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# Determinants of choice of semantic web based Software as a Service: An integrative framework in the context of e-procurement and ERP

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ABSTRACT

The ever increasing Internet bandwidth and the fast changing needs of businesses for effectiveness with the partners in the procurement chain and is leading organizations to adopt information systems infrastructures that are cost effective as well as flexible. The question seems to be: what is driving organizations to go in for Software as a Service (SaaS) based e-procurement and ERP, rather than the packaged model of software provisioning? Whereas there have been studies reporting technology, cost, quality, network externalities and process as the main variables in the utility function of the user, but most of the studies have modelled either one or two in the their models. The study is exploratory in nature and tries to identify, classify and rank dimensions affecting SaaS sourcing decisions. In this study, we developed an integrative framework to identify the determinants of choice of SaaS in the specific context of SaaS based e-procurement and ERP. The framework was then analyzed using the extended Analytic Hierarchy Process (AHP) method suggested by Liberatore (1987) and the relative importance and the weights of the criteria identified using data collected on 8 users and 9 service providers of SaaS based e-procurement and ERP. Although the analysis helped in identifying quality and costs as the two most important determinants of choice of SaaS based e-procurement and ERP, but the other criteria such as network externality benefits, technology and process were also found to be significant determinants of choice.



## 1. Introduction

The ever increasing Internet bandwidth and the fast changing needs of businesses for effectiveness with the partners in the procurement chain and is leading organizations to adopt information systems infrastructures that are cost effective as well as flexible [14]. In Software as a Service (SaaS) based e-procurement and ERP business model of software provisioning, the consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings [30]. SaaS takes advantage of the thin client technology and provisions SaaS based upon the Internet and semantic technologies, where all the software and the data reside on the server and the client side needs an interface application like the browser, as against the packaged software provisioning model where the software is sold as a product. Some of the successful examples of SaaS are SalesForce.com and NetSuite. Although there are pure SaaS vendors, i.e. only provide SaaS, such as SalesForce and NetSuite, but some traditional packaged vendors such as Oracle, Microsoft, SAP and IBM are fast adopting hybrid SaaS i.e. Provide SaaS as well as packaged software to accommodate customer expectations and preferences [2]. According to the Sand Hill Group and McKinsey & Company report [13], The SME organizations are the biggest adopters of the SaaS based e-procurement and ERP model.

The question seems to be: what is driving organizations to go in for SaaS based e-procurement and ERP rather than the packaged model of software provisioning? Some of the major drawbacks of packaged model of software provisioning are the high upfront and implementation costs [9,15,16,36,42]. Also the software is difficult and costly to maintain and upgrade [14,35]. Long lead times, high costs, complex planning sessions and deployment delays inherent to packaged, make SaaS based e-procurement and ERP a viable may to overcome these challenges and provide easy-to-use and cost-effective tools for system integration.

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This paper contributes to the literature of SaaS and IS outsourcing. Research in IS outsourcing/ASP/SaaS although has talked about the motivations for going in for IS outsourcing/ASP/SaaS but has just listed the determinants either on the basis of a qualitative study or through a survey of literature but none of the studies have ranked the criteria for SaaS sourcing decisions. This study helps to determine: What dimensions organizations use when evaluating SaaS sourcing? How many dimensions they may use in a SaaS sourcing situation? The relative importance of each dimension in SaaS sourcing. The study is exploratory in nature and tries to identify, classify and rank dimensions affecting SaaS sourcing decisions. The reasons behind using extended AHP are: firstly, each respondent will not perceive a decision making situation to have the same dimensionality; secondly, the respondents need not attach the same level of importance to a dimension, even if all respondents perceive this dimension; and thirdly, judgments of a stimulus in terms of either dimensions or levels of importance need not remain stable over time and context.

The paper is organized as follows: an introduction is followed by a literature review of the important concepts used in the study. The next section is the theoretical framework which introduces the way in which the sub-criteria were clubbed together into criteria variables. A methodology section clarifies two stages in which the study was conducted. The analysis section introduces the step by step method of the extended AHP analysis and the results. Finally the study ends with a section on discussion and future directions for the study.

