Avestia Publishing
Journal of Machine Intelligence and Data Science (JMIDS)
Volume 5, Year 2024
ISSN: 2564-3282
DOI: 10.11159/jmids.2024.013

Adopting Collaborative Robotics in Traditional Crafts: A User Acceptance Model for Small Businesses in Saudi Arabia

Banan Bamoallem[1]
[1] Umm AlQura University, Department of Visual Arts
Mecca, Saudi Arabia
bsbamoallem@uqu.edu.sa

Abstract *- This research presents an approach to integrating Collaborative Robots (CoBots) into Saudi Arabia's traditional craft industries, addressing both economic challenges and the preservation of cultural heritage. By combining the Technology-to-Performance Chain (TPC) and Unified Theory of Acceptance and Use of Technology (UTAUT) models, this paper proposes an evaluation framework specifically tailored to small businesses involved in traditional crafts, such as Al-Sadu weaving and Al-Qatt Al-Asiri. Recent trends in CoBot technology, such as increased intelligence, human-centric design, and customization, highlight the potential of CoBots in craft-based industries to enhance productivity without compromising artisanal quality. Saudi initiatives like the Diriyah Gate Development Authority (DGDA) and AlUla restoration projects showcase the integration of modern technologies in heritage preservation, creating opportunities for future CoBot applications. However, the cultural and emotional attachment to handmade products in Saudi Arabia presents unique challenges that must be addressed for successful adoption. This paper critically analyses these challenges by offering a practical model into how CoBots can be integrated while preserving artisanal heritage. The paper concludes by offering policy recommendations for the adoption of CoBots in traditional Saudi crafts, facilitating their integration into the global economy.*

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

1. Introduction

Saudi Arabia's traditional crafts are deeply embedded in its cultural identity. Crafts like Al-Sadu weaving, pottery, Najdi door carvings, and Al-Qatt Al-Asiri are not just economic activities but represent a tangible link to the Kingdom's rich cultural history [1]. Al-Sadu weaving, for example, is a traditional Bedouin textile craft involving intricate hand-weaving techniques to create patterns symbolizing Bedouin lifestyle [2]. Similarly, Al-Qatt Al-Asiri is a UNESCO-recognized traditional wall decoration art that embodies the aesthetics of Asir's mountainous regions, passed down through generations of women [3]. Also, the Najdi door carvings, passed down through generations in central Saudi Arabia, symbolize both hospitality and local identity [4].

However, globalization and modernization pose a threat to the sustainability of these crafts. Younger generations are often less interested in learning these artisanal skills, and the global market demands faster production cycles, creating pressure on artisans to adapt [5]. Saudi Vision 2030, which aims to diversify the economy and promote the Kingdom's cultural heritage, seeks to preserve these crafts while integrating modern technologies that can help traditional artisans remain competitive on the global stage [6].

Recent advancements in collaborative robots (CoBots), such as increased intelligence and autonomy, have made them more adaptable to dynamic environments like traditional crafts. CoBots can now learn from human operators and handle more complex tasks over time [7]. Moreover, the development of

Date Received: 2024-04-18
Date Revised: 2024-09-14
Date Accepted: 2024-10-01
Date Published: 2024-10-18

human-centric design in CoBots makes them easier to operate, crucial in craft sectors where artisans may not have advanced technical skills [8]. In the Saudi context, where workshops could be small and crowded, collaborative safety features could allow CoBots to work alongside artisans without posing a safety risk.

Recently, several Saudi initiatives have been actively blending modern technology with heritage preservation, offering valuable insights into how CoBots could be applied to traditional crafts. For instance, the Diriyah Gate Development Authority (DGDA) has been restoring traditional Najdi architecture, including carved doors and walls, by using advanced tools to ensure precision and historical accuracy [9]. Similarly, the Royal Commission for AlUla (RCU), which is spearheading the restoration of ancient historical sites, is using modern technologies like 3D scanning and digital mapping to preserve traditional stonework [10]. While CoBots have not yet been formally introduced, they could assist artisans by handling repetitive tasks such as preparing materials and base carvings, allowing skilled craftsmen to focus on the intricate details supporting efforts to maintain cultural authenticity while increasing efficiency.

