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ASSESSING THE FACTORS THAT AFFECT ADOPTION OF SOCIAL RESEARCH NETWORK SITE FOR COLLABORATION BY RESEARCHERS USING MULTI-CRITERIA APPROACH

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ABSTRACT

Collaboration in research continuously gains importance. Recent developments in online collaboration technology, namely social research network sites (SRNS), specifically aim to support research collaboration. SRNS allow researchers to present themselves, to network, to communicate, and to collaborate. Acceptance of this technology by researchers has received little academic attention. Understanding the relationships between a user's intention and the utilization of SRNS is an essential step in engaging the SRNS as an educational tool. Previous research focused on explaining user adoption from technology perceptions such as perceived usefulness, perceived ease of use, interactivity, and relative advantage. However, current research models for technology acceptance can hardly explain the impact on the intention of using SRNS from the perspective of technology fit due to the lack of social constructs. However, users' adoption is determined not only by their perception of the technology but also by the task technology fit. In other words, even though a technology may be perceived as being advanced, if it does not fit users' task requirements, they may not adopt it. This study examines the impact of Performance Expectancy, Effort Expectancy, social influence, facilitating condition, user resistance, individual, technology, task and social characteristics on users' intentions in using SRNS by integrating the unified theory of acceptance and usage of technology (UTAUT), task-technology fit (TTF) model and social capital theory. In addition, we applied the technique for order preference by similarity to ideal solution (TOPSIS) for ranking aforementioned factors. The TOPSIS, one of the multi-criteria decision making methods (MCDM), is developed to solve real-world decision problems that has continued to work satisfactorily across different application areas. Accordingly, we develop a new hierarchy model for TOPSIS using the aforementioned factors to assess their importance on adoption of social research network site for collaboration by researchers.

Keywords: *Assessing, Social Research Network Site (SRNS), Unified Theory of Acceptance and Usage of Technology (UTAUT), Task-Technology Fit (TTF), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)*

1. INTRODUCTION

Social networking sites (SNS) provide services for users to create their own profiles, share information, and interact with one another over the Internet. The rapid growth of SNS has significantly changed our daily lives and impacted our social interactions. Successful SNS such as Facebook, MySpace, LinkedIn, and Twitter could attract millions of users in a few years. This phenomenon has drawn much attention in the study of SNS for both industry and academia. SNS can be used for business and education settings [1]. Recent developments in online collaboration technology, namely social research network sites (SRNS), specifically aim to support research collaboration. Using SRNS, researchers can collaborate more effectively and efficiently by presenting themselves with their academic profile beyond the boundaries of their institutions, by networking and communicating, by staying updated on current trends, and by jointly working on publication projects – from shared literature management to actual writing [2]. Latest usage statistics of the two leading social research network sites Mendeley and ResearchGate indicate that researchers adopt and use this online collaboration technology specifically designed for their work context. By July 2011, one million researchers had subscribed to each of the two SRNS, representing a significant share of the

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target group of six million full-time researchers worldwide [3].

For social network sites, attempts to understand users' motives to accept and adopt online technologies have so far concentrated on hedonic technologies like Facebook [4]. Acceptance and adoption of the novel online collaboration technology by researchers have not yet received academic attention, a void this research seeks to address.

UTAUT [5] attempts to unify previously identified antecedents of technology acceptance. The model explains how Performance Expectancy and Effort Expectancy (behavioral beliefs), Social Influence (normative beliefs), and Facilitating Conditions (control beliefs) affect Intention to Use.

However, simply focusing on user perceptions of the technology may be not enough. The task technology fit (TTF) model argues that individuals will adopt a technology based on the fit between the technology characteristics and task requirements [6]. It is possible that, although users perceive a technology as being advanced, they do not adopt it if they think this technology is unfit with their tasks and cannot improve their performance [7]. In other words, these users may be utilitarian, and their adoption is no only determined by their perception and attitudes toward the technology but also by a good task technology fit.

