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Acceptance Framework for Collaborative Robots in Traditional Crafts and Handmade in Small Businesses: An Integrated Model

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Abstract **-** Although, the deployment of collaborative robots (CoBot) in support of traditional manual roles can provide significant opportunities for increased efficiency in general, however, this introduction also represents massive changes in the design and the management of the work. This paper focuses on the acceptance-related factors that affect the introduction of a movement-enabled robot in traditional crafts and handmade products in small businesses. It's crucial to conduct thorough evaluations to ensure that systems adequately fulfil these special users' requirements and information processing needs within the defined scope to determine how to improve its acceptance. The area of end users for acceptance evaluation of CoBots technology has a lack of knowledge to examine some features of the robotic technology/system in the content of traditional crafts and handmade products in small businesses. This paper proposes a novel evaluation model to evaluate user acceptance of a movement-enabled robot system. It outlines the theoretical foundation driving the construction of the factors model. Technology-to-Performance Chain (TPC) model and The Unified Theory of Acceptance and Use of Technology (UTAUT) model were used for the framework for the classification of properties of adaptations and human-centred requirements that are necessary for introduction. We then apply the framework to traditional crafts and handmade products in small businesses that can inform the acceptance of these new robots to improve and ultimately a smooth adaptation of such a system.

Keywords**:** Handicrafts, handmade products, CoBot, Small Business, Technology Acceptance

1. Introduction

The handicraft plays a significant role in preserving cultural heritage, fostering economic development, and promoting sustainable livelihoods worldwide. It is defined as "Items made by hand, often with the use of simple tools, and are generally artistic and/or traditional in nature [1]. We can understand from there that there is a strong relationship between a place and its human part or the people living in that environment. Craftsmanship develops when skilled individuals, deeply connected to a region to utilize their expertise to create new special objects. Then, they often pass down these skills and knowledge through generations. Thus, these skills and knowledge are mostly informal not well protected, poorly documented and face social and cultural disadvantages. This can affect the quality of their products, innovation passing down of knowledge between generations, sustainability of skills, incorporation of knowledge into practices and the connection, between local traditions and the global market. These issues collectively weaken the long-term prospects of the market for crafts and therefore, create certain challenges and constraints in the collaborated robotics (CoBot) introduction. Understanding their special factors will help in the successful acceptance of the CoBot.

2. Background

In recent years, the integration of collaborated robotics into various industries has led to significant advancements in productivity, efficiency, and innovation. Collaborative robots are "Systems that function as smart, programmable tools, that can sense, think, and act to benefit or enable humans or extend/enhance human productivity" [2]. This definition speaks more about human productivity and less about human perception, whereas in research the goals of which are not always productivity. The acceptance of collaborative robots presents unique challenges, this might be a critical issue when introduction starts in traditional crafts and handmade products in a small business. Although, the deployment of collaborative robots (*CoBot*) in support of traditional manual roles can provide significant opportunities for increased efficiency in general, however, this introduction also represents massive changes in the design and the management of the work. This can be explained by the unique owner-manager characteristic in such an environment. Accordingly, challenges stem from the individual end users, as they can be affected by the way that they perceive the CoBot applications would affect their job performance, especially their routine practices [3]. In addition to the cultural significance, emotional connection, and artisanal authenticity associated with these industries. These characters will be critical to the interaction and will play a significant role in the uptake of the technology. Therefore, the owner's perception and acceptance factors of the relative advantage of using such systems in their work need to be defined precisely. Understanding and addressing these acceptance-related factors are crucial for the successful adoption of movement-enabled robots in small businesses dealing with traditional crafts and handmade products.

3. Theoretical Framework and Acceptance Model

The special characteristics of handicraft in small businesses make it more difficult to study the owner's acceptance, and therefore to study or even define their acceptance factors. Luckily, there have been investigations during the past into the acceptance-related factors in which humans will accept humanoid forms (CoBots). Starting with the Technology-to-Performance Chain (TPC) mode [4], [5], [6]. In addition, the diffusion of innovation theory, the unified theory of acceptance and use of technology (UTAUT) model [7] identified various determinants of acceptance such as behavioural intention to use, technology use and contingencies. In this paper, we discuss three theories that we believe are relevant to our research problem.

