Company staff intention to use RFID technology in fashion and apparel retail sector: a UTAUT based-model

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Abstract: The last two decades have seen a growing trend towards the application of item-level RFID technology in the fashion and apparel retail sector, with the main goals of automating supply chain processes and increasing their accuracy. Extensive research has shown that the chief advantages of deploying RFID technology in this sector are, amongst others, quick identification of customers' needs and quick delivery of new products to the market; localization of products along the supply chain, as well as in retail stores; reduction of out-of-stock situations, and increased labour efficiency. Even though RFID is clearly in the ascent phase of technology lifecycle, it is not yet a standard in the sector of reference, and many companies, both at manufacturing and at distribution level, are still not certain of its payback period and return on investment. A key role for a successful RFID implementation is especially played by the inclination towards acceptance and use of technology by the company staff. In this paper, we present a questionnaire for assessing the acceptance and use of RFID technology at an important Italian company of the fashion and apparel sector. After a broad review of existing literature, we decided to use the well-known Unified Theory of Acceptance and Use of Technology (UTAUT) to evaluate the opinions and intentions of employees that use RFID technology to pursue different use cases. Our assumption is, in fact, that operative staff can provide information about the intentions and the ease-of-use of a new technology, as well as the "perceived usefulness". The responses to our questionnaire show a strong intention to use and perceived usefulness of the technology, and these results were used to further direct the implementation in other stores, and thus they can be of interest both for practitioners and researchers.

Keywords: RFID; Fashion and Apparel; Retail; Supply Chain; Unified Theory of Acceptance of Technology

1. Introduction

Radio frequency identification (RFID) is a technology that allows automatic identification and data acquisition. It is composed of three elements: (i) a tag, which is a chip associated with an antenna, (ii) a reader which transmits radio signals and receives them from tags, (iii) and finally a middleware connecting RFID hardware and user application (McFarlane, Sarma, Chirn, Wong, & Ashton, 2003). RFID is not a new technology any more, but recent improvements in microelectronics and data processing have given an important progress to its application and contributed to decrease its costs. Industrial interest in this technology originates from the possibility to improve the product traceability and the supply chain (SC) visibility (Sarac, Absi, & Dauzre-Prs, 2010)

Angeles (2005) disclosed how RFID can be considered as a successful technology for improving and optimizing supply chain management processes and Gaukler, Seifert, & Hausman (2007) led important studies on its applications. Successful case studies have been conducted to foster RFID implementation in several sectors, and it became crucial since it has been intensively and increasingly implemented up to item-level tagging, covering most of the SC operations (Vlachos, 2014). In fact, the technology enables monitoring and optimization of logistics operations, and fosters actions to improve customer experience by acquisition of itemized information about traceability, transfer, and exhibition of garments. In summary, RFID technology in fashion and apparel may grant the following main benefits: (i) higher inventory accuracy, (ii) process automation, (iii) greater in-store stock visibility (replenishment from the backroom), as it is largely proved in literature (Bertolini, Bottani, Ferretti, Rizzi, & Volpi, 2012; Bottani, Ferretti, Montanari, & Rizzi, 2009; Rizzi, Romagnoli, & Thiesse, 2016). RFID technology, however, also implies investment and operational costs as well as new challenges; hence, even if the decision on its adoption and implementation is made by top management, achieving the acceptance of the users, that is the staff, is essential (Ngai et al., 2012).