## 2. Semantic technologies supporting Software as a Service

Software as a Service is its first phase of evolution, also known as the ASP, was just an externally hosted software solution, which was owned and managed by the service provider and customized and subscribed by the client. Such type of software service provisioning increased the transaction costs of software service outsourcing and also built in switching costs for the client [1,36]. A large number of studies report the failure of the traditional ASP model of software provisioning for the same reasons [10,41]. The second wave of SaaS was designed for distributed object-oriented computing system, in which the service was designed manually and every time a new service was required it had to be programmed. The flexibility and scalability provided by such sort of a service is less compared to the semantically transparent software services that are dynamically discovered without prior negotiations between client and service developers in the third phase of evolution. The cost and the quality of the dynamically designed services would be lower and well defined respectively. For commercial Web services, it is increasingly important for service providers to be able to adapt their interfaces to support new products and service options without interrupting or requiring changes to the software that clients use to access those services. An open-source ontology for different kinds of services and products will enable broad-based, automated, service discovery in the same way search engines now make it easy to discover new Web sites [18]. The current study designs the software as service business framework keeping in mind the benefits of semantically based SaaS.

Software as a Service based on semantic technologies has two parts: the (1) service orchestration on a (2) semantic base. SaaS based e-procurement and ERP publish descriptions of service interfaces on the Web using Web Services Description Language (WSDL). These descriptions include information about how to invoke the services using HTTP, SOAP and other protocols. But, WSDL does not allow for automatic service descriptions. The Semantic Web vision lets people publish and share the ontology i.e. a set of conceptual terms labelled by URLs, which can be used in describing other published descriptions. Semantic Web services ascribe meanings to published service descriptions so that software systems can automatically interpret and invoke them [8,18,32,34,38]. The semantic service-based model configures, executes, and disengages one or more services to meet a specific set of requirements instantly and automatically as sown in Fig. 1 [38].

Some of the benefits of flexibility, integration and functionality are only achievable because of the semantic web capabilities of a SaaS based solution. Since a semantic web based SaaS solution is a demand led system as shown in Fig. 1 so understanding the demand side factors leading to adoption of a semantic web based SaaS is important.

## 3. Software as a Service in the context of e-procurement

E-procurement involves the use of the Internet and related technologies to perform purchasing activities, with the most basic form being merely buying products and services over the Internet. Along with its advancement, e-procurement has evolved to mean "automating the whole purchasing process and making order and requisition information available along the entire supply chain" [37]. E-procurement is the linking and integration of inter-organizational business process and systems with the automation of the requisitioning, the approval purchase order management and accounting processes through an Internet-based protocol [32]. Some of the impediments to adoption of e-procurement systems are high initial investment, fast obsolescence, risks involved in applying uncertain technology to core processes, problems integrating with existing systems, lack of common standards for e-commerce software development, lack of suppliers accessible through the organization's e-procurement system, etc. [11,37]. Thus in the study we identify the determinants of choice of semantic web based SaaS framework for e-procurement and ERP,

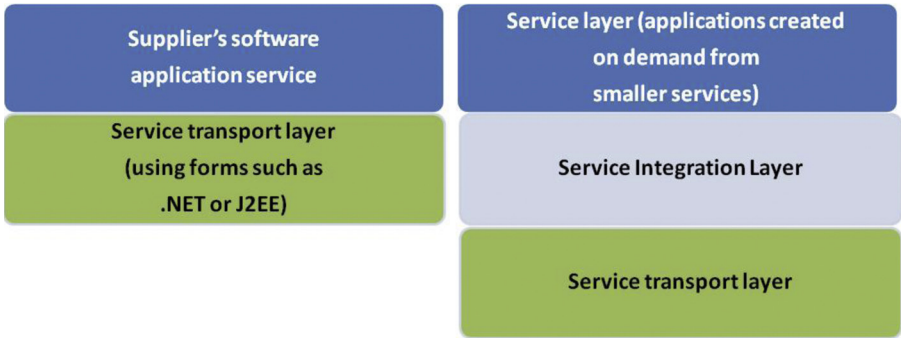


**Fig. 1.** SaaS based e-procurement and ERP models [38]. (a) The supply-led service model provides only a predetermined range of services from a remote server. (b) The proposed demand-led semantic web based service model has a service integration layer inserted above the transport layer.

which provides the benefits of cost, flexibility in service design, accessibility, quality and a common standards based software services and also compute the ranks for the various criteria determining choice of SaaS based e-procurement and ERP.