This paper addresses a critical gap by focusing on the adoption of CoBots in Saudi traditional crafts—a sector that has received limited attention in the robotics and technology acceptance literature. The novelty lies in the customized evaluation model that is adapted specifically to Saudi Arabia's cultural landscape. This research fills the gap by emphasizing the economic benefits of CoBots. Recent studies, provide evidence that CoBots can be utilized in artisanal industries to handle repetitive tasks while allowing artisans to focus on the creative elements of their work [11]. Furthermore, the trend of modular and customizable CoBots could allow these robots to be tailored to specific needs within different Saudi crafts, making them more adaptable and specialized.

2. Background

Collaborative robots (CoBots) have emerged as transformative technologies across various industries, including manufacturing and healthcare. CoBots are designed to work alongside human operators, enhancing productivity while complementing human labour rather than replacing it [12]. This collaborative, human-centric approach makes CoBots particularly well-suited for industries requiring precision and creativity, such as traditional crafts. In addition, recent advancements in affordable and scalable CoBots have made this technology more accessible to small businesses, including those in craft industries. Especially, in sectors where manual skills and artisanal knowledge are paramount, CoBots have demonstrated their capacity to increase efficiency while preserving the integrity of the craft. For example, in the textile industry, CoBots are used to assist with repetitive tasks like cutting and sewing, allowing artisans to focus more on design and quality control [13].

The traditional crafts industry in Saudi Arabia, encompassing Al-Sadu weaving, pottery, metalwork, and other artisanal skills, faces increasing pressure to adapt to modern market demands. For instance, the traditional craft of Al-Sadu weaving, which is deeply rooted in Saudi heritage, has struggled against these pressures while striving to maintain its cultural significance [14]. Similar challenges could affect crafts such as pottery and metalwork, where small, family-owned businesses often face difficulty scaling operations while preserving the generational artisanal skills that are central to their identity. Therefore, Saudi artisans who operate in small, family-run businesses with limited resources could benefit from CoBots to assist with labour-intensive tasks, resulting in enhanced productivity without compromising the cultural and creative elements of production. This represents a significant opportunity for Saudi traditional crafts to thrive in the global market while maintaining their authenticity.

However, the introduction of CoBots must be carefully managed to respect the deep emotional attachment that both artisans and consumers must have to handmade, culturally significant items. While CoBots offer the potential to enhance productivity in traditional crafts, the success of their integration depends on understanding the unique cultural and emotional factors that influence user acceptance. The strong emotional attachment that artisans and consumers feel toward handmade products presents a particular challenge for the adoption of automation technologies in this space.

By examining factors that influence the acceptance of CoBots in traditional crafts, this paper contributes to the research on technology adoption in culturally significant industries by proposing an evaluation framework, which integrates the Technology-to-Performance Chain model (TPC) [15] and the Unified Theory of Acceptance and Use of Technology (UTAUT) model [16] models that address the specific needs of Saudi small businesses in the traditional crafts sector, offering a pathway for the successful introduction of CoBots.

3. Theoretical Framework and Acceptance Model

The Technology-to-Performance Chain model (TPC) [15] emphasizes the importance of aligning technology with the tasks. Thus, it identifies how CoBots can complement traditional tasks without replacing the essential artisanal elements of design and creativity. In the Saudi context, the TPC model is particularly relevant due to the unique nature of tasks performed in traditional crafts. The production of handmade goods, such as Al-Sadu weaving or pottery, requires a high degree of skill and expertise, which are often acquired through years of apprenticeship. The TPC model helps to identify how CoBots can be integrated into these tasks without disrupting the artisanal process.

Whereas The Unified Theory of Acceptance and Use of Technology (UTAUT) model [16] provides a complementary framework for understanding the factors that influence user acceptance of new technologies. The UTAUT model addresses the social and cultural factors that influence the acceptance of CoBots. In Saudi Arabia, where traditional crafts are deeply tied to cultural identity, the introduction of CoBots may be perceived as a threat to artisanal authenticity. The UTAUT model identifies key factors such as performance expectancy, effort expectancy, and social influence that affect how artisans perceive the value of CoBots.