The aim of the present study is to assess the acceptance and use of RFID technology in fashion retail stores of Diffusione Tessile (DITE) through an *ad hoc* questionnaire on technology acceptance. DITE is an outlet of high quality fashion and apparel products, and one of the most important and influential ones in fashion and apparel industry since it was established in early 90s. DITE has been using RFID technology since the last 10 years, and it can be considered as a pioneer in its sector. As a matter of fact, DITE implemented an RFID system (RFID-S) to support company operations of several functions: these are Real Time Locating System (RTLS), Picking App (PA), Receiving and Shipping (R&S), Inventory Count (IC), Replenishment and Assortment (R&A), Size Requested

Desk (SRD). To evaluate the user's acceptance of RFID technology in DITE stores, this study proposes and carries out a questionnaire survey, based on the Unified Theory of Acceptance and Use of Technology (UTAUT), whose aim is to capture how this technology is perceived and used by the DITE' staff in all the RFID-enabled company's stores. The analysis started in December 2016 by submitting the questionnaire to the staff. The reminder of the paper is organized as follows. Section 2 proposes an overview of the literature on the acceptance and use of new technologies; acceptance models are listed and characterised by their main features. In Section 3, we describe the selected model and the questionnaire. Section 4 presents and discusses the results of the study, and Section 5 draws conclusions and suggests future works.

2. An overview of the literature on technology acceptance model

In the industrial engineering context, survey research methodology allows to capture data from the whole business organization (Brandon-Jones, Squire, Autry, & Petersen, 2014). Several different models have been developed to this purpose. These are not strictly bound to a unique application. Nonetheless, specific constructs of every model, which identify individual reactions and intention to use the technology, are usually consistent to the particular technology under examination (Holden & Karsh, 2010).

In this section, a set of models are listed and typified through (i) determinants described by core constructs, each one to be exploded in specific items, and (ii) key moderating variables. The former measure reaction and intention. The latter are significant in conjunction with each model and address behaviour (Venkatesh, Morris, Davis, & Davis, 2003). The models are used to assess people behaviours when they need to accept and use a new technology. The main models described are well-known in scientific literature, and our goal is to provide the reader with a comprehensive overview before selecting the specific model of our study.

Settled in social psychology science, the **Theory of Reasoned Action (TRA)** is an important theory of human behaviour. Firstly applied to individual acceptance of technology by Davis (1989), it consists of two constructs, i.e. (i) the attitude toward behaviour and (ii) the subjective norm. The key moderating variables are experience and voluntariness. TRA evaluates the impact of perceived usefulness and ease of use on behavioural intention to use and actual use (Abbasi, Sarker, & Chiang, 2016).

Derived from TRA, the **Technology Acceptance Model (TAM)** is a theory drawn by Davis, Bagozzi, & Warshaw (1989) toward information software (IS) environment, in order to predict information technology (IT) acceptance and usage in working processes. Unlike TRA, core constructs are (i) perceived usefulness and (ii) perceived ease of use, while key moderating variables are (i) experience, (ii) voluntariness, which is not explicitly present in TAM but is linked to subjective norms, and (iii) gender. The last one does not result in the original TAM, but Venkatesh & Morris (2000) empirically proved that gender influences both ease of use and subjective norms and included it in **TAM2**. TAM is very used to evaluate IT (i.e. big data analytics) in terms of the perceived benefits, perceived risk and predictive analytics accuracy (Kim, Lee, & Seo, 2013).

Adapted by TAM, the general motivation theory named **Motivational Model (MM)** was applied to technology context by Davis, Bagozzi, & Warshaw (1992) to detect new technology adoption and use. In this study, the authors related the two core constructs, i.e. (i) extrinsic motivation and (ii) intrinsic motivation. These discloses the usefulness perception and the hindrance to use the technology (P. C. Sun, Tsai, Finger, Chen, & Yeh, 2008). In this theory, it is very difficult to identify moderators as indirect drivers influencing motivation to use and the own use.

Ajzen (1991) extended TRA by adding the construct of perceived behavioural control which is theorized to be an additional determinant of intention and behaviour. As a result, the author formulated the **Theory of Planned Behaviour (TPB)**. Central in this theory is the intention: the core constructs are (i) attitude toward behaviour, (ii) subjective norm and (iii) perceived behavioural control: these make TPB effective in evaluating willingness to use technologies replacing humans in tasks which have a different meaning depending on how they are carried out: for instance to drive against to move (Lee, Geiger-Brown, & Beck, 2016). Moderators for TPB are (i) experience, (ii) voluntariness, (iii) gender and (iv) age.