## 4. Determinants of choice of SaaS

The main advantage of this type of software provisioning is that the organizations are able to avoid upfront procurement costs and operating costs involved in maintaining the hardware and software resources and also manpower costs for expertise, thereby converting capital expenses to operating expenses and redirecting capital to core business investment [36]. The economic make-or-buy decision is based on the comparison between the production costs of internal operations versus transaction costs arising out of IS outsourcing [1,3,5–7,20,25,26,29,33,35,36,40]. The SaaS model is especially suitable to enterprise and SME customers, who can choose to get out of the traditional process of buying a software license, paying for the maintenance contracts and then going through time-consuming and expensive upgrades [9,14,16,39].

Table 1 shows the determinants of IS outsourcing/ASP/SaaS in the various studies in IS literature but none of the studies have ranked the determinants of choice of SaaS [31].

After an extensive literature review, the determinants listed in the various studies conducted in ISO/ASP/SaaS, listed in Table 1, were used to create a conceptual integrative framework as shown in Fig. 2. The determinants were clubbed together based on similarity and relevant theories and finally SaaS based e-procurement and ERP choice was found to be dependent upon five criteria: Technology, Process, Cost, Quality of software, Network externalities.

The factor technology includes variables: accessibility, flexibility and scalability.
The factor process includes variables: co-ordination, integration, standardization.
The factor cost considers: upfront cost, implementation cost, and transaction/co-ordination cost.
The factor quality of software includes the variables: reliability, usability and functionality.
The factor network externalities consider variables: bundling, the network size and co-ordination externalities.

Some of the criteria have more sub-criteria, but in an AHP analysis the data collection and calculations become complicated if there are more sub-criteria, so the number of sub-criteria was generally restricted to three per criteria. For example, quality has more sub-criteria like sustainability, adaptability, extensibility, etc. but only three were used for the study. The three used for the study were those that were listed in the literature review on ISO/ASP/SaaS.

The integrative framework, shown in Fig. 2 depicts that the vendor decision is based on consumer decision. Both the vendor and the customer make the decision simultaneously.

## 5. Methodology

### 5.1. Stage1

In the study, the researcher's design an integrative framework for evaluation of SaaS. Since the concept of SaaS is a recent concept in the application outsourcing domain, so, to the best of our knowledge there are few works in the area of SaaS, but they do not completely address our intention to find out a comprehensive list of criteria which determine the choice of SaaS based e-procurement and ERP. So, the literature search was conducted using other keywords like Application Service Providers, IS Outsourcing, subscription licensing, Software on Demand and Service-Oriented Computing, in addition to SaaS to define the framework. The literature search was done on research databases EBSCO, PROQUEST, and JSTOR, ScienceDirect, SpringerLink, ACM, IEEE CSDL and Google Scholar. From out of 200 research papers that we selected on the basis of keywords, only around 60 we could use in defining our framework on criteria determining choice of SaaS based e-procurement and ERP, and which are part of the reference section. Out of the 60, there were approximately only 18–20% empirical studies, around 10% were conceptual mathematical papers with an economics focus, around 40% were defining the business models, literature reviews and frameworks for ASP, SaaS based e-procurement and ERP and IS outsourcing and the rest were talking only of technology issues. Most of the studies talked about either two or three criteria and there was no integrative framework for evaluation of SaaS based e-procurement and ERP model of software provisioning.

### 5.2. Stage 2

After the integrative framework, as shown in Fig. 2 (left-hand side) was developed, it was analyzed by creating a questionnaire through which inputs from 8 clients and 9 service providers of SaaS based e-procurement and ERP were asked to rank the importance of the criteria and sub-criteria while making a decision to go in for SaaS based e-procurement and ERP or packaged. The respondents were the IT heads of the organizations which had implemented SaaS based e-procurement and ERP (clients of SaaS based e-procurement and ERP) and the IT heads or CIO's of Organizations which were providing SaaS based e-procurement and ERP solutions (Experts in SaaS based e-procurement and ERP). Based on the rankings given by the users and the experts, the criteria and the sub-criteria were weighted using the Liberatore (1987) [27] technique. The details of the technique are given in the empirical results section.

## 6. Analysis and results

The demand side of the above integrative framework was analyzed based on data from 8 clients and 9 service providers of SaaS based e-procurement and ERP. The analysis followed the five steps as shown in Fig. 3.