In general, the TPC model emphasizes the alignment between task requirements and technological capabilities, and the UTAUT model examines social, psychological, and organizational factors that influence user behavior. Together, these models provide a comprehensive framework for evaluating the acceptance of CoBots in traditional crafts.

The proposed evaluation model integrates both the TPC and UTAUT frameworks, offering a holistic approach to understanding the challenges and opportunities of CoBot introduction in Saudi traditional crafts. This integrated approach enables a nuanced assessment of technology adoption in this culturally significant industry, balancing modernization with heritage preservation.

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 the 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 [15]. 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. In the context of Saudi traditional crafts, where tasks such as hand weaving or pottery-making require intricate human skills, the TPC model helps identify the tasks that CoBots can assist with without undermining the artisanal process. For example, CoBots can handle repetitive tasks like material preparation or assembly, allowing artisans to focus on the creative and skill-intensive aspects of production.

Since our focus will be on identifying the factors affecting user adoption related only to small businesses, especially the Saudi 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 [15] Technology-to-Performance Chain (TPC) model (Figure 1).

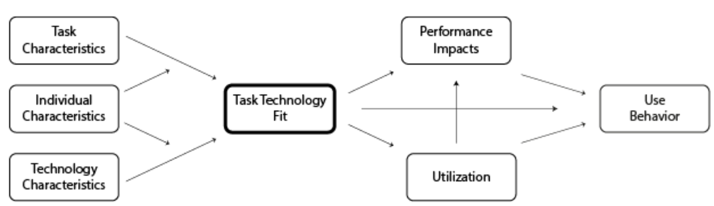

Figure 1. Technology-to-Performance Chain (TPC) model

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 [17-20]. In the context of Saudi traditional crafts, these factors are critical. Artisans and small business owners may resist adopting CoBots due to concerns that automation will devalue their handmade products or that it will lead to job displacement. The UTAUT model allows us to examine these socio-cultural barriers, offering insights into how CoBots can be positioned as tools that enhance rather than replace artisanal skills. 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

Existing evaluation frameworks for technology adoption have been applied in various industries, from manufacturing to healthcare [21], but few studies have focused on culturally significant sectors such as traditional crafts. In Saudi Arabia, where artisanal industries are closely linked to national identity, existing frameworks must be adapted to account for the emotional and cultural factors that influence technology adoption.

One of the primary limitations of existing frameworks is their focus on productivity and efficiency, often at the expense of cultural preservation. For example, the TPC model has been successfully applied in industries such as manufacturing, where the primary goal is to increase output [22]. However, in the context of traditional crafts, the value of handmade goods lies in their uniqueness and cultural significance. As a result, the introduction of automation technologies such as CoBots must be carefully managed to ensure that the cultural value of these products is not diminished.

In contrast, the UTAUT model offers a more holistic approach by considering social and psychological factors that influence user acceptance. However, even this model requires adaptation to account for the specific cultural context of Saudi traditional crafts. For example, the model's focus on performance expectancy may not fully capture the emotional attachment that artisans and consumers have to handmade products. By integrating both the TPC and UTAUT models, the proposed evaluation framework offers a more comprehensive approach to understanding the challenges and opportunities associated with CoBot adoption in Saudi traditional crafts

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. 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 [23]. All these factors tend to limit ongoing market prospects and growth potential. Therefore, it is crucial to formally document both skills and knowledge frameworks 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 [24]

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 defined [15] 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:

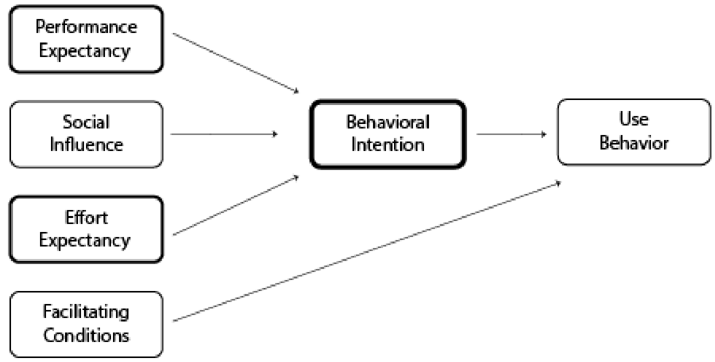

Figure 2. Technology-to-Performance Chain (TPC) model

- **Performance Expectancy**

Venkatesh et al., [16]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 [25]

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 (Holmes et al., 2018). 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 [16] as the expectations the user has of the effort that is needed to use the system (Table 3).