Combined TAM and TPB (C-TAM-TPB), as the name implies, unifies paths from TAM and TPB. In the latest of two works, Taylor & Todd (1995) integrated organisational and control keys in TAM through TPB model. The resulting model has as core constructs (i) the attitude toward behaviour, (ii) the subjective norm, (iii) the perceived behavioural control, and finally (iv) the perceived usefulness. C-TAM-TPB has a single moderator only, i.e. the experience. Due to its constructs and moderator, C-TAM-TPB is useful to state the intention to use a technology during the learning or developing activities (Chen, Chen, Yu, Chen, & Li, 2012).

The **Model of PC Utilisation (MPCU)** is derived largely from the theory of human behaviour. Thompson, Higgins, & Howell (1991) modified this theory fitting its fundamentals to the IT environment. This model is set to predict use behaviour rather than intention and has subjective norms as pillar (H. Sun & Zhang, 2006). It consists of six constructs: (i) job-fit, (ii) complexity, (iii) long-term consequences, (iv) affect towards use, (v) social factors and finally (vi) facilitating conditions; experience only attends as key moderator.

Moore & Benbasat (1991) formalised the **Innovation Diffusion Theory (IDT)** and adopted it in sociology, by refining a set of constructs which could be used to study individual technology acceptance. IDT devises 7 core constructs: (i) relative advantage, (ii) ease of use, (iii) image, (iv) visibility, (v) compatibility, (vi) results demonstrability, (vii) voluntariness of use. Also, the authors introduced

subjective norms as elements that influence the inclination to adopt and use a technology. Moderators in this model are experience and voluntariness.

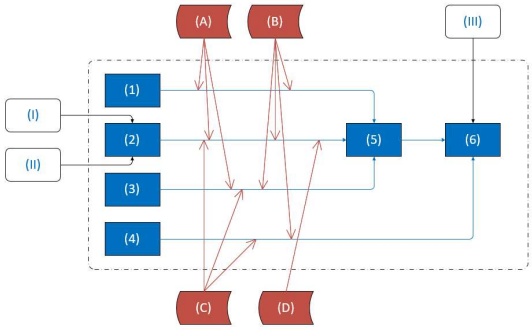
The **Social Cognitive Theory (SCT)** was first applied by Compeau & Higgins (1995) to the IT context. SCT refers to the knowledge acquirement when observing other behaviours and their consequences. Accordingly, by positive and negative incentives it is possible to predict from the acceptance up to the real use of the technology (Safiullah, 2015). Core constructs of this model are: (i) outcome expectations as performance, (ii) outcome expectations as personal (improvement), (iii) self-efficacy, (iv) affect and (v) anxiety. In this model no moderates become involved in addressing behaviour.

Venkatesh et al. (2003) sought to integrate the numerous theories about technology acceptance described above, generating a single model able both to match the advantages and to overtake the disadvantages of each one. Model devised is the **Unified Theory of Acceptance and Use of Technology (UTAUT)**. Due to its completeness in determinants and moderators, this model was found suitable for the sake of this study.

3. The selected model and questionnaire

Venkatesh et al. (2003), leading a review of all the models presented in the previous section, aimed to recognise the core constructs recurring in the models analysed in different ways but with the same focus and meaning. To this end, they developed a set of application differing by (i) environment, (ii) competence of the sample, (iii) timing of survey and (iv) number of point of measurements. The settled UTAUT aims to be compliant with all (or almost all) contexts. UTAUT consists of eight different constructs as: (i) performance expectancy, (ii) effort expectancy, (iii) social influence, (iv) facilitating conditions, (v) behavioural intention and (vi) use behaviour, (vii) self-efficacy and (viii) anxiety. The former four constructs can explain and predict an individual's behavioural intention and use behaviour, while the latter four flow indirectly into the construct (ii). Wang, Wang, & Lin (2018) highlighted that in UTAUT the users' acceptance and use of a new technology depends on social norms or social influences expressed by means of subjective norms. Social norms lead to 4 moderators in a model describing the users' intention to use, each one influencing one or more constructs: (i) gender, (ii) age, (iii) experience and (iv) voluntariness. For the sake of this study, it is important to include moderating variables to disclose the factors influencing the technology adoption: even if many existing researches neglect the moderators and do not consider their influence, it is absolutely necessary to care about their role (Nysveen & Pedersen, 2016).