Weighting criteria priority on the 2nd level is processed through rating scale technique as suggested by [27] as shown in Table 2. The major advantage of this method as against Analytic Hierarchy Process (AHP) is to overcome the number of comparisons when the number of alternatives is large i.e. $n\ (n-1)/2$. In our case it would be $n = 24$, including all criteria and sub-criteria. It is also very difficult to make pair wise comparisons among the sub-criteria, because of the number of comparisons required. Thus, the use of the rating scale system can allow the evaluator to assign a rating to criteria without making direct comparisons and thus avoiding time-consuming pair wise comparisons judgements.

Liberatore (1987) [27] method was used to calculate weights for ranks 1–9 as shown in Table 3,instead of a five point scale as given by Liberatore (1987) [27] as shown in Table 2.

Then the weights for the ranks were applied to the rankings given by the experts to the various criteria and sub-criteria as shown in Fig. 4 .The final weights for the criteria and the local and global weights for the sub-criteria are given in Table 3.

## 7. Discussion

The analysis of the results shown in Fig. 4 show that the weighting order of the determinants of SaaS based e-procurement and ERP is: quality (LW: .2), cost (LW: .175), technology (LW: .165),

**Table 1**
Motivations for IS outsourcing/ASP/SaaS theoretical framework.

| Literature | Determinants of IS outsourcing/ASP/SaaS | Theoretical framework |
|---|---|---|
| [20] | • Cost savings<br>• Cash infusion<br>• Faster applications development<br>• Improved service and quality<br>• Access to IT expertise and competence<br>• Access to new technologies<br>• Flexibility in managing IT resources<br>• Elimination of a troublesome function | • Transaction cost theory<br>• Risk return theory |
| [15] | • Focus on core activities,<br>• Service quality improvements, and<br>• Cost savings | |
| [4] | • Cost advantages<br>• Strategic flexibility<br>• Focus on core competencies<br>• Access to specialized resources<br>• Quality improvements (QI) | • Theory of Reasoned Action |
| [5] | • Application specificity<br>• Adoption uncertainty<br>• Attitude towards adoption<br>• Subjective norm<br>• Strategic value<br>• Application inimitability | • Transaction Cost Theory<br>• Resource Based Theory<br>• Theory of Planned Behaviour |
| [22] | • Cost reduction<br>• Focus on core capabilities<br>• Access to expertise/skills<br>• Improve business/process performance<br>• Technical reasons<br>• Flexibility<br>• Political reasons<br>• change catalyst<br>• Commercial exploitation<br>• Scalability<br>• Access to global markets<br>• Alignment of IS and business strategy<br>• Cost predictability<br>• Headcount reduction<br>• Rapid delivery<br>• Innovation | • Literature review |
| [17] | • Cost<br>• Access to complimentary resources and skills (performance motivation)<br>• Size of the IT department<br>• Decision making authority is non-IT<br>• IT intensity of the sector<br>Institutional environment | • Hypothesis testing |
| [12] | • Systemic factors<br>• Motivational factors<br>Contextual factors | • Systems theory<br>• Resource based theory |
| [19] | • Key criteria addressing ASP benefits or opportunities are potential cost advantages and access to qualified IT staff and support | |
| [28] | • Business costs<br>• IT costs<br>• IT performance<br>Firm performance | • Transaction cost theory |
| [24] | • Reduce IT costs<br>• Improve technology or technical service<br>• Jump on the bandwagon; outsourcing perceived as a viable, irreversible trend within their industry<br>• Focus business on core competencies; IT perceived as non-core<br>• Restructure IT budgets from capital budgets to fixed operating budgets<br>• Focus internal IT staff on critical IT activities, such as development, while outsourcing more stable and predictable IT activities, such as data centre operations.<br>• Eliminate an IT burden; assume a service provider will solve problematic IT function(s)<br>• Downsizing-the entire company is pressured to reduce headcount<br>Improve cost controls | • Case Study method to study determinants of IS outsourcing. |

process (LW: .149), resources (LW: .113) and network effects (LW: .112). The results imply that, for the decision maker, quality (LW: .2) and cost (LW: .175) criteria have the highest weight in the decision regarding whether to go in for SaaS based e-procurement and ERP or packaged. So, the decision to buy or rent software is dependent upon the quality of service and the cost, which corroborates with the theoretical models created by Choudhary (2007) and Fan et al. (2009) [9,16]. Although network effects is last in the weighting order but the weight is not small enough to be ignored. The impact of network effects on the pricing decisions for SaaS based e-procurement and ERP have been theoretically modelled by Zhang and Seidmann (2010) [42]. The results in the study show that the network externality effects have an impact on the decision of the user to go in for packaged software or SaaS based e-procurement and ERP. The Ang et al. (1998) [1] shows that the existing resources of the user have an impact on the