3.1. Technology-to-Performance Chain (TPC) model

When it comes to user performance and the link with the technology, the Technology-to-Performance Chain (TPC) model is the comprehensive model of this linkage (Figure 1). TPC draws on insights from two complementary streams one is user attitudes as predictors of utilisation, and insights from research on task-technology fit as a predictor of performance. According to their model, the attitudes of the end users towards any system are affected by factors of information and these attitudes besides social norms and other situational factors, lead to utilization. Whereas for the Task-technology fit, they suggested that the performance of the end users is affected by the information systems, based on the alignment between the requirements of task from the users and the capabilities of the system. According to the Task-Technology Fit theory, the influence on performance depends on the compatibility between the individual characteristics and the features of the system. The fundamental premise of this model is that for information technology to enhance individual performance, it must align effectively with the tasks it is intended to facilitate, and it must be actively utilized [6]. For example, implementing a new system will not guarantee effective utilization of this new system; rather, the user's skills must align with the requirements of the actual system.

Since our focus will be on identifying the factors affecting user adoption related only to small businesses, especially the handicrafts sector, we need to ensure that factors related to task technology fit are considered when a CoBot is designed and introduced. For this reason, we have chosen to base our arguments on Goodhue and Thompson's [6] Technology-to-Performance Chain (TPC) model (Figure 1).

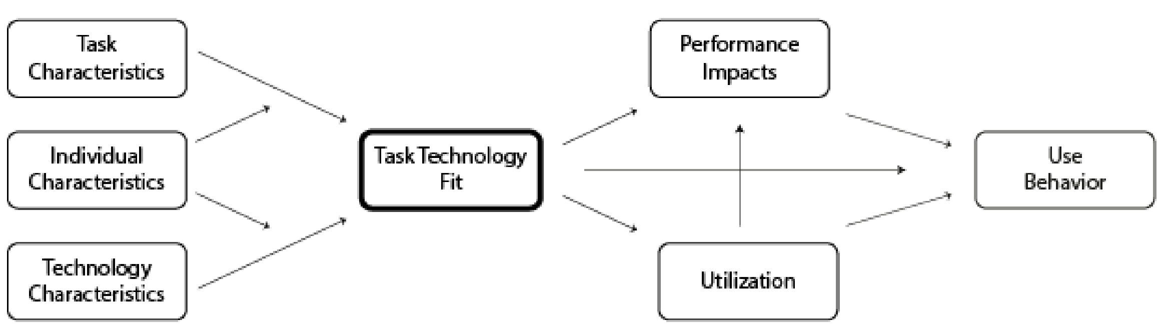

Fig. 1: Technology-to-Performance Chain (TPC) model

3.2. Unified Theory of Technology Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) has been widely used by scholars to investigate the attitudes and acceptance of new technologies in different contexts. They aim to understand and explain users' attitudes, and the factors that influence their attitudes towards interactive robotic systems including Performance expectancy, Effort expectancy, Social influence and Facilitating condition [8], [9], [10], [11]. To our knowledge, though the UTAUT model is relatively recent it has not been extensively used in the collaboration robot for the small business sector. Therefore, we aim to use this model to comprehend user acceptance of technology within the collaboration robot in handicrafts in the small business domain.

4. Observation on Early Study of Existing Evaluation Frameworks

4.1. Task Technology Fit for Traditional Crafts and Handmade Products in Small Businesses

The TPC model highlights the impact of task technology fit (TTF) as a critical factor in determining utilisation and user attitude or performance. TTF is the degree to which the technology assists users in performing their work. A series of studies reported the impact of the fit with the task on performance [12], [13]. In which TTF is the correspondence between task requirements, functionality of the technologies, and users' abilities [14], [15]. Therefore, we decided to focus on these three factors; Task characteristics, Individual characteristics and Technology characteristics in the task technology fit as a strong predictor of user performance for traditional crafts and handmade products in small businesses.

4.1.1 Task Characteristics for Traditional Crafts and Handmade Products in Small Businesses

One of the first factors influencing the technology fit is task characteristics. Tasks are viewed as a set of activities performed by individuals to achieve outputs (mainly products) by utilising technologies that help them to perform these tasks. Regarding traditional crafts and traditional handmade products, the quality of the goods produced is highly dependent on the craft producers' skills (activities). This limits innovation and impacts the ability to integrate traditional knowledge into a wider market and technology and the sustainability of their skills is a weakness due to the transfer of them between generations. In these tasks, skills tend to be hereditary and are handed from generation to generation. In addition to the skills, producers employ complex knowledge systems that have evolved over long periods of time. Producers gain a total mastery of the techniques because many processes are complex and mastery takes many years, often via an apprenticeship. The required skills and therefore the knowledge systems will be informal, largely undocumented, and imperfectly adaptive [16]. All these factors tend to limit ongoing market prospects and growth potential. Therefore, it is crucial to formally document both skills and knowledge frameworks in order to seamlessly adapt to technology. As a result, this will enhance the value of skill acquisition, fostering market growth and stability. In addition, this will strengthen the quality, innovation, intergenerational knowledge transfer, and sustainability of crafts production. Furthermore, it facilitates the integration of traditional knowledge into technology and establishes connections between local heritage and the global market. Thus, the first factor for user acceptance of CoBot in traditional crafts and handmade products is Task Knowledge availability which is positively related to the utilisation of task technology fit and the second factor is Task Skills availability which is positively related to the utilisation of task technology fit (Table 1)