The pattern of the UTAUT model is drawn in Figure 1. The flowchart, drawn to address how determinants and moderators operate concurrently, rearranges the original author's scheme. In our opinion, a flowchart is a useful tool to summarise both the linkages among the core constructs, and the influences by the moderators. Furthermore, it allows to introduce, in the pattern, the construct that have indirect effect toward intention to use technology, which are not included in the original scheme. We draw the pattern using different colours and boxes. To be more precise, squared blue box (with white writing) include directly-affecting constructs while cornered white box (with blue writing) include indirectly-affecting constructs, linked to the direct-affecting ones that they influence. Finally, moderators are in reddish boxes (with white writing). The dashed cornered box limits the players which express the intention to use, while outside act the players which just influence the intention to use. UTAUT is based on all the models described in Section 2; hence, the model items were identified starting from the models taken into consideration to set it up (de Vreede, de Vreede, Ashley, & Reiter-Palmon, 2012). These items express the core constructs of the determinants.



(1) Performance expectancy, (2) Effort Expectancy, (3) Social Influence,
(4) Facilitating Conditions, (5) Behavioural Intention, (6) Use Behaviour
(I) Self-Efficiency, (II) Anxiety, (III) Attitude toward Using
(A) Gender, (B) Age, (C) Experience, Voluntariness of Use

Figure 1: pattern on how determinants / core construct and moderators operate on the intention to use the technology

3.1. Case study survey

In this section we describe the setting up of the survey according to the DITE's needs. To carry out the questionnaire survey we firstly simplified the UTAUT constructs: we selected this model because of its completeness in determinants and moderators. Second stage of this section is the modelling of the submitted survey complying with the case study deliverable. The following section presents the findings of the research. With the aim of designing a consistent and reliable model, we fixed the followings. (i) To limit quantity of items in 10-15 questions. We agreed this measure with DITE, to maximise the number of responses while not affecting too much respondents. The result is a simplified questionnaire of 12 questions, as opposed to 32 questions for the original model, which comply with just 6 constructs of the total 8. Questions are formulated in Italian so that it would be appreciated by the users. (ii) To set a 1-4 scale of judgement. This choice was made to avoid (i) to disperse attention due to lots of possibilities, and (ii) to avoid mean-value answers (which often is the rule). Table 1 lists the located questions about the RFID-S implemented.

4. Results and Discussion

The questionnaire, submitted via Google Forms, requested mandatory answer to each item. The survey assessed the

respondents' characteristics through the set of moderators in Figure 1. The questionnaire was sent to all DITE staff that operates in RFID-enabled stores in December 2016. A total of 114 valid answer was received in January 2017.

Table 1: questions submitted (derived from UTAUT)

Construct	N°	Question
Perceived Usefulness (1)	1	How useful is RFID-S for your job?
	2	How much faster are you now?
Ease of Use (2)	3	Is it easy to interact with the RFID-S?
	4	Would it be easy for a new employee to learn how to use RFID-S?
Context (3)	5	Do you think this technology is important for your company?
Control (4)	6	Do you have the resources needed to use RFID-S?
	7	Do you have the skills to use RFID-S?
	8	Are you assisted when you need?
	9	How much does RFID-S fit your work style?
Intention to use (5)	10	Do you like to work with this new system?
	11	How often are you going to use it?
Real use (6)	12	Are you using it frequently during a work day?

Aiming for clearness, in the following we describe how the results were statistically investigated once the questionnaire is formulated and then submitted.