Table 3. Instrument of Effort Expectancy [25]

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 [26]. 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 [27]. In addition, [28] 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 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).

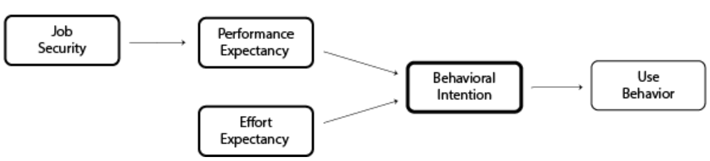

Figure 3. Job Security

Table 4. Instrument of Individual Characteristics [27]

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 businesses is individual characteristics. Research on information technology in society has for a long time looked at how and why individuals adopt new technologies. 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 [29]. 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 [30]. These are the reasons why many craftspeople express a strong desire to remain in their traditional profession [31]. Another important aspect is the value of the product, as the uniqueness of the handmade goods is irreplaceable for the end consumer [32].

Thus, early researchers on observing information technology implementation have identified user characters and factors leading to resistance as critical variables for implementation success [33, 34]. Only recently, [35] 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 [36, 37]. The research [38, 39] 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 [35], (Table 5).

Table 5. Instrument of User Resistance [25, 39]

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 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.

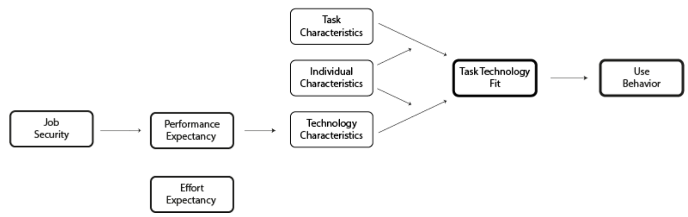

Figure 4. The Proposed Technology Acceptance Model for Traditional Crafts and Handmade Products in Small Businesses

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 Human-Centered Design and Anthropomorphic Capabilities in CoBots

In the second phase of our research and for future work, In the validation phase, special attention will be paid to the human-centred design and anthropomorphic capabilities of CoBots, particularly in traditional Saudi crafts like Al-Sadu weaving and pottery. CoBots equipped with hand and arm gesture recognition will be evaluated for their ability to replicate human actions in a way that complements the artisan’s creative process. The validation phase will include observations of CoBots performing repetitive tasks such as material preparation and measuring their impact on artisans' ability to focus on high-skill tasks.

Safety concerns will also be a primary focus. Anthropomorphic designs—such as using soft, human-like features—will be tested to see if they improve the comfort and acceptance of CoBots in craft settings. This is critical in environments where artisans work with delicate materials and have a strong emotional attachment to handmade processes.

6. Conclusions and future work

In conclusion, this paper presents a framework for understanding and evaluating the integration of collaborative robots (CoBots) in Saudi Arabia's traditional crafts industry, specifically tailored to the intersection of CoBot technology and small Saudi businesses. By combining the TPC and UTAUT models, this research offers a unique perspective on the socio-cultural barriers to technology adoption in sectors crucial to Saudi Arabia's cultural identity, such as Al-Sadu weaving, Al-Qatt Al-Asiri, and Najdi door carving. The study highlights the importance of balancing technological innovation with the preservation of artisanal heritage, ensuring that the authenticity and cultural value of handmade products are maintained.

Recent trends in CoBot design, such as human-centric interfaces, modular customization, and affordability, make them particularly well-suited for small Saudi businesses. These developments align with Saudi Vision 2030's goals of promoting economic diversification while preserving cultural heritage. The proposed evaluation model provides a pathway for the sustainable integration of modern technology into traditional industries, fostering economic growth while safeguarding cultural heritage.