The task-technology fit (TTF) model is a widely used theoretical model for evaluating how information technology leads to performance and usage impacts. For an information system to positively affect technology utilization, the technology must fit the task it supports to have a performance impact. Since its initial publication, the TTF model has been applied to various information systems [8]-[13].

However, the information systems in previous studies all lacked social features. Therefore, little is known about using the TTF model to evaluate those information systems with social features, such as social networking sites. To date, the impact on the intention of using SRNS from the perspective of technology fit is not completely clear.

So far, there is insufficient research on the study of SRNS acceptance based on the application of to integrate of UTAUT and TTF model. When the TTF model applies to SRNS, the model may not be well suited as the TTF model itself does not address the social construct. To handle this, we extended the TTF model by combining it with a social construct adopted from social capital theory to conduct our study.

The rest of this paper is organized as follows: Section 2 gives a brief overview on the related work Section 3 describes the theoretical background of our study. Section 4 explains the initial model of research. Section 5 and 6 explain the TOPSIS method and result of TOPSIS. Reaches conclusions is finally given in Section 7.

2. RELATED WORK

Technology adoption is one of the most mature streams in information systems (IS) research. For our research, we build on studies exploring acceptance and use of collaboration technology [14] and attempts to apply UTAUT [5] to online technologies like microblogging or social networking [15]-[16].

In the context of collaboration technology, Brown et al. [14] identify a need for a measurement model given that "adoption of collaboration technologies is not progressing as fast or as broadly as expected" [14]. Combining UTAUT with theories from collaboration research, they find performance expectancy and effort expectancy to be mediated by technology characteristics as well as by individual and group characteristics (e.g. computer self-efficacy). Additionally, they integrate task characteristics which moderate the relationship between technology characteristics and performance expectancy. The authors find that a set of situational variables, i.e. influence of peers and superiors, effect social influence while facilitating conditions are mediated by another set of situational variables (influence of the environment). Concerning acceptance and adoption of online technologies, Niehaves and Plattfaut [17] study the effect of age concerning acceptance and use of the internet and confirm constructs of UTAUT. Their study encompasses also the moderators education and gender. McElroy et al. [18] study the influence of personality and cognitive style on the use of online technologies, finding strong evidence for personality to explain internet use variance. In the more focused area of (hedonic) online technologies, Facebook as the leader in the market of social network sites has been given significant attention [19]. Koroleva et al. [20] explore information overload on Facebook, Thambusamy et al. [21] find that enjoyment is more important to Facebook users than privacy concerns, and Krasnova et al. [4] examine network constructing behavior. Integrating UTAUT constructs, Theotokis and Doukidis [22]

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developed and tested a use-diffusion model for online technologies. From the results of their survey among Facebook users, they stress the importance of the social aspect for adoption and use. Building on TAM [23], Church and Salam [9], established a research model of satiation and variety-seeking behavior in Facebook. They analyze feelings of consumptional and relational satiation as antecedents of an individual's intention to engage in a variety-seeking behavior.

To present a model of collaboration technology use, Dennis et al. [24] integrated the technology acceptance model (TAM) with constructs from collaboration technology research. Particularly, using collaboration technology, constructs in four sets of characteristics " individual and group, task, technology and situational "drawn from different media choice theories are offered as determinants of the TAM constructs of perceived ease of use, perceived usefulness, , and attitude toward. Peng Lu et al. [1] examined and compares the impact of task, social, and technology characteristics on users' intentions in using SNS by integrating the task-technology fit model and social capital theory. The results reveal that the social technology fit has a dominant impact over the task technology fit on users' intentions to employ SNS. In the particular field of online collaboration technology for researchers, Soeldner et al. [25] use semi-structured interviews with members of virtual research teams to identify their requirements for an online collaboration technology. The taxonomy of social research network sites presented by Bullinger et al. [2] is established on the basis of case studies and in-depth interviews. Building on TAM [23], Kalb et al. [15] investigate knowledge sharing by international researchers on a (hedonic) social network site. Richter [26] differentiates the support of Social Capital for virtual teams in enterprise and academic context by reporting on two case studies.