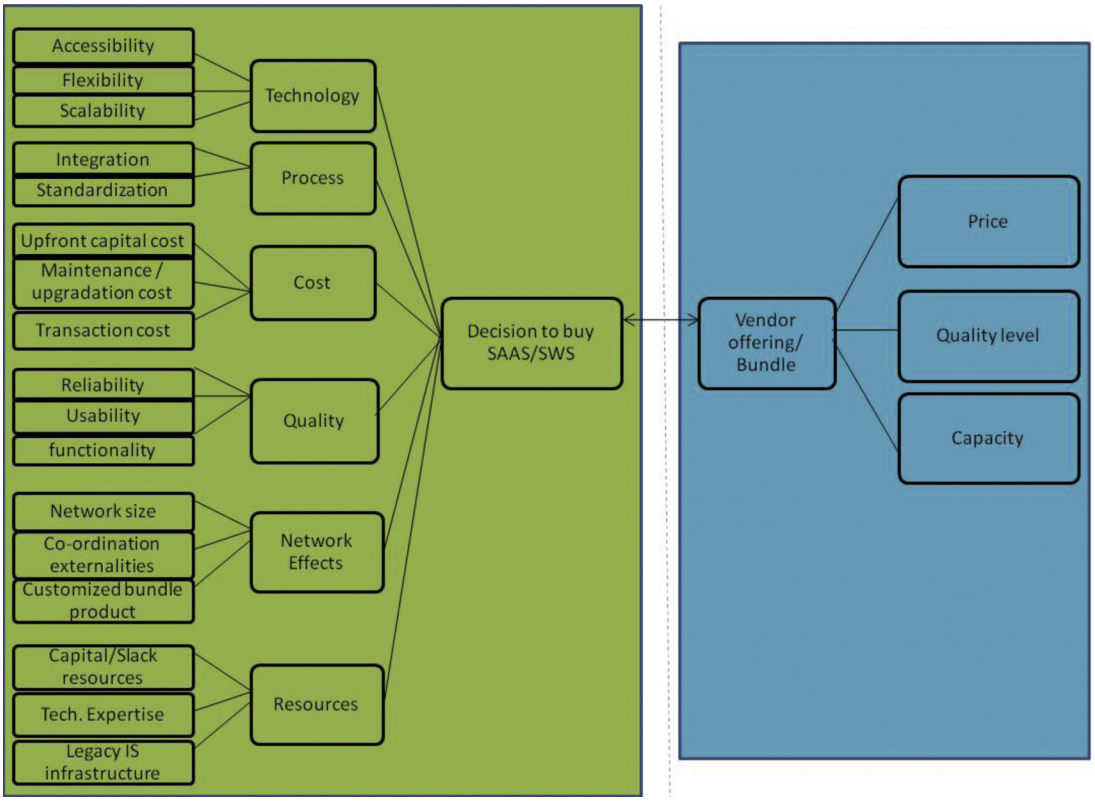


**Fig. 2.** Integrative framework for SaaS based e-procurement and ERP.

outsourcing performance. The study shows that the existing resources of the user organization also have an impact on their decision to use packaged software or go in for SaaS based e-procurement and ERP.

Amongst the sub-criteria CAPEX (LW: .269, GW: .047) and OPEX (LW: .26 GW: .04) have the highest global weight in decision making. This seems to imply that upfront costs and implementation costs, which constitute the CAPEX and the maintenance and upgrade costs, which constitute the OPEX, are the most important criteria when deciding to go in for SaaS based e-procurement and ERP. So the users decision to buy or rent software is influenced by the upfront, implementation, maintenance and upgrade costs, which corroborates with the results of many studies [1,21,23,28]. The next in importance are the criteria flexibility (LW: .165, GW: .027), scalability (LW: .177, GW: .029), standardization (LW: .177, GW: .026), reliability (LW: .136, GW: .027), functionality (LW: .129, GW: .026), and transaction cost (LW: .115, GW: .02). This means that the need for a flexible and scalable information systems architecture provided by SaaS based e-procurement and ERP model of software provisioning makes organizations choose SaaS based e-procurement and ERP. Since flexibility, scalability and standardization are important second level criteria, so a semantic web based SaaS based e-procurement and ERP would be better choice than a managed services/hosting model of SaaS based