Future research will focus on optimizing CoBots for biomorphic and anthropomorphic designs that align with Saudi artisans' cultural expectations. Social norms and the emotional attachment to traditional methods will be explored further to ensure that CoBots are viewed as supportive tools, rather than threats to artisanal authenticity.

Expanding the research into gesture recognition and human-centric interfaces is another crucial area. For instance, testing CoBots with biomorphic forms that mimic the natural hand movements of artisans could help bridge the gap between traditional methods and automation.

In the future, integrating CoBots with culturally sensitive interaction models will be necessary to ensure the robots can adapt to the unique requirements of Saudi traditional crafts. Investigating the potential for autonomous CoBots in other crafts, such as Najdi door carving, could also offer new insights into how these robots can handle tasks without undermining the creative value of artisans' work.

References

[1] D. E. Long, *Culture and customs of Saudi Arabia*. Bloomsbury Publishing USA, 2005.

[2] L. M. N. Salaghor, *The re-invention of traditional weaving in Saudi Arabia*. Coventry University, 2007.

[3] UNISCO, "Al-Qatt Al-Asiri, female traditional interior wall decoration in Asir, Saudi Arabia,"

[4] M. M. AlNaim, "Dwelling form and culture in the traditional Najdi built environment, Saudi Arabia," *Open house international*, vol. 46, no. 4, pp. 595-614, 2021.

[5] D. Chudasri, *An investigation into the potential of design for sustainability in the handicrafts of northern Thailand*. Lancaster University (United Kingdom), 2015.

[6] "Saudi Vision 2030." https://www.vision2030.gov.sa/en (accessed 27 Septemper, 2024).

[7] T. Sorell, "Cobots,"co-operation" and the replacement of human skill," *Ethics and Information Technology*, vol. 24, no. 4, p. 44, 2022.

[8] M. Ciccarelli, M. Forlini, A. Papetti, G. Palmieri, and M. Germani, "Advancing human–robot collaboration in handcrafted manufacturing: cobot-assisted polishing design boosted by virtual reality and human-in-the-loop," *The International Journal of Advanced Manufacturing Technology*, pp. 1-16, 2024.

[9] "Diriyah Gate Development Authority, the beating heart of Riyadh, celebrates its 5th anniversary," in *ARAB NEWS*, ed, 2024.

[10] R. C. f. Al-Ula, "New archaeological finds in Saudi Arabia's AlUla are filling in "missing links" in the history of the region,"

[11] R. Eglash, L. Robert, A. Bennett, K. P. Robinson, M. Lachney, and W. Babbitt, "Automation for the artisanal economy: enhancing the economic and environmental sustainability of crafting professions with human–machine collaboration," *Ai & Society*, vol. 35, no. 3, pp. 595-609, 2020.

[12] A. Ajoudani, A. M. Zanchettin, S. Ivaldi, A. Albu-Schäffer, K. Kosuge, and O. Khatib, "Progress and prospects of the human–robot collaboration," *Autonomous robots*, vol. 42, pp. 957-975, 2018.

[13] A. M. Bernar, C. Prévot, J. Legardeur, and H. Chanal, "Assuring a human-centred transition to Industry 4.0 in the textile-clothing sector,"

FUTURE OF FASHION-TECH ALLIANCE, pp. pp. 49-58, 2022.

[14] UNISCO, "Traditional weaving of Al Sadu,"

[15] D. L. Goodhue and R. L. Thompson, "Task-technology fit and individual performance," *MIS quarterly*, pp. 213-236, 1995.

[16] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS quarterly*, pp. 425-478, 2003.

[17] T. W. Bickmore, L. Caruso, and K. Clough-Gorr, "Acceptance and usability of a relational agent interface by urban older adults," in *CHI'05 extended abstracts on Human factors in computing systems*, 2005, pp. 1212-1215.

[18] B. De Ruyter, P. Saini, P. Markopoulos, and A. Van Breemen, "Assessing the effects of building social intelligence in a robotic interface for the home," *Interacting with computers*, vol. 17, no. 5, pp. 522-541, 2005.