Table 1: Instrument of task characters adopted [17] (Subramaniam & Venkatraman, 2001)

Task Knowledge availability	The knowledge required for my task is easy to comprehensively document in manuals or reports.
	The knowledge required for my task is easy to comprehensively

	understand from written documents.
	The knowledge required for my task is easy to precisely communicate through written documents.
	The knowledge required for my task is easy to communicate without personal experience.
Task Skills availability	The skills required for my task is easy to comprehensively document in manuals or reports.
	The skills required for my task is easy to comprehensively understand from written documents.
	The skills required for my task is easy to precisely communicate through written documents.
	The skills required for my task is easy to communicate without personal experience.

4.1.2 Technology Characteristics for Traditional Crafts and Handmade Products in Small Businesses

Goodhue & Thompson [6] defined the characteristics of technology as tools used by individuals in carrying out their tasks. Depending on the required task and the abilities needed to perform it the software and hardware must be carefully chosen. Thus, we can argue that there is a clear connection between technology characteristics and the two constructs of The Unified Theory of Acceptance and Use of Technology (UTAUT) model: Performance expectancy and Effort expectancy (Figure 2).

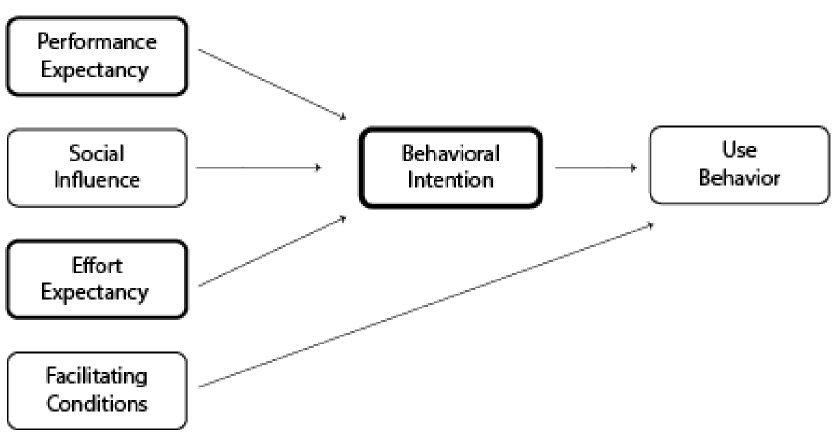

Fig. 2: Technology-to-Performance Chain (TPC) model

- **Performance Expectancy**

Venkatesh et al., [7] define performance expectancy as the extent to which an individual believes that using an information system will help him or her to attain benefits in job performance. Performance expectancy for a CoBot in a small craft venture context suggests that users will find it useful because it enables them to delegate simple, repetitive, or load-bearing tasks to their CoBot more quickly and flexibly and focus on higher-level elements which will help increase their work effectiveness. Based on Performance expectancy plays a role in the influence on behavioural intention (Table 2).

Table 2: Instrument of Performance Expectancy [18]

I find the CoBot system useful in my work.
Using the CoBot system increases my chances of achieving things that are important to in my work.
Using the CoBot system helps me accomplish things more quickly.
Using the CoBot system increases my productivity.

- **Effort Expectancy:**

The CoBot can make the working environment more pleasant, but as a human, it is natural that the worker will hold expectations relating to interaction and the characteristics and nature of the CoBot. Negative experiences of working with a CoBot will not deliver the benefits of an increase in manufacturing efficiency. In the case of unskilled workers who have had limited experience in working with CoBots, it is important to understand how they will react to such an introduction, and they will need help with the transition to semi-automated from fully manual work processes [19]. The uptake of the technology will be significantly affected by the attitudes of the workforce towards the interaction. This position can clearly be described under the heading of Effort expectancy. This was described by Venkatesh et al. [7] as the expectations the user has of the effort that is needed to use the system (Table 3)

Table 3: Instrument of Effort Expectancy [18]

Learning how to use the CoBot system is easy for me.
My interaction with the Robot system is clear and understandable.
I find the Robot system easy to use.
It is easy for me to become skilful at using the Robot system.