- The following pattern is used both on a general level for the whole application, and on a punctual level for its constructs that have two or more questions: both are here called *model*. *Model* is set up and then analysed using the Cronbach's index: a value higher than 0.7 validates it, otherwise model is invalid. Validation of the model enables data analysis.
- The population of the samples was split according to the four moderators. The mean value of the answers, a value of 0 to 4, was calculated according to each one of the six constructs.
- Answers enable inferential statistics on the moderators according both to items and constructs. Pattern for the analysis is the same for both and is shown in Figure 2. In the flowchart, boxes contain processes, trapezoids contain data and rhombus represents gateways. Events are described by circles.

  The method of analysis varies depending on its purpose: ANOVA method is applied to evaluate the general statistical significance about the users' acceptance. Multivariate regression is applied to evaluate whether local result can be generalised about behaviours. Influence depends on the confidence level set for the index $\alpha = 0.0x$. The latter is applied both to the whole application and to samples with highest statistical relevance.

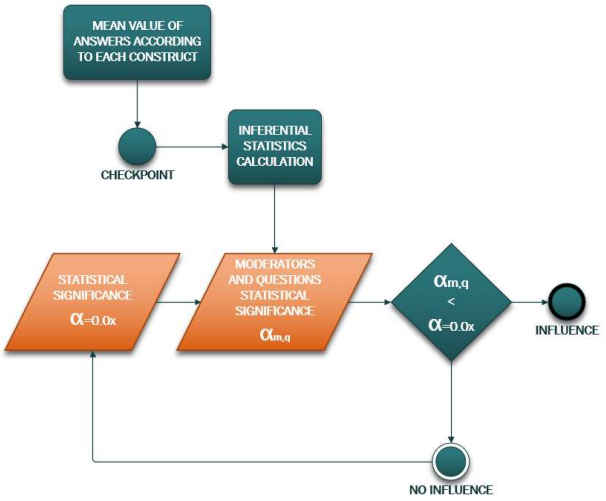


Figure 2: pattern of inferential statistics analysis

- The dashboards on the most decisive moderators address the result.

Firstly, we have calculated the Cronbach's α according to Field (2013). This value was used as an estimate of the reliability of a psychrometric test. Cronbach's α was calculated with IBM SPSS Statistics (version 24.0) with the 12 items of the questionnaire, returning a value of 0.876. The reliability indicated by this value, in the assessment scale (George, 2011), is close to "excellent", whose threshold value is of 0.9. The indicator in α was calculated also for constructs having more than one single question to assess their own reliability. In this case too, the model returned good results. For instance, the Perceived Usefulness (2 items) got an α value of 0.813, the Control (4 items) got a value of 0.754. We note that threshold value for *good result* in the assessment scale of the theory is 0.8. We report in Figure 3 the results of the moderating factors, i.e. age (A), gender (G), frequency of use (F) and experience (E).

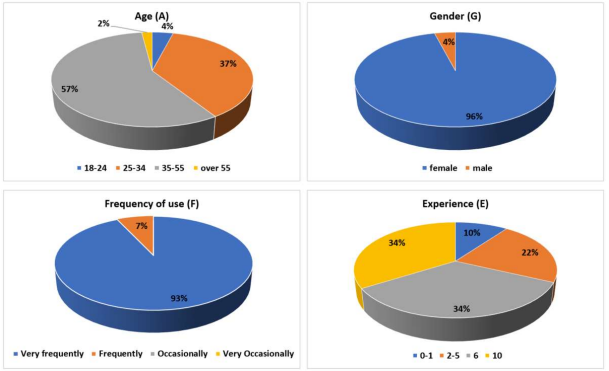


Figure 3: distribution of respondents via moderators

Each moderator has a set of alternatives, all listed in the related pie chart in the own figure. It is immediately clear that most of our sample, as well as the large part of the staff population in DITE stores, consists in females which use

RFID services very frequently. The total number of respondents to the survey is 114 for 350 RFID uses on 6 functions, which means an average of 3.1 uses per questionnaire. The responses are shared as follows (out of 100% of the uses): RTLS 3.51%, PA 16.67%, R&S 42,11%, IC 66.67%, R&A 83.33%, SRD 94.74%. If we consider the overall average responses on the 12 items, mean values for each item are always above 3.3 on a 0-4 scale, which is a very positive value and highlights a strong intention to use and a high perceived usefulness of RFID technology. The detailed answers for each construct, as suggested by UTAUT, are reported in Figure 4. The lack of significant differences between the responses among the different clusters is due to the high percentage of positive responses, resulting in non-significant variations among them.