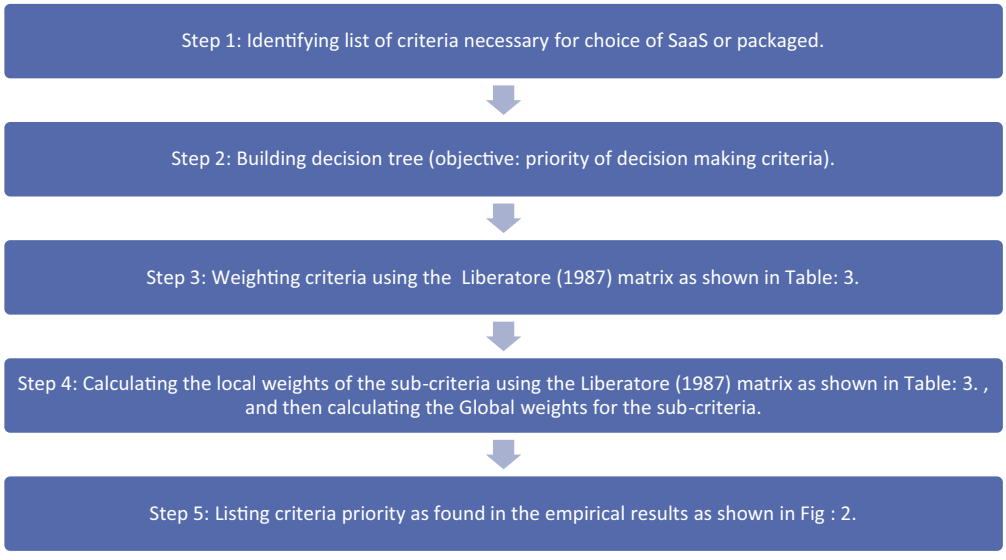


**Fig. 3.** Flow chart to conduct the extended Analytic Hierarchy Process (AHP) (Libertore, 1987).

**Table 2**
Liberatore (1987) [27] for pair wise comparison judgement matrix for five point rating scale (1-most important, 5-least important).

| | O | G | A | F | P | Local priority weights |
|---|---|---|---|---|---|---|
| O | 1 | 3 | 5 | 7 | 9 | 0.513 |
| G | 1/3 | 1 | 3 | 5 | 7 | 0.261 |
| A | 1/5 | 1/3 | 1 | 3 | 5 | 0.129 |
| F | 1/7 | 1/5 | 1/3 | 1 | 3 | 0.063 |
| P | 1/9 | 1/7 | 1/5 | 1/3 | 1 | 0.034 |

**Table 3**
The pair wise comparison judgement matrix for nine point rating scale (1-least important, 9-most important) based on [27] method.

| Rank order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Local priority weights |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 0.019 |
| 2 | 1/2 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 0.026 |
| 3 | 1/3 | 1/2 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 0.037 |
| 4 | 1/4 | 1/3 | 1/2 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 0.053 |
| 5 | 1/5 | 1/4 | 1/3 | 1/2 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 0.076 |
| 6 | 1/6 | 1/5 | 1/4 | 1/3 | 1/2 | 1.00 | 2.00 | 3.00 | 4.00 | 0.109 |
| 7 | 1/7 | 1/6 | 1/5 | 1/4 | 1/3 | 1/2 | 1.00 | 2.00 | 3.00 | 0.154 |
| 8 | 1/8 | 1/7 | 1/6 | 1/5 | 1/4 | 1/3 | 1/2 | 1.00 | 2.00 | 0.218 |
| 9 | 1/9 | 1/8 | 1/7 | 1/6 | 1/5 | 1/4 | 1/3 | 1/2 | 1.00 | 0.307 |

e-procurement and ERP which is not flexible and the transaction costs are high.

In the context of e-procurement, since interaction with partners is an important determinant of choice of SaaS based e-procurement and ERP, so criteria such as flexibility, standardization, integration and functionality and network size were found to be some of the important second level criteria. Amongst the first level criteria, process factor was a factor of medium importance.