- **Job Security:**

One of the early works on robotic implementation that addressed the issue of job loss is [20]. They estimated that the ratio of jobs lost and jobs created from implementing robots to be 5 to 1. This loss is more likely to affect low-skilled workers including line workers, job setters and skilled trades [21]. In addition, [22] highlighted that “if there is an increase in unemployment as a result of the spread of robotics technology, we fear the burden will fall on the less experienced, less educated part of our labour force”. This highlights that employees with greater skills would tend to exhibit more positive perceptions towards the robots because they would view this as providing opportunities for skill enhancements. Skill level is strongly connected to performance expectancy, and therefore to behavioural intention (Figure 3) and (Table 4)

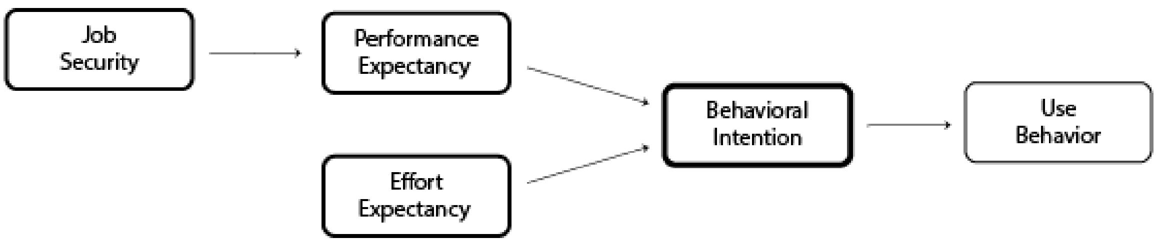

Fig. 3: Job Security

Table 4. Instrument of Job Security [21]

With more and more robots everywhere, my chances of finding another job are small.
The Robot system seriously threatens my work future.
The Robot system and other new forms of automation reduce my job security.
The introduction of the Robot system will slowly displace jobs.
I have only a small chance of keeping my job as technological advances increase.
I fear that someday I will lose my job to a robot.
Robots will make me less useful as a worker.
Increased use of the Robot system will mean less and less work for people.
The Robot system will result in more competition among workers.
As a result of robots in the workforce, I will have a smaller and smaller part in the plant.

4.1.3. Individual Characteristics for Traditional Crafts and Handmade Products in Small Businesses

The final factor to influences the acceptance of cobot in handicrafts and small business is individual characteristics. Research on information technology in society has for a long time looked at how and why individuals adopt new technologies. There are several theoretical models which describe the acceptance of technology by individuals with usage or intention as the key dependent variable [reference]. There is a basic concept which underlies the models of user acceptance, which can be described as follows: The individual’s reaction to the usage of information technology is step 1 which leads to step 2 – an intention to use information technology, which results in step 3 - actual usage of information technology. Naturally, an individual's reaction to using information technology and the actual use are interdependent.

The crafts sector has acquired a central place in national cultural policy because it is associated with social value and represents a local identity. There have been a number of research projects on how to protect and preserve this inheritance of traditional skills and knowledge. Attempts to preserve the values represented by craftmanship from being destroyed by an impersonal machine age such as those discussed in the UNESCO Convention (2003). The loss of specific livelihoods that for centuries have been a characteristic of families and the loss of the ability to learn from the past generation and to teach skills to the new one so that the creative skills are handed down through the generations [23]. These are the reasons why many craftspeople express a strong desire to remain in their traditional profession [24]. Another important aspect is the value of the product, as the uniqueness of the handmade goods is irreplaceable for the end consumer [25].

Thus, early researchers on observing information technology implementation have identified user characters and factors leading to resistance as critical variables for implementation success [26], [27]. Only recently, [28] highlighted its antecedents as critical variables for implementation success. This view was also supported by different studies in information technology research into the user acceptance [29], [30]. The research [31], [32] stated that user resistance is based on beliefs and attitudes towards the technology in question. Examples of these beliefs include perceived threats, technology inhibitors and loss of power, etc. Individual users of information systems could react in different ways to a new technology. They might reject it completely, partially use its functions, actively resist it, unwillingly accept it, or embrace it fully. Research into resistance still lacks the provision of a unified understanding of resistance towards information technology. The analysis of resistance theories proposed and used by IS research reveals several important implications for future research on user resistance according to [28], (Table 5).