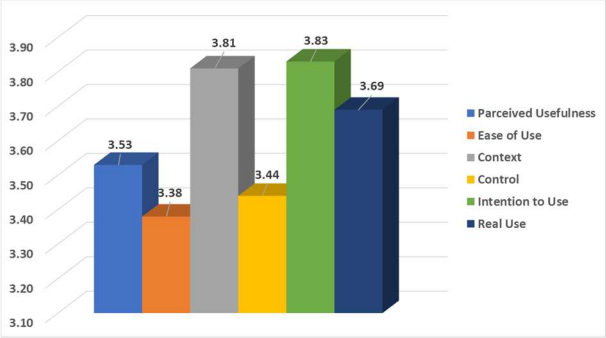


Figure 4: overall mean values for each construct

To obtain clear result by the scenario we carried out an inferential analysis. To this end, we deployed ANOVA to locate questions whose answers were different because of a moderator. Results are listed in Table 2. Just by setting a statistical significance value of $\alpha = 0.05$, a correlation between question #2 and the experience is disclosed, while is however true the relation between question #12 and the frequency of use. The links are in table highlighted by a double asterisk. Following the same line of reasoning, setting $\alpha = 0.10$ we obtained a further link between question #2 and the frequency of use, and between question #8 and the moderators gender and experience: this result is highlighted in Table 2 by a single asterisk.

Table 2: statistical significance of moderators per question

Question	Statistical Significance of Moderator			
N°	Age	Gender	Experience	Frequency of Use
1	0.182	0.959	0.137	0.590
2	0.414	0.170	0.025**	0.078*
3	0.746	0.966	0.124	0.350
4	0.648	0.595	0.326	0.594
5	0.656	0.338	0.198	0.666
6	0.170	0.783	0.089*	0.646
7	0.218	0.724	0.634	0.797
8	0.231	0.100*	0.072*	0.627
9	0.885	0.825	0.544	0.212
10	0.721	0.154	0.489	0.500
11	0.290	0.311	0.401	0.746
12	0.812	0.286	0.465	0.000**

Therefore, it becomes interesting to examine the relationship between constructs and moderators: to this end, we analysed this link using a multivariate regression. This analysis allows to link judgements on constructs to the characteristics of the respondent. Table 3 shows the value of the coefficient of determination R^2 for each construct and the related statistical significance of moderators.

Table 3: coefficient of determinations and statistical significance of moderators for each construct

Construct	R^2	Significance of Moderator			
		A	G	E	F
(1)	0.078	0.024**	0.939	0.022**	0.267
(2)	0.055	0.097*	0.722	0.023**	0.335
(3)	0.023**	0.631	0.321	0.477	0.732
(4)	0.054*	0.023**	0.898	0.077*	0.742
(5)	0.051*	0.032**	0.163	0.285	0.759
(6)	0.135	0.870	0.585	0.670	0.000**

Values of R^2 very far for one suggest that moderators (independent variables) are unable to predict the trend of the constructs (dependent variables) even though some moderators have a suitable value of statistical significance (e.g. $\alpha < 0.05$). These are Age and Experience, so we developed an analysis on the construct expressed by these two most relevant moderators. Here again, considerations on the α value may be the same as in the ANOVA analysis. Figure 5 summarises the results, where operators with age ranging between 35 and 55 show significantly lower values of perceived usefulness, ease of use and control. Similar results can be achieved considering other moderators, but we have not reported them here because of space constraints. Survey exhibits positive assessments (mean values) for each construct. It is undeniable that these results will depend on the specific function: although all mean values are in general high, we must note that not all functions address correctly the analysis, due to the lack of a significant sample, in terms of quantity. This lack could be either intrinsic in the specific function, or due to the low number of employees for some functions. As an example, the only functions that achieved responses in more than 50% of the received questionnaires are (i) size requested desk and (ii) replenishment and assortment and (iii) inventory count.