## 8. Limitations

The study takes a positivist quantitative approach. The quantitative approaches fail to account for past experiences, knowledge of the domain, and personal preferences. The interpretive qualitative researches are much more valuable in finding out these behavioural nuances and one of such approach is being taken for a future study.

## 9. Future directions

The study is a first attempt to create an integrative comprehensive framework for SaaS based e-procurement and ERP. The current literature is focussed on IS outsourcing. So there is need for studies to be conducted on how the various criteria identified in this study can change the whole architecture of service provisioning from the packaged to the SaaS based e-procurement and ERP architecture.

The study can be extended to do a proper pair wise AHP analysis or other techniques on data collected from actual decision makers. The study can also be extended to compare whether the determinants of choice vary with the size of the organizations and also the availability of resources and with other variables acting as moderators and mediators does the choice change.

Also companies are still not using SaaS based e-procurement and ERP but SaaS based general applications. So studies need to be conducted to find out whether the determinants of choice are

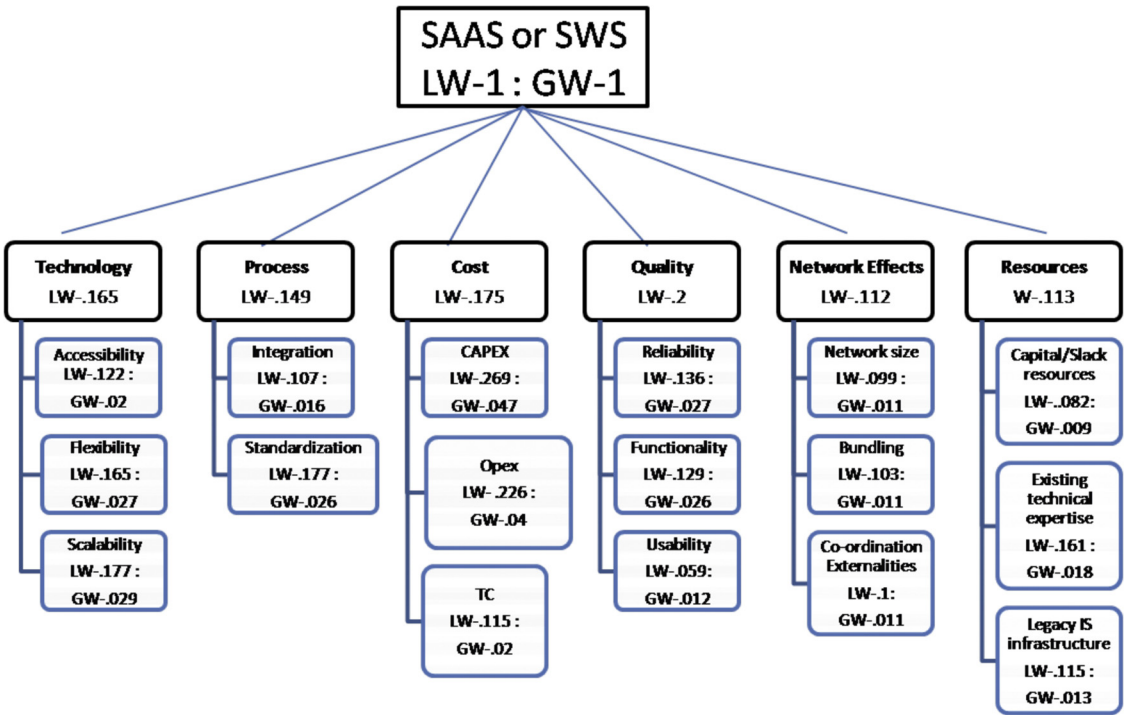


**Fig. 4.** Weights for the criteria and Local (LW) and Global (GW) weights for the sub-criteria.

different if SaaS based e-procurement and ERP is being used for core applications (like e-procurement and ERP, etc.) and general applications (like HR systems, accounting, customer services, etc.).

The rate of adoption of SaaS based e-procurement and ERP is different in the developed and the developing nations like India. The study has major implication for the emerging world countries like India, where the small and medium enterprises do not have resources to implement and use packaged in-house software. So studies could be conducted on what are the criteria which will have an impact on the adoption of SaaS based e-procurement and ERP for the emerging world countries and bring them at the same technological level of maturity as the developed nations of the world.

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