According to the prior study about adoption of social research network sites, Bullinger et al. [3] proposed the model based on the Unified Theory of Acceptance and Use of Technology and its recent extension for collaboration technology. Her study presented a design of a theory-based research model to investigate acceptance of online collaboration technology by researchers. She integrated User Resistance to UTAUT model. Additionally, three constructs are identified as antecedents of Performance Expectancy (communication benefits and noise) and Effort Expectancy (privacy concerns). Table 1 describes previous research on SNS adoption in the past three years. As Table1 Shows few studies focusing on SNS adoption in the researchers' context especially social research network sites.

3. THEORETICAL BACKGROUND

For studying technology acceptance and utilization, the technology acceptance model and the task-technology fit model are two of the most frequently employed models. The technology acceptance model (TAM) is widely used for explaining and predicting technology acceptance [23]. Although it has become a highly cited model for the past two decades, some researchers regarded its theoretical accuracy of the TAM with skepticisms. Bagozzi [27] presented an insightful paper for the analysis and critique of TAM and pointed out some limitations, such as its over-simplified constructs with two critical gaps in the framework. The intention-behavior linkage is uncritically assumed [27]. Hence, the ongoing studies on TAM tend to refine the framework by including other variables and modifying the relationships that it initially formulated as an extension to overcome its limitations.

Venkatesh et al. [5] have proposed UTAUT as an extension to TAM. They found that usage of an information Technology and user adoption are affected by four factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. Integrating following eight theories built UTAUT: the PC utilization model, the theory of reasoned action (TRA), TPB, TAM, the motivational model, the social cognitive theory (SCT), the innovation diffusion theory (IDT) and the integrated model of planned behavior and technology acceptance. However, UTAUT has not been as broadly used as TAM, recently researchers tend to apply it to user acceptance of technologies [28]-[30]. According to TTF, a complex task will decrease the task technology fit [6][31]. In other words, technologies will scarcely meet task requirement, if tasks become more problematic [8]-[32]-[7]. Users' adoption intention will decrease by poor task technology [10][33]. Shang et al. [34] said that users' usage of blogs affected by the relations between technology and task characteristics. Dishaw and Strong [8] recognized that task technology fit has effect on users' utilization of information technology. As the TTF model does not address social factors, this may limit its predictive ability for social networking technology. The limitation can be overcome by extending it with social capital theory.

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Table 1: Related work on Social Network Site Adoption

Author(s) / year	Context	Theory Used
Saeed et al.[35]	e-commerce unit in an Australian higher education	Technology Acceptance Model (TAM)
Leng et al.[36]	University students	TAM, Theory of Planned Behavior (TPB) And Intrinsic Motivation
Zeng et al.[37]	Renren users Renren is one of the most famous social networking sites in China	TAM & Uses and Gratification Theory
Mustaffa et al.[38]	Young people in the age group between 15 and 25 years old in Klang Valley in Malaysia.	Diffusion of Innovation Theory (DOI)
Bullinger et al.[3]	Researchers	UTAUT
Nasri [39]	University students in Tunisia	TAM & Theory of Reasoned Action (TRA)
El-Haddadeh et al.[40]	Facebook and Renren users	TAM
Chan et al.[41]	SME firms in three industries were conducted (manufacturing, retail/wholesale, agriculture)	Technological-Organizational-Environmental(TOE), Inter organizational Relationships(IOR) & UTAUT
Ernst et al.[42]	University students	TAM
Arthur[43]	Selected private Universities	Unified Theory of Acceptance and Use of Technology (UTAUT)
Sabir et al.[44]	University students in Pakistan	TAM and (TRA) with an extension of TPB
Glass[45]	Business organization	TAM
Pai et al.[46]	Facebook users in Taiwan	Uses And Gratifications (U&G) theory
Lu et al.[1]	Facebook users	Task Technology Fit (TTF) & Social capital theory