Table 5: Instrument of User Resistance [33], [18]

I will not comply with the change to the new way of working with the Robot system.
I will not cooperate with the change to the new way of working with the Robot system.
I oppose the change to the new way of working with the Robot system.
I do not agree with the change to the new way of working with the Robot system.
Considering the perfection of the product, the change to the new way of working with the Robot system is worthwhile.
I have already put a lot of time and effort into mastering. the current way of working.
Switching to the new way of working with the Robot system could result in unexpected difficulties.
I would lose a lot in my work if I were to switch to the new way of working with the Robot system.
Most people whom I deal with in my job encourage my change to the new way of working with the Robot system.

5. The Proposed Integrational Model

With the special characters of small business handicrafts and after examining existing previous models and theories regarding user acceptance of technology especially for collaboration robots, we identified five main categories which we presented, that are related to the implementation of such a system in the handicraft sector by adopting the

Technology-to-Performance Chain (TPC) model as a primary theoretical framework and Use of Technology (UTAUT) the proposed model (Figure 4) can be used to analyse and understand the acceptance of human-centred robotic work environments for traditional crafts and handmade products in small businesses that are necessary for the adaptation of such a system

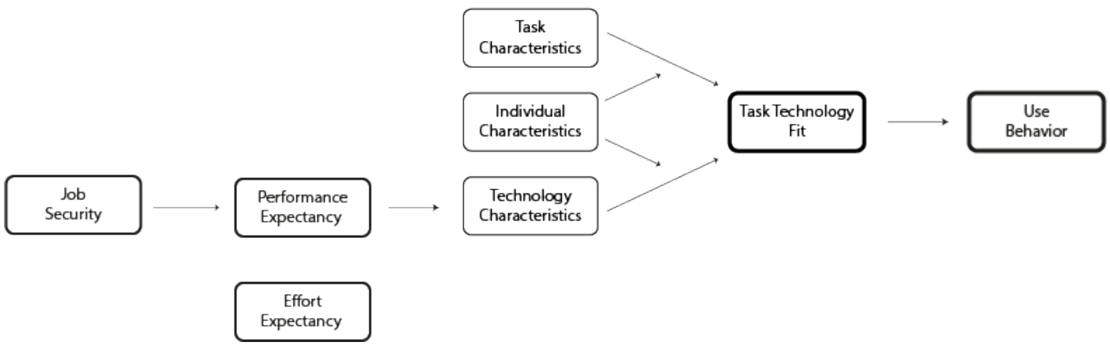

Fig. 4: The Proposed Technology Acceptance Model for Traditional Crafts and Handmade Products in Small Businesses

5.1 Validation of Proposed Evaluation Model: Phase 1 (Literature Review)

During the initial phase of our research, we undertook a literature review to validate the proposed model, aiming to identify factors linked to the adoption of new technology especially collaboration robots for handicrafts in small businesses. We gathered and categorized all these factors based on the constructs outlined in our model, to assess whether our defined constructs could encompass these factors. Then, we successfully categorized the identified factors.

5.2 Validation of Proposed Model: Phase 2 (Case Study Strategy)

In the second phase of our research and for future work, a case study approach will be conducted. This case study will serve dual purposes: firstly, to assess the adoption of collaboration robots within the context of handicrafts in small businesses, and secondly, to validate the proposed evaluation model. Throughout the evaluation process, we will also conduct interviews with users, observe their interactions with the system, and analyse relevant documents.

Conclusions and future work

While robots are increasingly becoming flexible and intelligent to use in different places within different situations, little research has been conducted to study their acceptance. In this paper, we introduce an evaluation model designed to assess user acceptance of collaboration robot technology within the handicrafts in small businesses sector. Our proposed model integrated two well-established theories of information systems to highlight the factors influencing user acceptance of collaboration robot technology. In the initial phase of our study, we conducted a comprehensive literature review to identify factors associated with user acceptance of technology. These factors were subsequently categorized according to the constructs outlined in our model. Through this process, we demonstrated the efficacy of our model in representing factors related to technology acceptance. As part of future work, we plan to further validate our model by conducting a case study on handicrafts in small businesses. Findings from fieldwork will help in refining and enhancing the model. Recognizing the factors that are related to the acceptance of the users which can influence the successful implementation of new technology among users is vital, as they play important roles in the success and failure of any new systems.

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