[19] M. Heerink, B. Kröse, V. Evers, and B. Wielinga, "Influence of social presence on acceptance of an assistive social robot and screen agent by elderly users," *Advanced Robotics*, vol. 23, no. 14, pp. 1909-1923, 2009.

[20] R. Looije, F. Cnossen, and M. A. Neerincx, "Incorporating guidelines for health assistance into a socially intelligent robot," in *ROMAN 2006-The 15th IEEE International Symposium on Robot and Human Interactive Communication*, 2006: IEEE, pp. 515-520.

[21] H. Taherdoost, "A critical review of blockchain acceptance models—blockchain technology adoption frameworks and applications," *Computers*, vol. 11, no. 2, p. 24, 2022.

[22] Y.-T. Jou, M.-C. Lin, R. M. Silitonga, S.-Y. Lu, and N.-Y. Hsu, "A Systematic Model to Improve Productivity in a Transformer Manufacturing Company: A Simulation Case Study," *Applied Sciences*, vol. 14, no. 2, p. 519, 2024.

[23] R. Boyd and P. J. Richerson, *Culture and the evolutionary process*. University of Chicago press, 1988.

[24] M. Subramaniam and N. Venkatraman, "Determinants of transnational new product development capability: Testing the influence of transferring and deploying tacit overseas knowledge," *Strategic management journal*, vol. 22, no. 4, pp. 359-378, 2001.

[25] V. Venkatesh, J. Y. Thong, and X. Xu, "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology," *MIS quarterly*, pp. 157-178, 2012.

[26] P. Kalmbach, R. Kasiske, F. Manske, O. Mickler, W. Pelull, and W. Wobbe-Ohlenburg, "Robots effect on production, work and employment," *Industrial Robot: An International Journal*, vol. 9, no. 1, pp. 42-45, 1982, doi: 10.1108/eb004509.

[27] G. T. Chao and S. W. Kozlowski, "Employee perceptions on the implementation of robotic manufacturing technology," *Journal of Applied Psychology*, vol. 71, no. 1, p. 70, 1986.

[28] H. A. Hunt and T. L. Hunt, *Human resource implications of robotics*. ERIC, 1983.

[29] UNESCO, "Traditional craftsmanship,"

[30] L. Pierantoni, "The heritage value of the craft sector in fast-growing cities," *Sustainable Urban Development and Globalization: New strategies for new challenges—with a focus on the Global South*, pp. 289-297, 2018.

[31] M. Liebl and T. Roy, "Handmade in India: Traditional craft skills in a changing world," *Poor people's knowledge: Promoting intellectual property in developing countries*, pp. 53-74, 2004.

[32] W.-e. Yang, "Packaging design development for Taiwanese souvenirs," Iowa State University, 2018.

[33] P. G. Keen, "Information systems and organizational change," *Communications of the ACM*, vol. 24, no. 1, pp. 24-33, 1981.

[34] M. L. Markus, "Power, politics, and MIS implementation," *Communications of the ACM*, vol. 26, no. 6, pp. 430-444, 1983.

[35] S. Laumer and A. Eckhardt, "Why do people reject technologies: a review of user resistance theories," *Information Systems Theory: Explaining and Predicting Our Digital Society, Vol. 1*, pp. 63-86, 2012.

[36] K. Joshi, "A model of users' perspective on change: the case of information systems technology implementation," *MIS quarterly*, pp. 229-242, 1991.

[37] L. Lapointe and S. Rivard, "A multilevel model of resistance to information technology implementation," *MIS quarterly*, pp. 461-491, 2005.

[38] R. T. Cenfetelli, "Inhibitors and enablers as dual factor concepts in technology usage," *Journal of the Association for Information Systems*, vol. 5, no. 11, p. 16, 2004.

[39] M. J. Martinko, R. W. Zmud, and J. W. Henry, "An attributional explanation of individual resistance to the introduction of information technologies in the workplace," *Behaviour & Information Technology*, vol. 15, no. 5, pp. 313-330, 1996.