The concept of social capital draws insights from sociology and economics. There has been increasing interest in the study of social capital in the past decade, evidenced by its application to various areas [47]-[49] [11] [50]. When social capital comes to the study of SNS, attention was put on how SNS could be employed to build and maintain it [51]. Okoli and Oh [11] investigated the impact of social capital in users' social networks on their recognition based performance. Wang and Chiang [52] examined the continuance intention of websites by adopting the perspective of social interactions in online auctions. Their findings indicated interaction within a social context can influence both social capital and continuance intention to use. The relationship between the use of SNS and an individual's social capital has been identified in previous research [48]. Positive relationships between intensive use of Facebook and students' life satisfaction, social trust, civic engagement, and political participation were revealed [53].

Social capital contains various entities by its function, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors [47]. It is multi-dimensional, and it includes various aspects of social context [54]. Nahapiet and Ghoshal [55] described different aspects of social contexts with three distinct dimensions: the structural dimension, the relational dimension, and the cognitive dimension. Although social capital can be considered in terms of the three dimensions, many of their features are highly interrelated. The structural dimension concerns the properties of the social system and of the network of relations as a whole. It refers to the overall pattern of connections between actors, who you reach and how you reach them. Relational dimension focuses on the particular relations people have, such as respect and friendship, that influence their behavior. It refers to those assets created through relationships. Cognitive dimension refers to those resources providing shared representations, interpretations, and systems of meaning among parties. It represents an important set of assets not yet discussed in the

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mainstream literature on social capital [55]. SNS provides people with the functions of interacting with each other, creating and maintaining relationships. For our research purposes, social capital is defined as the resources that can be accessed through the relationships among people over social networks, and then be utilized to facilitate an individual's tasks.

4. DEVELOPING INITIAL MODEL

According to Table 1, most previous studies have used the TAM theory, but according the weakness of TAM,as discussed earlier, UTAUT is one of the important extensions of TAM has used for this research. The based of our model built on Bullinger [3], because her model especially based on SRNS. But Zhou [12] said that users' adoption is determined not only by their perception of the technology but also by the task technology fit. In other words, even though a technology may be perceived as being advanced, if it does not fit users' task requirements, they may not adopt it. By integrating the task technology fit (TTF) model and the unified theory of acceptance and usage of technology (UTAUT), he tried to explain user adoption. According to Bagozzi [27] that said the limitations of TAM, such as over-simplified constructs and two critical linkage gaps with the framework. In line with the thought of Bagozzi, it is unreasonable to expect that a simple model would explain behavior fully across a wide range of technologies and adoption situations. The application of the TTF model to complex contexts, such as social networking sites, can cause the same situation for its simple construct framework. Lately, in order to explain user adoption, TTF has been used. For instance, adoption of emerging Internet services such as blogs [34]. Empirical study shows that users' evaluation of blogs influenced by interaction between technology and task characteristics affects [34]. Until now, research on the study of SNS acceptance based on the application of the TTF and UTAUT model is not enough.

Lu & Yang [1] mention that Understanding the relationships between a user's intention and the utilization of SNS is an essential step in engaging the SNS as a marketing or educational tool. However, current research models for technology acceptance can hardly explain the impact on the intention of using SNS from the perspective of technology fit due to the lack of social constructs. This study try to extant research on SRNS user adoption focuses on user perception toward technology and rarely consider the effect of the task technology fit and social capital. To handle this, we extended the UTAUT and TTF model by combining it with a social construct adopted from social capital theory to conduct our study[12] [3] [24] [1]. Therefore, in any effort to conduct study into matter of social network sites adoption, these constructs are imperative to add into the UTAUT-TTF-Social Capital model.

Consequently, this research suggest UTAUT model that combine related theories namely TTF and social capital in order to gain more insights into the adoption of social research network sites based collaboration.

Fig.1 depicts the proposed research model, which extends the TTF model by introducing the constructs of intention to use and social characteristics by integrating them with UTAUT. This model is employed to explore the impact on the intention to use SRNS. The construct definitions and theoretical bases are listed in Table 2.