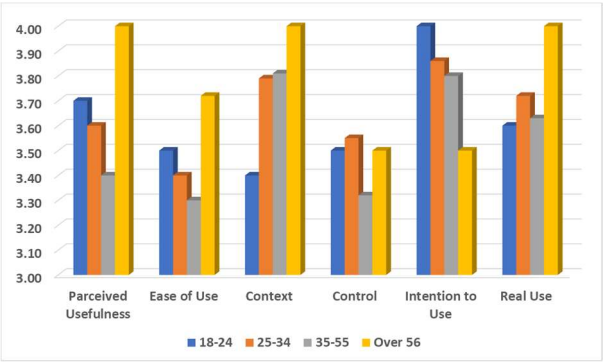


Figure 5: assessment of constructs moderated by Age

We thus proceeded with these functions with multivariate regression. Again, for all the functions, R^2 values are too low to suggest possible interpretations. Nonetheless, with an $\alpha = 0.05$, we may observe a significant influence of (i) the moderator Experience on the construct Ease of Use, (ii) the moderators Age and Experience on the construct Perceived Usefulness, (iii) the moderators Gender and Age on the Intention to Use, and (iv) the moderator Age on

Control. At same time, for Replenishment and Assortment, we noticed a significant influence of (i) the moderator Experience on the constructs Perceived Usefulness and the Ease of Use, and (ii) the moderator Age on the Perceived Usefulness and the Intention of Use.

5. Conclusions and future works

Survey research methodology is a well-known and reliable tool to assess and understand the intention of use and perceived usefulness of new technologies. Towards this aim, the UTAUT model is well-established in scientific literature, and it suggests a useful number of constructs and moderators. We developed and distributed a simplified UTAUT-based questionnaire to understand the intention of use and perceived usefulness of RFID in DITE. The 114 valid responses that we received refer to a total of 6 different functions of RFID at the company, for 350 total uses. The questionnaire was handed out when RFID technology was a well-established reality in the daily operations of the company, and this could have caused the unexpectedly positive answers. Nonetheless, the results are very useful. Firstly, the technology is well-received and accepted by the staff: this condition is expressed by very high average values for each answer, not far from the maximum value. Furthermore, we used inferential statistics to validate the model. We can state that the results obtained are very interesting: not only the test has shown a very good reliability proved by the lack of divergent clusters, but all the groups of items report very high average values, with an extremely strong attitude towards using. This is likely because RFID enables user-friendly operations. The high level of users' satisfaction may be strategic for fashion companies, for instance towards the introduction of Internet of Things (IoT) to connect physical objects and support intelligent decision making. Secondly, even if there is not a clear dependence of specific constructs on moderators, as well as between moderators themselves, Age and Experience seem to influence intention to use and use of the technology. It emerges, in fact, that female staff aged between 35 and 55 years of age and with an experience of 2 to 5 years at the company show lower Ease of Use, Perceived Use and Control. If this is statistically normal since women users are the majority, it is likely that age may be linked to inability to change practices consolidated by experience. Trying to recap these findings, it may be assumed that the RFID technology is likely to be well understood by users but the change in practices it requires must be assimilated by this category with more time than others. Unfortunately, UTAUT 'does not explain how or why initial acceptance is not always indicative of sustained use, and it does not include post behavioural model to predict future (de Vreede et al., 2012). The expectation of behaviours seems to go beyond the prediction of the intention to use the technology by its acceptance. Anyway, this aspect needs for others analytical social-based tools and it is beyond the scope of this study.

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