3		Performance Enhancement		9,27%
4		Tested, Approved		8,81%
5		Quality, Fault Prevention		8,70%
6		Ergonomic Factors		7,72%
7		Job Enrichment		6,89%
8		Employee Feedback		6,58%
9		Connectivity		5,73%
10		Short Learning Period		5,38%
11		Stress Level, Ergonomic Strain		5,05%
12		Marketing Purposes		4,93%
13		Flexibility		2,41%
14		Rugged Technology for Industrial Application		1,52%
15		Reliable, Failsafe		1,39%

Table 1. Data Set of the Elaborated Criteria

Discussion and Conclusion

The criteria, triggering the implementation of a new technology, are found with the methodology and corresponding analysis.

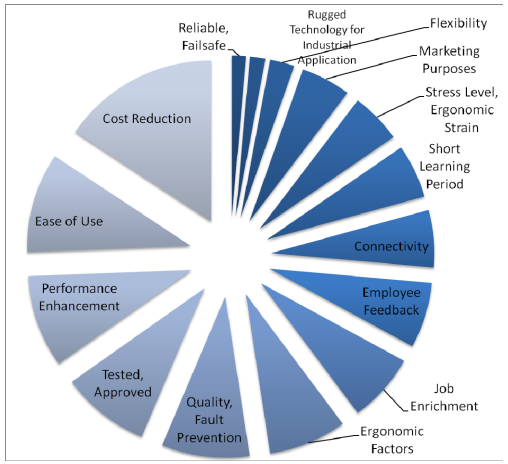

Figure 3. Pie Chart of the Elaborated Criteria for the Decision Making Process

The great overlapping of the deductive and inductive analytical methodology validated the methodological approach of semi-structured interviews.

The extrinsic motivators, like costs, performance and quality were expected to be of high value in the ranking as demonstrated. Nevertheless, also human factors like ease of use, ergonomics, job enrichment and employee feedback, proved to be very important for a positive decision for the implementation of Mixed Reality based systems. Technical basic functionality seemed to be a standard ability and not distinctive.

The results set the foundation for any further research in this area. The next step will be to prove different picking technologies against the found criteria in experiments. The results will then enable a value benefit analysis with the elaborated weighting of the criteria and therefore evaluate the fitness of Mixed Reality in manual order picking.

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