5. TOPSIS METHOD

Recently, MCDA (Multiple Criteria Decision Analysis)/MCDM (Multi-Criteria Decision Making) has been an active research for solving real-world decision problems [60]-[62]. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) developed by Yoon [63] as presented in his thesis titled "Systems Selection by Multiple Attribute Decision Making" and echoed by Hwang [64], is one the major techniques in dealing with multiple criteria decision making (MCDM) problems.

TOPSIS makes full use of attribute information, provides a cardinal ranking of alternatives, and does not require attribute preferences to be independent. To apply this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units.

The procedure of the TOPSIS method consists of the following steps Hwang [64]:

Step 1: Construct normalized decision matrix:

$$n_{ij} = r_{ij} \Big/ \sqrt{\sum_i (r_{ij})^2} \quad for\ i = 1,\ldots,n\ ;\ j = 1,\ldots,m \qquad (1)$$

where r_{ij} and n_{ij} are original and normalized score of decision matrix respectively with n alternatives and m indicators.

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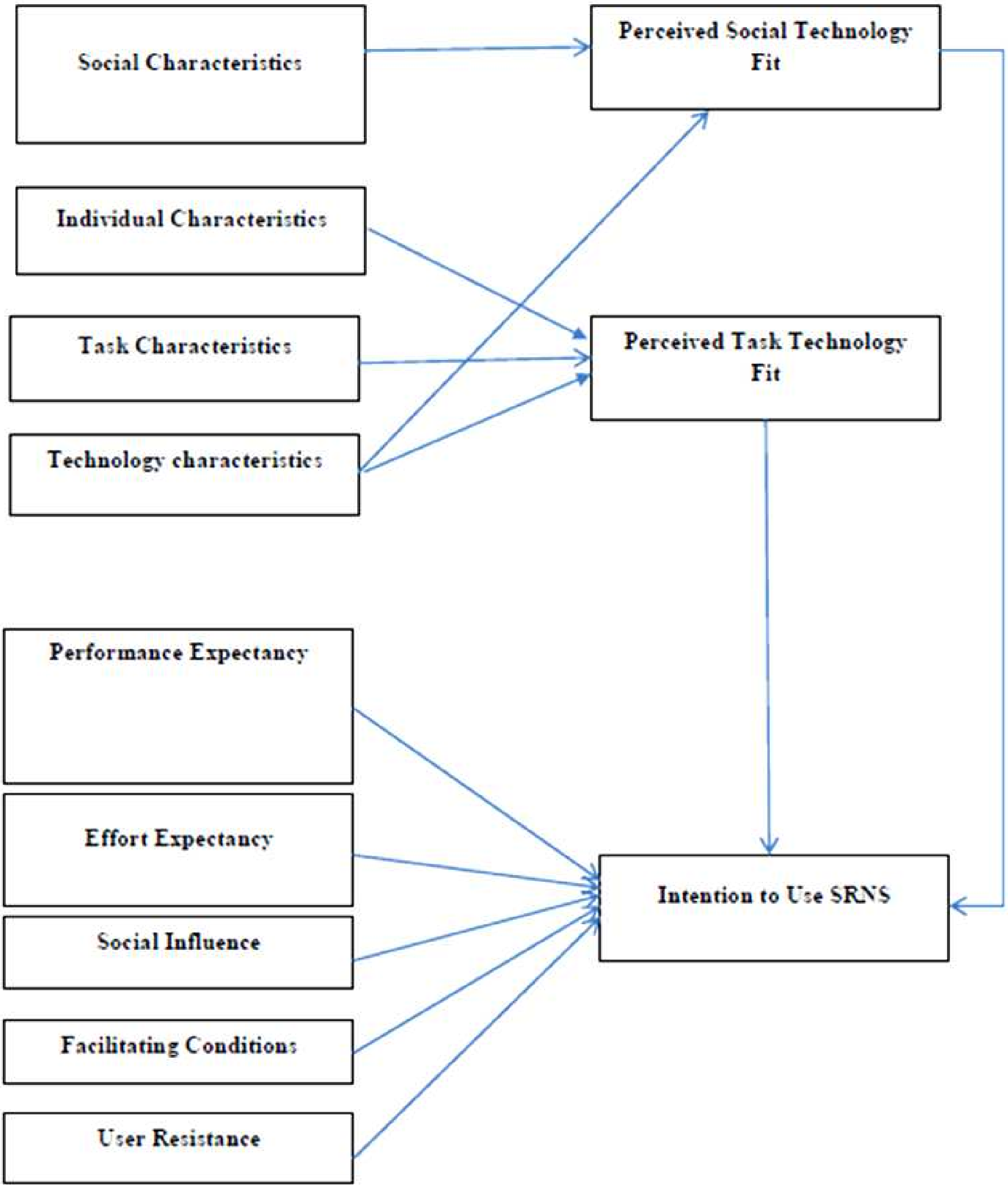

Figure 1: Proposed model

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Table 2: Construct Definitions And Theoretical Bases

Constructs	Definition	Theoretical bases
Technology characteristics	The functions provided by social networking sites	Kietzmann et al. [56]
Task characteristics	Users' needs for work or coursework	Simon [57]
Individual Characteristics	potentially to the successful use of collaboration technology	Dennis [58]
Social characteristics	Users' needs for social demands	Nahapiet and Ghoshal [55]
Task-technology fit	The degree to which a technology (SRNS) assists users in performing their work or coursework	Goodhue and Thompson [6]
Social-technology fit	The degree to which a technology (SRNS) is fit for users' social needs	Lu & Yang[1]
Performance Expectancy	Degree to which an individual believes that using the system will help him or her to attain gains in job performance	Venkatesh [5]
Effort Expectancy	As the degree of ease associated with the use of the system	Venkatesh [5]
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system	Venkatesh [5]
Facilitating Conditions	Refers to the extent to which various situational factors enable adoptionand use of technology	Venkatesh [5]
User Resistance	Opposition of a researcher to change associated with a new online collaboration technology implementation	Kim and Kankanhalli [59]
Intention to use	The intention of users to use or continues to use SRNS	Davis [23]

Step 2: Construct the weighted normalized decision matrix:

$$v_{ij} = w_j r_{ij} \quad (2)$$

where w_j is the weight for j criterion.

Step 3: Determine the positive ideal and negative ideal solutions:

$$A^* = \{v_1^*, ..., v_n^*\} \quad \textit{Positive ideal solution} \quad (3)$$

$$\text{where } v_j^* = \{\max(v_{ij}) \; if \; j \in J; \min(v_{ij}) \; if \; j \in J^{'} \quad (4)$$

$$A^{'} = \{v_1^{'}, ..., v_n^{'}\}, \quad \textit{Negative ideal solution} \quad (5)$$

$$\text{where } v^{'} = \{\min(v_{ij}) \; if \; j \in J; \max(v_{ij}) \; if \; j \in J^{'} \quad (6)$$

$$A^* = \{v_1^*, ..., v_n^*\} \quad \textit{Positive ideal solution}$$
$$where \; v_j^* = \{\max(v_{ij}) \; if \; j \in J; \min(v_{ij}) \; if \; j \in J^{'}\}$$
$$A^{'} = \{v_1^{'}, ..., v_n^{'}\}, \quad \textit{Negative ideal solution} \quad (7)$$
$$where \; v^{'} = \{\min(v_{ij}) \; if \; j \in J; \max(v_{ij}) \; if \; j \in J^{'}\}$$

Step 4: Calculate the separation measures for each alternative. The separation from positive ideal alternative is:

$$S_i^* = [\; (v_j^* - v_{ij})^2 \;]^{1/2} \quad i = 1, ..., m \quad (8)$$

Similarly, the separation from the negative ideal alternative is:

$$S_i^{'} = [\; (v_j^{'} - v_{ij})^2 \;]^{1/2} \quad i = 1, ..., m \quad (9)$$

Step 5: Calculate the relative closeness to the ideal solution C^*_i:

$$C_i^* = S_i^{'} / (S_i^* + S_i^{'}), \quad 0 \le C_i^* \le 1 \quad (10)$$

Select the Alternative with C^*_i closest to 1.

5.1 Ascertaining the entropy weight vector

Information entropy is an uncertainty measure in information theory. Using the entropy method, objective weights are calculated.

Objective weights of the objective ratios can be determined by Shannon's entropy concept [65]. In this research, the concept of entropy is applied to determine the criteria weight. According to Ding and Shi [66], entropy is a term in information theory, also known as the average amount of information. The

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criteria weights are calculated by the entropy method. According to the degree of index dispersion, the weight of all indicators is calculated by information entropy.

Entropy method is highly reliable and can be easily adopted in information measurement [67].

Formally, the entropy method begins with a normalization process using the values of matrix $N = \left(n_{ij}\right)_{n \times m}$ (n alternatives and m indicators) by the following specific formulation Hwang (1981):

$$n_{ij} = r_{ij} / \sum_{i=1}^{n} r_{ij} \qquad (11)$$

The following equation calculates entropy measure of every index:

$$E_j = -K \sum_{i=1}^{n} \left[n_{ij} ln(n_{ij}) \right] \ \forall_j = 1, 2, ...m$$
$$K = \frac{1}{ln(n)} \qquad (12)$$

The degree of divergence d_j of the intrinsic information for each criterion C (j= 1, 2, …, n) may be calculated as:

$$d_j = 1 - E_j \qquad (13)$$

The value d_j represents the inherent contrast intensity of c_j. The higher the d_j, the more important the criterion c_j is for the problem. The objective weight for each criterion can be obtained. Accordingly, the normalized weights of indexes may be calculated as:

$$W_j = \frac{d_j}{\sum_{k=1}^{m} d_k} \qquad (14)$$

Since E_j is less than or equal to one, the entropy weights are therefore always positive.

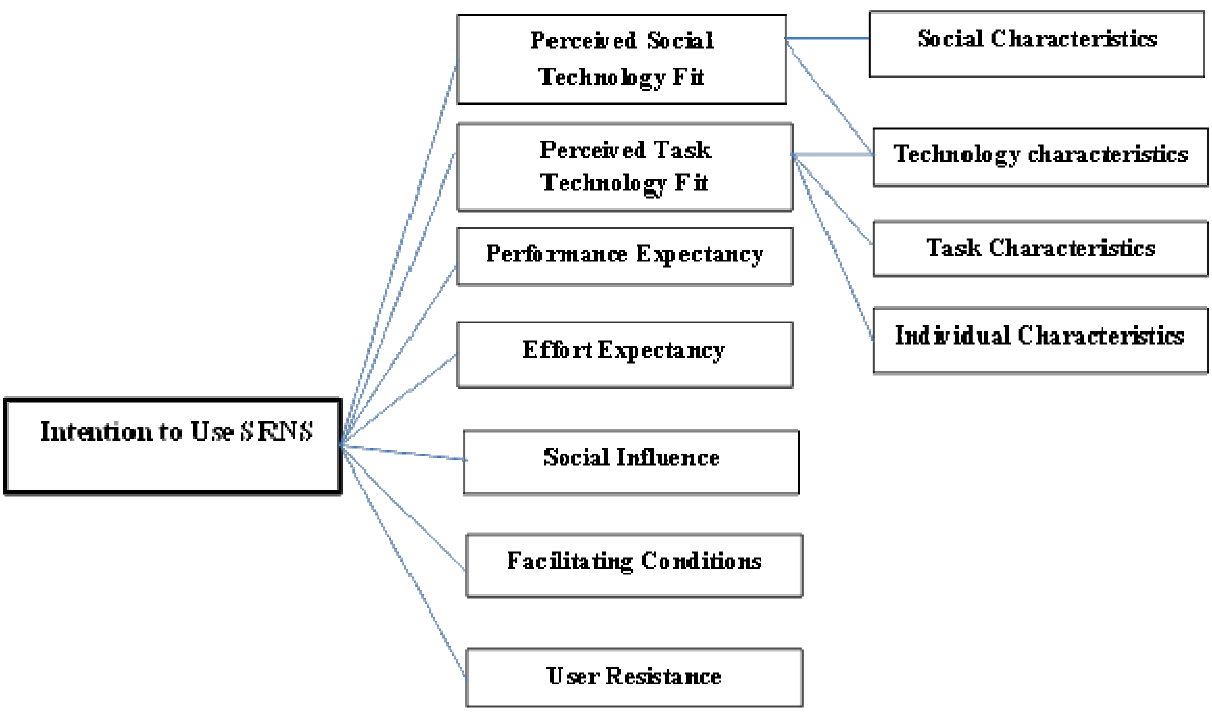

Figure 2: TOPSIS hierarchy structure

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6. RESULTS OF TOPSIS

In this paper TOPSIS was used to rank effective parameters on features in the first tier. Based on the 11 parameters in Fig. 2, the questionnaire was developed to gather data from 100 respondents. Afterwards, TOPSIS was applied for ranking of the participants' responses and were categorized using a 5 point Likert scale that classified them as: not important, extremely important, low important, moderate important and very important. Finally, 11 factors were chosen based on their priority using the TOPSIS method.

Using the entropy method, objective weights were calculated as follows:

$$w_1 = 0.03\ ,\ w_2 = 0.11, w_3 = 0.17, w_4 = 0.3$$
$$and\ \ w_5 = 0.39$$

Therefore matrix W can be defined as:

$$W = \begin{bmatrix} 0.03 & 0 & 0 & 0 & 0 \\ 0 & 0.11 & 0 & 0 & 0 \\ 0 & 0 & 0.17 & 0 & 0 \\ 0 & 0 & 0 & 0.3 & 0 \\ 0 & 0 & 0 & 0 & 0.39 \end{bmatrix}$$

And finally the ranks of all the 11 factors of the intention to use SRNS were calculated as shown in Tables 3 and 4.

Table 3: Final ranking of factors for first level

Factor	Final ranking orders and values by TOPSIS
Perceived Social Technology Fit	0.815 (1)
Perceived Task Technology Fit	0.618 (5)
Performance Expectancy	0.765 (2)
Effort Expectancy	0.743 (3)
Social Influence	0.727 (4)
Facilitating Conditions	0.616 (6)
User Resistance	0.593 (7)

Table 4: Final ranking of factors for second level

Factor	Final ranking orders and values by TOPSIS
Social Characteristics	0.745 (2)
Technology characteristics	0.788 (1)
Task Characteristics	0.642 (4)
Individual Characteristics	0.713 (3)

7. CONCLUSION

This study has theoretical and practical contributions. It tests the usefulness of integrates both UTAUT and TTF framework to explain user adoption. At the same time, it suggests that a framework to identify and understand the way the potential key factors contribute to the adoption of SRNS. Third, by assessing the factors of theoretical model with TOPSIS, importance of each factor has been identified.

This integrated model is able to identify the factors that impact the adoption of SRNS among researchers for collaboration. This study suggested a framework to identify and understand the way the potential key factors contribute to the adoption of SRNS. As the proposed model is conceptual in manner, it needs to be empirically tested for its usefulness and application in the implementation of collaboration, as it is still in the conceptual stage. The model is open to debate and deliberations and further improvements and expansions may be mooted in tandem with inclusions of other suitable variables in the future.

Furthermore, from the multi-criteria perspective, we evaluated the incorporated factors in the developed model and ranked them by TOPSIS method. By TOPSIS the weight of ranking for were calculated as presented in Tables 3 and 4. But the results of applying the TOPSIS as a MCDM tool require a thorough investigation, which is recommended by the authors for future investigations.

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